The Island Jersey

A Breeding Plan 2018 - 2028

A Report to the Royal Jersey Agricultural and Horticultural Society

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Summary

Report 1 'Ten years of breeding to international pedigree Jersey bulls', described the pattern and degree of uptake of imported semen in Jersey since 2008. It documented the changes in milk production per cow, and in the animals' conformation and reproductive performance from data supplied by AHDB-Dairy and NBDC. These changes have almost all been favourable, and have fully justified the farmers' request to access the improved strains of the breed around the world.

The Society now wishes to look ahead and consider what further changes are desirable during the next decade. This second report reviews the way genetic understanding and technology have moved forward and been implemented in the world's dairy industries. There have been massive shifts in the structure and organisation of the breeding sector which are still being played out. As in so many parts of agriculture and animal production, the leading roles have rapidly been acquired by the corporate sector. In many ways, breeding is the last activity to make this change, and with their low female reproductive rates and less controlled environments, the cattle and sheep breeding sectors have lagged behind poultry and pigs.

The Island's resources and structures are summarised. These too have changed. Soon there will only be around a dozen professional dairy cow businesses maintained on modernised farms supported by a range of professional services. They all supply milk to the same up-to-date, farmer-owned dairy which produces a range of products for Island consumption while also exporting to a number of wealthy overseas markets.

The breeding goals for this unique population of cows must reflect the raw material needs of the dairy, the desires of Island residents and customers, and the need to improve economic efficiency on the farms. No numerical targets have been set. If Jersey Dairy can continue to build the value of its brand, then the Island farmers will be able to concentrate more on the product quality, health, welfare, and environmental goals rather than always driving production costs down through ever higher yields.

The final section reviews the several ways in which farmers could pursue these many goals. It proposes a programme which closely follows the one which they have successfully developed in the last decade. This favours a continuing reliance on the use of semen from proven bulls offered by the international semen companies. It maintains the coordinating role of the Society while encouraging every farmer to take his/her own decisions about which bulls will sire their replacement heifers.

In addition, three new policies will require decisions and then detailed plans from the Society working with Jersey Dairy, the States, and other players. These are whether, and how quickly, to pursue A2 milk, a naturally polled Island herd, and a more comprehensive health recording and management scheme.

Naturally, any 10-year plan will need to be reviewed at intervals. The arrival of new technology or major market changes may require shifts of emphasis. Annual genetic change is continuous and incremental, but 10 years is not much more than two cow generations.

Key Conclusions

1. Continue importation of semen from international pedigree Jersey bulls in compliance with current Jersey Herd Book rules.
2. Adopt an additional Jersey Herd Book rule to allow for non-qualification of animals that, whilst complying with all other herdbook rules, exhibit characteristics that are not of the 'true type' Jersey breed according to the non-exclusive list in an appendix. This would define the permissible type-colour variations, markings, and perhaps size and weight.
3. Appoint a panel to review available bulls and monitor and record ineligible animals.
4. Develop the health recording element of the existing herd recording programme to full Scandinavian standards in conjunction with all interested parties.
5. Work with Jersey Dairy to devise a programme for the production of A2 milk.
6. Investigate the feasibility of adopting a target for the Island herd to become naturally polled.
7. Arrange for an AHDB-Dairy breeding specialist to conduct a discussion with herd owners on index-based selection for local conditions (perhaps jointly with Guernsey owners).
8. Continue to explore all possible ways of reducing the number of calves disposed of at birth.

Acknowledgements

I am grateful for the opportunity offered to me by the Agricultural General Committee of the Royal Jersey Agricultural and Horticultural Society to participate once again in their planning for the future of the Island's world famous cattle. I have been supported for more than nine months by the Society's two senior staff, James Godfrey and David Hambrook. During my Island visits I enjoyed invaluable discussions with current and past members of Council, and herd visits with breeders including several of the younger ones who hold the future of the Island herd in their hands. I also met with senior officials in the States Office for Economic Development and the management team at Jersey Dairy. I owe particular thanks for the continuous support of David Hambrook. While my name is on the front cover, and I take full responsibility for the proposals, my role has often been to try to absorb his knowledge and then combine it with my own experience with other livestock improvement programmes involving different breeds and species.

I do not expect that the consequences of this report will be as momentous as those which flowed partly from my 2003 recommendations to allow semen imports. Nevertheless, I hope that they may help to ensure the breed continues to flourish in its Island home.

General

1. Aids to Selection

All genetic plans for breed improvement work on the basis that every animal's appearance and performance depend to some degree on the inherited instructions (genes), obtained equally from its two parents, and contained within the nucleus of its cells. The breeder aims to identify animals within the group of candidates which may possess more favourable genes, and allow these to become parents of the next generation in the herd. How can this be done efficiently? This first section briefly reviews the tools available since breeders first organised themselves into a Society in the mid-19th century. The aim is to show how scientific developments have strengthened the hand of everyone engaged in further developing the breed in Jersey.

1.1 Visual Inspection

In Derrick Frigot's recent book 'Pioneers of the Jersey breed' he says that when the RJA&HS held its first show in 1834, the judges reported that the cattle had many defects of conformation. As a result, the preferred type was specified and scales of points were drawn up for bulls and cows, though these tended to emphasise cows that were pleasing to the eye rather than udder development or dairy qualities generally. No doubt these scales of points were soon used informally by breeders when selecting future parents, but after the establishment of the Herd Book (1866) they became mandatory. No calf could be registered unless both its sire and his dam had 'qualified' by scoring sufficient points at official inspections. The original scales were modified during the 19th century to put more emphasis on dairy qualities, but the 1904 version then persisted for over 50 years. The inspections were carried out regularly at various 'depots' around the Island. This system of 'Qualification' was only changed to 'Classification' in 1972 when visits were made twice-yearly to farms.

Similar schemes were evolved in Jersey populations in other countries. In the early 1980s a new system called linear assessment was developed in USA, and has since been adopted widely. These scores are more repeatable between classifiers who (in UK) give points for 17 different type traits, including condition score. Assessments from groups of related traits are also combined to produce two different composite scores; feet and legs, and mammary.

1.2 Production measurements

No doubt a cow's milking ability was always a factor in deciding whether to select a son for breeding, but formal records were not part of the rules governing registration. Production data started being collected from 1893, though only on selected animals brought to a central location for 24 hours, where one day's milk, cream, and butter yields were measured. The Society launched an annual milk recording scheme in 1912 with certificates of merit awarded for superior performance (milk and fat yield). There was a slow take-up initially. By 1962 only some 30% of cows were enrolled (similar to the UK), but after the States took over the service and paid incentives, it reached 92% in 1978. Today all cows are recorded and the milk production data may be supplemented by service dates, pregnancy diagnosis, calving, and such health-related traits as incidents of mastitis, metabolic illness, foot problems, and reasons for culling or death. In future, many more traits may be recorded, often automatically, including liveweight, activity (walking and cudding), and various physiological and milk parameters. The Scandinavian countries pioneered the compulsory collection of such data and have shown how it can be used within the breeding programme.

1.3 From type scores and production records to estimated breeding values

Today's breeder is faced with far more information than was available even 30 years ago. Geneticists, statisticians, and programmers have combined to produce much more useful figures from the initial observations and measurements (even before the advent of genomic technology).

- The initial data on any candidate animal may need to be 'cleaned up' by adjusting for herd, season or parity and then expressed as positive or negative deviations from the average
- Since the interest is in the candidate's potential offspring, then a cow's milk yield deviation needs to be reduced since only a part (say 50%) is heritable. This then gives a simple estimate of her breeding value though this is usually expressed as a Predicted Transmitting Ability (PTA); similarly for other traits according to their heritability. (A list of current UK dairy trait heritabilities is in Table 1.1).
- There may be additional useful information to be gained from all known close relatives because they share a proportion of their genes (e.g. on average half-sisters share one quarter). This is pooled with the candidate's record so that the accuracy of the new breeding value is improved. Obviously if the candidate is a bull, then the only sources of information on his PTA for milk are his relatives (dam, sisters, or daughters).

The total quantity of information recorded on a herd or breed is added to every day. More data will normally lead to a revised estimate of an individual animal's breeding value, and increase its reliability. At birth, a heifer calf can only have a prediction based on what is already known about its sire and dam. Its PTA will be the mean of their current values – the so-called parent average or Pedigree Index. It is not 'official' as the reliability will usually be below the minimum level for publication (50%). As its dam calves again, and its sire has an increasing number of recorded daughters, the calf will itself enter the milking herd and more useful data accrue. The worldwide convention is for the national authority (AHDB-Dairy for the UK) to re-calculate the PTA for every individual (for each trait), three times a year[1] and publish the latest predictions or 'proofs' as they are known. Note that this process continues indefinitely, even after the animal has died.

All PTAs are expressed as deviations from the average animal (in that national population). Because improvement in some traits, especially annual milk yield, has been quite rapid for some decades, the definition of the 'average' animal is revised every five years (a base change). This causes all PTAs for milk to be reduced overnight by an amount reflecting the progress made by the breed during those years.

1.4 Selection Index

The breeder is thus faced with a series of discreet pieces of information; PTAs for many different type and production traits. Each of these may have a bearing on one or more of his several goals, most of which will be related to the economic returns from the farm business. Within a given system of milk production, it is possible to estimate the effect on farm profits of a unit increase in average milk yield or fat percentage. Improvement in feet and legs or mammary scores will affect profits if they improve herd life and thus reduce annual replacement costs. ADHDB-Dairy therefore tries to summarise everything that is known about an animal's genotype for all relevant single or composite traits, and expresses this as an overall score.

[1]The publication dates for revised bull proofs in 2018 are 3 April, 7 August, and 4 December. These are synchronised around the world.

Table 1.1 Current UK trait heritability estimates (Holsteins)

Heritability %					
Linear type		**Production**		**Management**	
Stature	41	Milk yield	55	Somatic cell count	11
Chest width	25	Fat %	68	Locomotion	10
Body depth	33	Protein %	68	Lifespan	6
Angularity	34			Fertility	3
Rump angle	30			Temperament	11
Rump width	26			Ease of milking	21
Rear side leg	20			Body condition score	27
Foot angle	10			Direct calving ease	7
Legs and feet composite	16			Maternal calving ease	4
Fore udder attachment	22				
Rear udder height	23				
Udder support	19				
Udder depth	35				
Teat placement rear	29				
Teat placement side	29				
Teat length	29				
Mammary composite	27				
Type merit/score	32				

Source: AHDB-Dairy, Breeding Briefs

In the past this was PIN. Today it is £PLI (Productive Life Index, expressed in £). This predicts the additional profit margin which any daughter is expected to create over her lifetime compared with daughters from an average bull (or cow). It has been derived for herds which calve throughout the year. Other indices are available for spring- and autumn-calving herds. Other countries have devised comparable indices for their own production systems.

1.5 Genomic proofs

The estimates of breeding value given in the previous section are in the form of PTAs for single traits, for composite scores for health and management traits (lifespan or calving ease), and for overall profit. They have gradually become available over the past decades. The basic concepts were mainly discovered 60 to 80 years ago. During the intervening time

- new statistical methods have been developed
- much more information has been collected and analysed
- AI has produced large daughter groups from many bulls

and perhaps most important of all

- data processing capacities and speeds have expanded exponentially.

But there are still problems if the breeder is limited to using these PTAs calculated only from observations on the candidate or its relatives.

- A dairy bull can only be accurately proven when he has lived long enough to have produced a number of daughters milked in several herds. If he is to be widely used as a proven sire, he must be kept alive and active, or semen must be collected from all bulls when young and stored in case it is needed.
- By the time a cow is adequately proven, she is near, or at the end of her breeding life
- Resistance to infection can only be assessed in the presence of disease pressure
- Some important traits can only be directly measured after slaughter (obviously more important in meat breeds)

The idea of being able to interrogate a candidate's genes directly, at a young age, has long been attractive. Molecular biology is now beginning to provide this ability. The practical advances have naturally been first made in the world's most numerous dairy breed – the Holstein. Governments and producer organisations (e.g. AHDB-Dairy) funded much of the basic R&D, but the international semen companies and breed societies also contributed.

The procedure needed two distinct phases. The first (training stage) involved the assembly of a reference population. Tissue samples (semen, hair follicles, or ear tissue from the hole made during tagging) from large numbers of high-reliability, daughter-proven bulls were sent to specialist labs for DNA extraction and analysis. Sequences of Single Nucleotides (SNPs) were read, put onto so-called SNP-chips, and the data files sent to the computing centres (EGENES in UK). Genomic analyses then looked for associations between some of these SNPs and bulls' proofs for the multiple traits which interest the breeder.

Once these SNP-keys have been established, then tissue samples from candidate animals are sent to the laboratories, their SNPs are read and sent to EGENES which uses the previously established prediction equations (SNP-keys) to provide genomic proofs. (These do in fact blend the genomic information with whatever conventional data are available from the candidate and its relatives.)

As the cost of the chip depends upon its density (from 9,000 to 150,000 or more SNPs), females are often evaluated at lower density than males. In the Holstein breed these genomic proofs on young bulls have now been shown to be quite close to the daughter proofs which they acquire several years later (Table 1.2). The semen companies are continuing to offer bulls evaluated in both ways and farmers are increasingly showing a willingness to buy from the higher scoring, though lower reliability genomically tested young bulls – making a one-off, two-generation gain.

The semen companies benefit from not having to rear and hold onto large numbers of bulls (or their semen) until their accurate proofs arrive at five to six years of age. Furthermore, since annual genetic progress depends in part upon the generation interval, they can move forward faster by taking future bulls from much younger sires and dams – all evaluated genomically. Naturally there is a danger here. If a breed can be changed more quickly, it is even more important to be taking it in the right directions!

Table 1.2 Reliabilities over time for traditional and genomic evaluations for bulls.

Example: Milk yield in Holsteins

Traditional %		Genomic %
99	Second crop daughter proof	99
85	Progeny milking	90
35	Progeny bred	70
35	Progeny born	70
35	Semen collected	70
35	DNA analysis	70
35	Born – based on sire and dam proofs	35

Source: AHDB-Dairy, Breeding Briefs

Notes:

1. All the figures are likely to be much lower for traits other than milk yield, fat, and protein.

2. If the sire and dam proofs have lower reliability, then all the traditional figures will be lower until there are milking daughters.

3. The genomic reliabilities for breeds other than Holstein will be lower because of smaller data sets. For Jerseys, the comparable UK figure is 65%.

1.6 Tests for single 'genes'

While most production traits seem to involve the joint actions of large numbers of genes of small effect, and are subject to environmental effects to varying degrees, breeders have always been aware of a few conditions whose appearance has been explained by single genes inherited in simple ways. Coat colour, or pattern in some breeds, polledness and horn shape, and several congenital defects like 'bulldog' calves (chondrodystrophic dwarfism with hydrocephalus) are all in this category. More recently some 'haplotypes' (single genes or small clusters of SNPs) have been shown to cause lowered fertility. Medical researchers are continually revealing human defects attributable to the presence of specific genes and, if serious, then carriers of these may be advised before they decide to have children.

It seems likely that such tests for harmful genes will become more common in cattle, perhaps within the genomic testing package, but their deployment will probably be limited to the exclusion of carrier bulls from widespread use in AI.

2. The Evolving Structure of Dairy Cattle Breeding

2.1 Structures before the 1950s

A pedigree breed consists of all the registered animals in herds owned by different breeders. These vary in their interests and in their knowledge and capabilities as businessmen and stockmen (of course, breeders can be female!), and in the size of their herds. Unless the breed has declined in numbers to the extent that preservation has become the main aim, then improving performance in changing circumstances will always be an objective. Some breeders put more effort into this, and a characteristic structure evolves. (This discussion refers to a common situation found in many livestock species and countries, and not necessarily in dairy cattle on the Island).

Before the widespread use of AI in dairy breeds (and still mainly true in beef breeds), some herds became recognised as having genetically superior stock. These elite (or nucleus) herds developed a trade in selling bulls to the rest of the breed – a two-tier structure (Fig 2.1). If the breed was large, then it became possible to recognise three tiers (Fig 2.2). The major transfer of genes was down through the tiers, from bull sales, though of course some movement of females (surplus heifers, cull cows or herd dispersals) also took place. There was very little transfer up the pyramid.

Figure 2.1 Simple 2-tier structure of a pedigree breed.

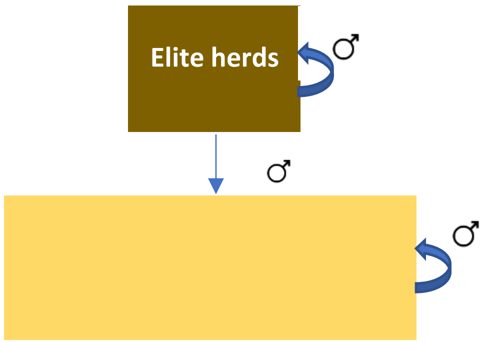
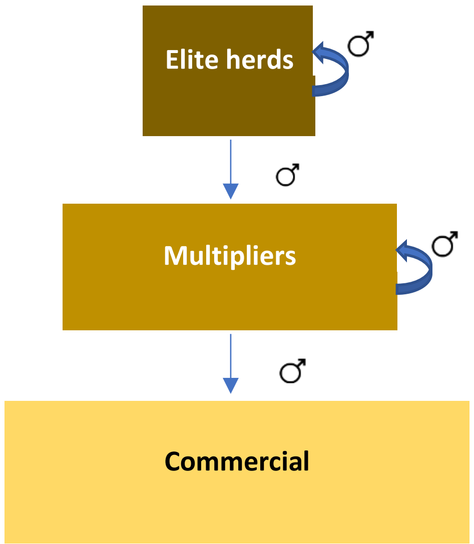


Figure 2.2 A typical 3-tier structure of many pedigree breeds.



The elite group was defined (in retrospect) by the fact that they usually used home-bred bulls and those purchased from other elite herds. The multiplier herds used some elite males and others from within their own tier, but also sold bulls down into the third tier. This commercial tier of purebred herds may not have registered any calves in the herdbook, or perhaps just heifers. (In Jersey, such second or third tier herds would have been tiny and would not normally have kept a bull, and so took their females to be served at a neighbour's farm.)

The different roles of these herds were associated with different breeding strategies. Elite herds had an additional source of income beside their milk cheque. But their place in the hierarchy depended upon them first creating genetic improvement in traits which mattered to their customers, or at least persuading them that they had done so. Both their bulls and surplus females would then be in demand by existing and new herds in the tier below. They competed with each other for this trade, and must therefore spend time and money. Time in studying all available pedigree, performance, and show data in order to make selection and mating decisions. Money in showing, entertaining visitors, in purchasing occasional expensive bulls from competitors, and in keeping extra bulls for limited numbers of matings and possible sales.

In contrast, the herds in the lower tiers could concentrate almost entirely on the economics of milk production. Their main genetic decisions concerned the trickle of bulls which they would purchase from the elite breeders.

These needed to be sufficient in number and variety. The limited number of replacement heifers from any one bull meant that any one mistake was not too serious. They also had to decide which of their heifers to retain before first calving and during early lactations. Before the availability of sexed semen, this was not usually a major task.

This division between upper and lower tier herds may seem exaggerated here, but it is done deliberately in order to clarify two different breeding plans which could still be available in the future.

2.2 Early changes brought by artificial insemination

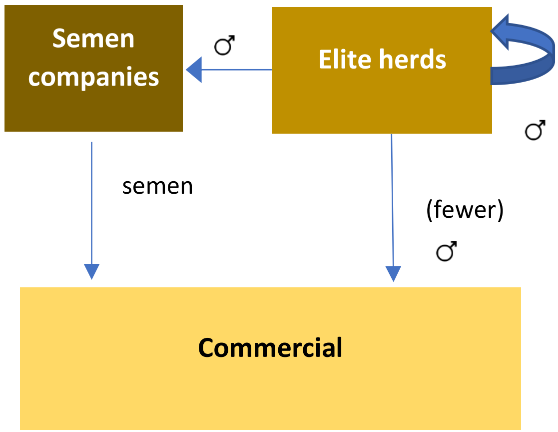
From the 1950s a new pattern began to emerge with the widespread availability of fresh and, later, frozen semen. The semen suppliers were often cooperatives of dairy farmers. The logical sources of bulls for the AI studs were the existing elite herds. Simultaneous with the take-up of AI was the adoption of a degree of production recording in all tiers. After a few years, the recording organisations were able to calculate and publish accurate daughter proofs for all the AI bulls. These were at first based upon daughter-dam comparisons until the contemporary comparison method was developed, and later still, BLUP.

The main traits emphasised in these evaluations were milk yield, fat and protein, and, not surprisingly, bulls from some of the fashionable elite herds did not show up too well. Their reputation may have been based largely on showring success.

The demand for bulls was greatly reduced as the best proven AI bulls produced thousands of daughters and natural service gradually became confined to heifers.

Herds in the elite tier soon had to demonstrate genetic superiority in both production and type traits if they were to keep selling bulls both to the AI stud and to the tier below.

Fig 2.3



2.3 The shift in decision making

Thus began a continuing shift of influence from the nucleus breeders, who were usually the major figures in the breed society, to the AI organisations. The major semen customers were the herds in the lower tiers whose interests were in high producing, commercial cows. Many of these herd owners did not think it worth registering their animals in a herdbook, but they increasingly embraced production recording to help manage their cattle. These recording systems also provided an alternative system of keeping track of their cows' 'pedigrees'.

Run as commercial businesses, the AI companies began to dictate which bulls they wished to purchase. They usually owned no cows of their own, but had rapid access to all the published data on performance of recorded, registered cows in both elite and lower tier herds. They could also follow the emerging proofs of their own bulls and those of their competitors. Their professional staff would approach the owners of a top cow with a proposition to buy a bull calf (or embryo) from her, if bred to a particular sire.

These young bulls from such 'contract matings' were still risky, and so a rigid system of progeny testing was developed. Only a limited quantity of semen was collected and sold, or provided preferentially to herds which could ensure that good daughter records were returned.

Meanwhile, the young bulls (around 100 Holstein/Friesians per year from the English Milk Marketing Board's programme alone) were kept on holding farms for several years until their daughter proofs were available. The top ranked bulls would then be quickly returned to active use to produce large numbers of 'second-crop' daughters, and the remainder slaughtered.

Some elite herds have survived to this day in part because they too have selected hard for the traits emphasised by the AI companies. But also, because breeding attractive purebred cows continues to appeal to quite a number of owners who enjoy interaction and friendly competition with like-minded people. The showring is still important, and animals are traded at prices higher than commercial values both among established breeders and to aspiring newcomers.

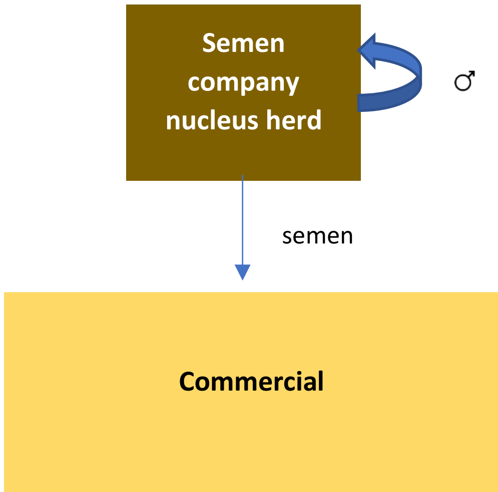
2.3 The semen companies take over?

The continuing influence of nucleus herds in dairy cattle breeding contrasts with the fate of their counterparts in the poultry and pig sectors. There, very few have survived, and only by servicing the endangered breeds which continue by offering specialist products, usually marketed through farm shops and farmers' markets.

It is already clear that further change is underway in the dairy sector. The phase when commercial breeding organisations continually dipped into the pool of registered pedigree animals will surely disappear. The companies cannot build up 'proprietary' lines in this way. Compare the existing semen companies with the poultry and pig breeders who own and strictly guard their own male and female 'lines', and continually develop these (to complement each other) in the directions they believe will be needed, using their own selection indices. Their lines are closely guarded from competitors and a package of products is marketed in a way to build customer loyalty.

In 2016 Genus-ABS announced that it had taken a controlling interest in a joint venture with 'America's leading independent breeder of Holstein bulls' following years of effective collaboration. The Genus plan is to accelerate their ability to produce their own bulls, from 20% up to 75% in less than five years. Cogent and its sister company (Grosvenor Estates), currently maintaining 1750 cows in Cheshire, has joined with Sexing Technologies, the dominant player in sexed semen. Viking Genetics has also been acquiring females. While these moves may not have immediate impact on the Jersey breed, they confirm the direction of travel. The semen companies will decide what bulls they should market based on the wishes of commercial milk producers, and they will bypass the traditional elite pedigree herds (Fig 2.4).

Fig 2.4



2.4 The next stage?

Until now the dairy farmer has usually maintained a continuing female thread through the generations in his herd, though constantly diluting it by successive imported bulls. Breeders and scientists disagree on the importance of such female lines or cow families. Genetic material is contributed equally by both sexes and there is little evidence to support the contrary. In which case, a heifer whose name refers back to a famous ancestor cow just six generations back, is only expected to retain some 3% of her genes, and is much more likely to resemble other heifers by her own sire than those with the same family name, but by a different bull.

Advances in harvesting ova, in-vitro fertilisation, and embryo transfers have already reached the stage where Genus-IVB is providing a new service to large dairy enterprises in Mexico. Technicians undertake to impregnate all cows with sexed embryos produced in their laboratory. In this way the breeding company now supplies both the male and female lines, and expects to use ova harvested from superior donors. It is copying the existing practice in the poultry and pig companies which provide a complete package. This is no longer science fiction, though it remains to be seen if it will become a commercially viable service. One obvious advantage could be to allow UK and Irish spring-calving herds to maintain all first-cross cows rather than the mixture which many currently contain. It could also assist herds to change their milk composition quite quickly to adapt to new contracts through varying the herd's genetic make-up.

Today's farmers may not like these trends, but they should not ignore the likelihood of continuing moves to keep the farmgate price of milk down via greater scale and uniformity of production. Indeed such changes may provide opportunities for some (including Jersey Dairy) to emphasise their differences and increase their appeal to niche markets!

JERSEY

3. Background: Resources, Structures, and Support Services

3.1 Government and the dairy industry

Jersey's government, the States, values the Island agriculture and wants to encourage its development both as an economic and an environmental entity. While direct subsidies to dairy farmers are likely to be phased out, they may well be re-calibrated to support such public goods as secure milk supplies and reduced pollution. The Government believes the industry is already well advanced in many areas of concern to the public such as animal health and welfare, antibiotic use, and sustainability. It appears to work well with the industry and encourages the leadership role of the Society.

3.2 The Island herd and farms

Currently, there are approximately 2800 milking cows in fewer than 20 herds supplying milk to Jersey Dairy (plus a further 80 in a single herd which processes and sells separately). The total number has only decreased slightly since 2008, though the number of herds has reduced by a third. Several more herds have plans to cease or combine, so it seems reasonable to forecast that a similar number of cows will soon be milked in as few as 15 herds, of which three may still be quite small. The majority of production would then come from 10 to 12 professionally managed units containing 70 to 250 cows and averaging over 200.

The owners and managers range in age and include a number of men and women with technical training, computer skills, and experience outside their own farms. On the several units with advanced succession plans, there has been considerable re-investment in

Table 3.1 Jersey Dairy Products currently being produced and their markets

	Jersey	UK	Holland	Hong Kong	Korea	Japan	China	Singapore	Mynamar	UAE	Qatar
Milk											
Fresh	√										
UHT	√			√						√	√
UHT-flavoured	√			√				√			√
Cream											
Fresh	√										
UHT	√										
Yogurt	√										
Ice cream											
Frozen	√			√			√				
UHT soft mix	√	√				√			√		
UHT											
Thickshake	√	√									
Milkshakes	√	√									
Cheese	√										
Butter	√		√	√	√	√					

modern buildings and equipment, financed during recent years within a more stable business environment.

3.3 Jersey Dairy

A huge advantage for the Island's dairy farmers is that all of their milk is purchased by the cooperative Jersey Dairy, the trading name of the Jersey Milk Marketing Board whose members are the active farmers. The Dairy went through financially difficult times prior to 2008. In recent years, with strong professional management, and the benefit of capital realised from the sale of a previous site, it has built a modern factory adjacent to the Society's headquarters.

Some 14 to 15 million litres of milk are processed into a range of products; fresh and UHT milks, cream, yogurt, frozen and soft-mix ice cream, milk drinks, butter, and cheese. It is important for the Dairy to be able to continue to satisfy the Island's fresh milk needs at all times at an acceptable wholesale price in order to justify the exclusion of more cheaply produced products from the UK. Other milk products are, of course, imported.

Some 60% of production is sold within the Island. The remainder is exported to the UK, plus an increasing amount to the Far East. More recently, sales are developing in the Middle East and butter is exported to the Netherlands (Table 3.1)

3.4 The Royal Jersey Agricultural and Horticultural Society (RJA&HS)

The Society is much more than the usual regional organisation providing horticultural shows and garden competitions while providing facilities for farmers to compete and show their animals to the public. The RJA&HS is also the Breed Society, maintaining the registry of all pedigree Jersey cattle born on the Island, while a subset of these data acts as Jersey Island's EU-compliant National Cattle Database: the Jersey Cattle Movement Service (JCMS). In 1994 Jersey Island Genetics (JIG) was established as a wholly owned company to trade in breeding stock from the Island. It is now also responsible for all technical services related to cattle breeding in Jersey, which include semen imports, herd recording, and support for artificial insemination (AI) using specialist facilities and equipment. A new development is the provision of technical services in support of projects with the breed in Africa, most of which is managed through JIG.

Through careful management of its original assets, the Society has acquired a new site and developed modern offices and show facilities. These have been further extended to become the Island's premier exhibition and conference venue. The RJA&HS is now a substantial business which employs an experienced and highly competent team of professionals. James Godfrey has been its CEO since 1996, and David Hambrook General Manager of JIG since 1999. These officers and their staff have established long-standing relationships with, and earned the trust and respect of, the herd owners particularly during the past 10 years. As a result, it is now possible to propose a plan for the future development of the Island's cattle which would be inconceivable for any breed society on the mainland of the UK.

3.5 Other support services

Some of these services are contracted from UK organisations either directly by the Society or through JIG.

JCMS and the Jersey Herd Book are managed by the Society through the system provided by the National Bovine Data Centre (NBDC) formerly known as the Centre for Dairy Information. This system is used by the majority of the British dairy breeds and an increasing number of beef breeds. Herd recording and management programme operations are supplied by Cattle Information Services (CIS) with delivery to Island herds by JIG. Both NBDC and CIS are separate entities but closely affiliated to Holstein UK which also provides independent type appraisers. These inspect age-specific groups of milking cattle every five months as part of the comprehensive phenotypic appraisal process.

Data analyses can be provided by NBDC, and updated estimates of breeding values ('proofs') for all mature animals are published three times a year by a division of the UK's Agricultural and Horticultural Development Board (AHDB - Dairy). These are calculated under contract by a unit within the Scottish Agricultural College (EGENES). Regular consultancy on milking machine operation and parlour hygiene comes from the top specialist within The Dairy Group, previously part of ADAS in the UK. Business analysis as well as advice on financial management are delivered from Kite Consultancy. GLW Feeds supplies several herds with concentrate feed and advice.

JIG manages an Island-wide Cattle Health Scheme which covers all bovines (dairy and beef). This high-level scheme is Cattle Health Certification Standards (CHeCS) accredited, and managed by a Scottish laboratory (Biobest Labs). It confirms freedom from any of the major cattle diseases, and is regarded by Jersey Dairy as an essential element of their unique offering.

Two local veterinary partnerships service the Island's dairy farms though few of these have yet committed to a comprehensive health plan.

All farms are routinely inspected and required by government to achieve certification under the UK's Red Tractor Scheme which assures food safety, animal welfare, hygiene and environmental protection. In future they will also have to achieve accreditation (through strict annual inspection) under the LEAF Marque Scheme (Linking Environment and Farming) which recognises environmental sustainability.

4. Goals for the Island herd

The dairy industry in Jersey has a particularly complex set of stakeholders. It is based on an historic breed which is known and admired worldwide. This leads to a higher than normal interest from consumers, both local and in export markets. These are joined by the many visitors who support the tourist/conference sector of the economy. Their interest naturally leads to concern about the system of milk production and its use of resources and impact on the environment and animal welfare. But of course, price and quality of dairy products are always important, especially as comparisons are easily made with similar items on the mainland. Veterinarians and the States are also concerned with welfare and freedom from disease.

Jersey Dairy, which is one of the interfaces between farmers and the public, has therefore set out its requirements, both in terms of the raw material (milk) which it purchases, but also the way it should be produced. These provide the context in which the Island herd must live, and the product required, so setting some of the farmers' goals. They will then have additional goals relevant to the efficiency with which they produce that product.

4.1 Goals arising from Jersey Dairy's 'Rules of Supply' and 'Pricing Schedules'

4.1.1 Jersey Dairy closely manages its requirements for volume by allocating the number of 'Licensed Litres' which it will purchase from each farm. These are set by the Milk Allocation Panel and revised annually. The actual price paid to the farmer depends upon how close the deliveries are to the agreed plan. The need is for all-year-round production, so calving must be spread throughout the year.

4.1.2 The required hygienic quality, defined by at least four separate measures, is already set at high levels with bonus or penalty payments for being above or below these.

4.1.3 Milk has to have above 4.0% butter fat. Between 4.0% and 5.4% it is paid at a flat rate. Above this level small bonuses are paid. Currently these are:

Table 4.1 Butterfat bonus paid by Jersey Dairy in two years

Butterfat %	Bonus (pence/litre)		Bonus as % of base price	
	2017	2018	2017	2018
5.4-5.6	0.1	0.5	0.25	1.2
5.7-5.9	0.2	0.75	0.5	1.8
Above 6.0	0.3	1.25	0.7	2.9

The bonus rates were increased considerably in 2018 as a consequence of increased global prices, and from 1 October 2018 these will rise further when protein bonuses will also be introduced. It is understandable that the milk price paid to producers should fluctuate in order to help the Dairy balance supply and demand. Farmers are able to help in this to some degree by faster culling, or altering feeding. But there is much less scope for short-term manipulation of milk composition. If the Dairy anticipates that, long-term, its business can profitably use more fat or protein, then it must set long-term incentives and not vary these with every price change in world markets. Increasing BF% by selection could be relatively simple, but it does take years.

4.1.4 Other milk constituents might also be targeted if the Dairy decided that raising or lowering their levels could add value to their products. One target might be to eliminate the proportion of milk which contains the AI variant of ß-casein so that it only contains the A2 and other less frequent variants. There are claims that this A2 milk is more easily digestible. (Other claims that A1 milk increases the frequency of Type 2 diabetes, coronary heart disease, autism, and schizophrenia have been downplayed recently.) Milk from cows of the Jersey breed already contains a higher proportion of the A2 variant, so it would be simpler to eliminate the unwanted A1 form than in the Holstein.

4.1.5 Jersey Dairy has also strongly emphasised some additional features of its raw materials which are basic to its successful export promotion. All the milk is from pedigree Jersey cows maintained pure for centuries, and grazed wherever possible on Island pastures under accredited conditions of health and welfare. The implication for future breeding goals is that cattle must continue to cope with a management system based on grazing whenever weather conditions permit. Strong legs and feet, and robust frames are obvious objectives.

4.2 Goals to improve production efficiency on the farm

The Dairy has to be able to justify its wholesale milk price to both the States and its retailer customers. It therefore has a strong interest in keeping the farmgate price low. If the farms are to remain viable, they must look for efficiencies.

The breeder is running a business and can improve efficiency by increasing output or reducing inputs. The most obvious way is to raise annual milk yield, or improve milk quality in those traits for which a higher price will be paid. But an equally effective way is to increase lifespan, the number of productive years in the milking herd. This implies having cows with the fitness to remain alive, productive, and suited to the production system. Some of the underlying traits are:

calving ease
disease resistance
feet and legs
mammary traits
fertility
temperament.

Finally, the maintenance cost of the animal is mainly a function of its liveweight.

4.3 Quantitative goals?

Viking Genetics has issued goals for the Danish Jersey in its home market (Appendix 1). It expects that customers should achieve the listed performance levels in 2025 by a combination of genetic selection and on-going improvements in management. The company's aims are summarised here (Table 4.2), **not** as precise numerical goals for the Jersey Island herd, but to illustrate the range of different traits which can be simultaneously targeted through the use of an economic index of total merit (like £PIN).

Table 4.2

	Viking Genetics' goals for 2025	Jersey Island actual 2017*
Annual milk yield kg	8,100	5,543
Butterfat %	6.25	5.28
Protein %	4.25	3.73
Fat yield kg	506	293
Protein yield kg	344	207
Somatic cell count (x1000)	150 max	155
Treatments/cow/year – mastitis – other	0.2 max 1.2 max	
Lifetime production – kg fat & protein	3,400	1833†
Survival: % live calves at 6 months : cow mortality % : lactations/lifetime	90 4 4	 3.94†
Size: rump stature, cm : liveweight, kg	126-132 450	

* CDI UK Breed Performance Statistics 2018 supplement, †CDI Statistics 2014 year

Clearly, these targets refer to very high performance levels for the breed. They imply a rather intensive nutritional regime, a dairy contract which emphases milk solids, and decades of past selection for health traits based upon data from a compulsory recording programme. With Jersey's commitment to a grazing regime, its yields would not be expected to reach these levels, but many of Viking's other goals are surely achievable.

5. Breeding Plans for the Island Herd

Report 1 summarised breeding and other developments on the Island over the past 10 years, and the current state of the cattle. Previous sections in this second report have reviewed the way genetic science has provided increasingly useful aids for selecting animals to be parents of the next generation, and described the changing sources of improved bulls. The unique characteristics of the dairy industry on the Island have been reviewed, and future breeding goals suggested. The main task now is to recommend ways of achieving these goals.

Ten years ago, many of the Island's farmers decided that their herds would benefit from the use of semen from bulls bred in several overseas countries. Most other herds followed later as the results from these first movers became clear. In 2017 around three quarters of registered heifers were sired by such bulls. This figure would probably be higher, but for the fact that many people find it more convenient to use natural service for their heifers.

Only 8% of the total were from bulls with no imported blood in their pedigrees. As a result, the current milking herd now contains around 50% imported genes, and this will continue to increase as the current heifers calve down.

The changes in type and performance documented in Report 1 have almost all been judged to be favourable. Future goals have not changed much. Farmers continue to want to increase annual milk yields towards the levels shown to be achievable in other countries, while putting even more emphasis on traits associated with longer herd life. Jersey Dairy is keen to receive milk with even higher fat and protein content, so these traits should receive greater weight in future.

5.1 Continue as now?

In view of farmers' satisfaction with results to date, a reasonable starting point for the plan for the next decade would be to continue broadly using the existing arrangements. David Hambrook researches the available bulls on offer in the UK, and circulates a list of suitable animals twice a year, with details of their latest proofs and prices. Herd owners consider these and make their choices. JIG places the orders, receives the semen parcels and delivers them to farms as needed.

Looking ahead, can farmers be sure that there will continue to be a supply of attractive bulls which will also fulfil the current requirements of the rules of the Jersey Herd Book? There are two slightly different causes for concern. The first is because the American Jersey Cattle Society is willing to admit animals known (or suspected) to have ancestors from another breed. These may arise from mistakes, or deliberate crosses. Such animals are identified for a number of generations by a JX prefix followed by a number in brackets which indicates how far back in the pedigree the non-Jersey ancestor appears. Thus JX(1) to JX(6). (A copy of the rules is given in Appendix 1.) The difficulty is that, for example, after seven successive generations, the offspring become eligible for normal registration in the Herd Book, without a tell-tale prefix.

Since many JX bulls have been marketed (but not taken up on the Island), some will eventually have normally registered descendants on offer. In theory these should be carrying less than 1% of genes from another breed, but if used on the Island they would still break the herdbook rules. Not only would this cause great upset within the Society, but it could have serious implications for post-Brexit relations with the EU because their directives are likely to retain very strict definitions of breed purity. The issues are still under discussion within AJCA, and it is possible that a helpful resolution will be achieved.

Fortunately there seems to be no danger to the purity of the Island herd at present, providing JIG remains vigilant when offering bulls for semen purchase. But one day the Society may have to choose between ceasing imports or revoking the rule that 'bulls shall have no known ancestors of any other breed'. Meanwhile, because of the fears provoked by the appearance of a few unusual coat patterns, it would be a sensible move for the Society to introduce a rule excluding such calves from full registration.

The second possible concern is perhaps more serious in the longer term. If the major semen companies continue to evolve their breeding methods as outlined in Section 2, then they may eventually decide that the 'pedigree market' for semen is too small for them to continue to operate within Herd Book rules – which could conflict with their desire to offer 'proprietary' genetics. Of course, there would be some smaller companies that would try to continue to service the pedigree customer, and those operating within the EU might have to conform to strict breed purity rules. This more extreme scenario is not yet in sight, and is certainly not a reason for the Island now to abandon its existing policy of relying for future gains on imported semen.

5.2 Close up again?

Some might argue that the aims for the breed back in 2008 have now been realised. A huge refreshment of the Island herd has taken place. New genes, or many more copies of the favourable ones, are safely in the herd. Both type and performance have improved. Should imports be halted, and those farmers who want to be 'elite breeders' be once again given the responsibility for developing a unique Island strain? Might there even be future export opportunities to other pedigree herds if the major semen suppliers lose interest?

The rather mixed success of purely local breeding programmes during the second half of the 20th century is not encouraging. They struggled to implement a reliable progeny testing programme to identify good bulls when the total population size was always a major handicap. So what has changed? Section 1 spelled out the new power available to the breeder now that a genomic test can provide a relatively accurate estimate of the breeding value of a calf, at least for the more heritable traits. In UK, the reliability is around 0.65. So a breeder could test all his bull calves and use a group of the best as soon as they can provide semen. He could also test all his females, select the best with more confidence, and turn them over quickly.

But there would be problems. If the Island population becomes separated from all others, and less genetically related, then the reliability of a genomic test could fall – it relies on a large closely related reference population. And all herds would need to back the programme and accept a degree of discipline. The best bulls would need to be used across most herds, and control measures to limit the rise of inbreeding (which causes a loss of genetic variation) would be required.

It is unlikely that any geneticist would advise such a small population of cows to willingly adopt this closed breeding programme if there is still the ability to remain open to improved bulls from outside. For the past several years, farmers on Guernsey have felt it necessary to organise their own co-ordinated programme because they are no longer able to source many suitable bulls from North America or UK. But it is not a solution that they would have chosen unless they felt they had to.

5.3 Elite breeders or milk producers?

If the plan is to continue to rely upon imported semen for serving most cows in order to maintain genetic progress, then the next issue is how to choose among the available offerings from the semen companies? Section 4 identified the several separate goals imposed by the Dairy and the public, and the usual ones suggested by the economics of milk production. Section 1 explored the tools that are now available to help the farmer put appropriate selection pressure on each individual goal in order to get the maximum overall progress. What is appropriate depends upon the extent to which each type or production trait is inherited, its relationship with other traits, the amount of variation in the breed, and its effect on herd profits.

In the past the process of trying to predict which animals were able to improve the breed was difficult, but some breeders evolved quite complex procedures based on years of studying type and performance and a natural 'eye' for stock. The successful ones enhanced both the appearance and production of their herds and were able to gain prestige and additional income through the sale of breeding stock.

No doubt some herd owners will continue to aim to be such 'elite breeders' and put a great deal of effort into studying pedigrees and cow families in their own and other herds. They are unlikely to follow too closely the geneticists' methods! They will enjoy their activity, and one or two may even achieve distinction. The good news is that those who are content to see themselves as 'milk producers' can now achieve similar rates of improvement through careful use of the aids provided (through the Society) by AHDB and NBDC, building on the work of statistical genetics over the past 70 years. The following practical guidelines are based on those set out by Professor Geoff Simm in his book 'Genetic Improvement of Cattle and Sheep', 1998 Farming Press) and updated to consider the role of genomic technology.

5.4 General guidelines for selection: addressed to the herd owner

Remember that your task is to improve the suitability of your next generation of replacement heifers through the choice of their sires. You don't have anything like as much scope for selecting their dams. This is because you need to rear most of the heifer calves (unless you use sexed semen). And don't confuse your intimate knowledge of a cow's behaviour, performance, and health with your limited ability to predict what genes she will pass on to her daughters!

5.4.1 Always use progeny-tested AI bulls with proofs of high reliability, or teams of genomically tested young bulls. If it is much more convenient to use natural service for your yearling heifers, then take a young bull from one of your (or your neighbour's) highest ranked cows by a top AI sire. But remember he is unproven, so restrict his use.

JIG can continue to provide you with a list of available bulls twice a year. This should be compiled in conjunction with interested breeders and presented in descending order of £PLI (or whatever index replaces it in future), but David Hambrook's additional comments are valuable.

5.4.2 Make a short list from the top indexed bulls, rejecting any which you have previously used heavily, or which are closely related to them, and those which are very highly-priced relative to their genetic merit.

5.4.3 If you firmly believe that your herd has specific real differences from the average, for example low BF%, or low mammary scores, then eliminate bulls which score badly on those specific traits. But do not over-do this second stage screening or the huge benefits of ranking bulls on an economic index will be severely diluted.

5.4.4 From the remaining animals at the top of your list, select a few (two to four) reliably proven progeny tested bulls **or** six or more genomically tested young sires (or a mixture of the two). In a 150-cow herd with NS on heifers, this should produce daughter groups of around 20, or 10 from young sires, in one year. Using fewer young bulls risks having too many daughters from a bull who proves to be a disappointment, and large groups of relatives limit the scope for avoiding close matings in future.

5.4.5 If there are more than the required number of healthy heifer calves born, then cull those with the lowest predicted merit based upon the scores of their sires and dams. Using sexed semen across all cows in future years would increase your choice, though with an added cost and probably with a lower conception rate. But unless you are expanding or have a market for the culls, it will produce more heifers to dispose of at birth. Sexed semen on your best females could slightly increase the merit of your heifer calves, though its major benefit can only be realised if there is profit from putting more cows to beef bulls. But for those who really want to pull their herds to the top positions in the Island, then sexed semen with full genomic testing of all heifers should be a way of staying closer to the genetic level of the international bulls. The added interest and possible local or export sales might compensate for the testing charges and costs of feeding surplus heifers which then had no worthwhile market.

5.5 Mating plans

The allocation of semen among the cows obviously needs some attention, but can easily be given too much importance. Herds of 100 to 200 cows now need to be managed in a different way from the time when a farmer looked after 10 individuals.

Closely related matings should obviously be avoided as general fitness declines with inbreeding. An adequate working rule is that matings with more than one common grandparent should not be allowed. With access to bulls from several countries, this should prove no problem.

Compensatory (or complementary) matings, where a bull with a positive proof for one trait is sought to 'correct' a cow showing a deficiency would work well if all traits were highly heritable – but many are not. Just remember how varied full sibs can be in a human family. Many mating programmes supplied by semen companies are a device to save the owners checking for close relatives, a trivial task, and locking them into a single supplier. Some Island herds make use of an inspector and advice from the Triple A system. Is this still a useful expense?

5.6 Selection for specific genes

It would surely be an advantage if the entire Island herd were to become naturally polled. This could avoid future public criticism for continuing to subject every animal to a routine veterinary operation that would not be necessary. There are now polled bulls available, though to date they have been little used in the Island. This should be a declared goal for the Society. Progress will depend upon the proportion of international bulls which are polled. Viking Genetics appears only to be aiming for 10% by 2025. If the decision is made to go this way, then the plan could surely be used as a USP in brand promotion as soon as it has begun.

It is possible that so-called A2 milk (not containing the A1 variant of ß-casein) could be an additional valuable attribute of Jersey Dairy's products. The Society should work closely with the Dairy to find out the proportion of the current herd which produces A2 milk, and consider the feasibility of eliminating the A1 variant by different policies. It seems likely that there would be testing costs involved for both animals and milk, and a royalty on sales, since the a2Milk Company has strong patents on the tests and the use of the name. No firm recommendation can be made until this information has been collected, and the business case presented.

5.7 The overall plan

The fact that the plan being recommended is largely a continuation and extension of the existing scheme should be seen as an endorsement of the Society's work over the past 10 years – both by JIG, led by David Hambrook, and members of its Agricultural General Committee.

Sections 5.3 and 5.4 have tried to argue that even though there are today many different and competing selection goals, there are also better tools and more advice available. This just mirrors the situation in most other areas of livestock production: nutrition, health control, and milking technology. The owner, or manager, is now running a significant business with few full-time employees, but with access to web-based data and many advisers/consultants. So he or she no longer has to be a lifelong expert in breeding in order to keep the herd constantly improving. But they do need to be confident that the economic index, which they are being advised to use as the primary criterion for selecting bulls, gives a reliable prediction of each bull's likely impact on their herd, selling milk to Jersey Dairy.

Since many bulls have been tested outside the UK, a variety of conversions may need to be applied. And the Jersey environment (nutrition, management, milk payment) is different even from those in the UK. It is not realistic to expect AHDB-Dairy to provide a Jersey Island-specific version of £PLI for only 5,000 animals. It would, however, be useful to arrange discussions with AHDB, perhaps using Tanya Colman of Kite Consulting alongside David Hambrook, in order to get a feel for how well the current £PLI is describing the type of animal needed in Jersey, and whether AHDB's proofs might benefit from additional interpretation when the list of available bulls is circulated.

Naturally, this study has identified a few other areas where JIG or the wider Society should be taking some action. The first concerns the strengthening of the Island's health recording scheme. Everyone admires the pioneering work of the Scandinavian countries in this area, and acknowledges the benefits these countries have gained by being able to select for healthier cows and implement improved herd health plans. There is a need for the veterinary practices, the States, and Jersey Dairy to work with JIG and CIS to introduce a more comprehensive scheme with effective auditing. The results would not only help famers select for longer herd life. They would provide real evidence to the public, and to customers, at home and abroad, of the health and welfare standards being achieved throughout the Island herd. It seems that the time is now right to devise and implement such a scheme.

A second area concerns cover, and eventually succession planning, for the key role which David Hambrook fills at the centre of the Island's improvement programme. With his increasing involvement in world Jersey affairs, in European cattle circles, and particularly with the Island's projects in Rwanda and Malawi, he is bound to be seen less in the office or on farms. This highlights the importance of developing one or more people to understand his more technical roles, and his knowledge of the breed worldwide.

5.8 Beef from the dairy herd

At present, most culled cows are used for beef. A few purebred male calves are reared for veal (100-120 kg carcass). Fewer than 200 beef cross calves, and a small proportion of the larger purebred bull calves, are reared to 300kg for prime beef at 22 to 24 months. But the high rearing costs on the Island, and ready availability of cheaper beef cuts from England, do not suggest that many more of the local calves can currently be utilised in this way. Nevertheless, the Society should continue to encourage the exploration of ways to reduce the number of both male and female calves which are disposed of at birth.

The fact that fewer than half of all calves now find their way into the meat chain is both a waste of resources and an easy target not only for vegetarians, but others who are uneasy with modern farming practices. It is possible that a co-operative programme could be organised in connection with retailers which would arrange for regular batches to be reared for meat, and sold together with the story.

Appendix 1

Overall Goal, Viking Jersey 2025

Goal 2025 is the expectations to the combined result of breeding progress and management improvements.

The main goal for Danish Jersey is a long living, trouble free and profitable cow that adapts well to future requirements an conditions for efficiency, environmental impact and sustainability.

The goal is achieved through regulation of each weight of traits in the total economical index (NTM: Nordic Total Merit) an by selecting all animals which enter the breeding programme after the same index and by ongoing improvements of th management conditions, which have an influence on production, health and longevity of the animal.

- **Production**
  In 2025 average yearly production is expected to be:
  8.100 kg M - 6,25% - 506 kg F - 4,25% - 344 kg P - 850 kg F+P

- **Percentages**
  The primary production goal is kg of fat + protein. With the current milk pricing formula at home market, it is expected that percentages will increase prioritizing the concentrated milk.

- **Milk ingredients**
  Maintain and develop the ingredients in Jersey milk with effect on human health, such as minerals, beta casein, saccharides etc. High frequence of ingredients affecting technical abilities, such as cappa casein, is also prioritized.

- **Health**
  Wishes improved, so that the costs for treatment and the number of diseases will reduce. This will be achieved by including the breeding values for diseases in the breeding work and by fortified and improved management effort. Th use of antibiotics is to decrease.

- **Cell count**
  Max. 150.000.

- **Treathments**
  Mastitis: Max. 0.20 per cow/year (re-treathments included)
  Other: Max. 1.20 per cow/year (re-treathments included)

- **Hoof health**
  Maintain the high level and ensure Jersey having lowest frequency. Maintain the dark hoof horn.

- **Longevity**
  The goal is that the cows reach a life time production of 3,400 kg fat + protein (and average 4 lactations).

- **Survival**
  Calves: Minimum 90% of all calvings result in a live calf 6 months later.
  Cows: Minimum 96% leave the herd to keep producing in another herd or to be slaughtered.

- **Fertility**
  Time from first insemination to pregnancy is max. 20 days for heifers and max. 65 days for cows. Reproductive efficiency (insemination% x pregnancy%) is to be minimum 0.30.

- **Conformation**
  The goal is a tall cow, 126 - 132 cm in rump stature, and for mature cows in normal feeding condition a weight of approx. 450 kg.

  The front must have a width and depth, which is appropriate for the size of the cow. The topline is straight and the rump must be slightly sloped and not too flat.

  Strong Feet and Legs with fine bone structure and parallel legs (with an angle of approx. 150° seen from the side) is preferred. Strong feet and the dark hoofs maintained. This is to ensure mobile cows that walk easily and to avoid that problems with feet & legs and hoofs affect longevity.

  A well-formed, shallow and well-attached udder is expected. The front udder attachment and the udder depth is of most importance. The teats must be 5.0 cm long and 2.5 cm. wide and with a stump end. Well-placed teats (below the udder glands) are required. Unusual close, crossing and backwards rear teats are not wanted. The mammary must be suitable for automatic and modern milking systems.

The development of the body traits is controlled by the weighing of each of the traits, partly in the compound traits Body, Feet & Legs and Mammary, and through the weight of each traits in the NTM-index.

There are no requirements to the color of the cow. All colors, also white markings, are accepted however, a consistent golden yellow-brown color is considered the typical color.

- **Sustainability**
  Traits affecting sustainability in dairying will be included.

  Efficiency: The Jersey cow is to be 10% more resource efficient than cows of bigger breeds, measured on feed intake (kg DM/kg ECM) and productivity (kg ECM/kg live weight).

  Environmental friendly cow: The VikingJersey is to be the most environmental friendly cow Worldwide, measured on Green House Gas, GHG (CO_2 & Methane) Nitrogen and Phosphate emissions. Jersey cows are to affect environment 20% less than cows of bigger breeds.

- **Polled genes**
  Available to all Jersey breeders and 10% of active bulls are to be polled.

- **Genetic diseases**
  Taken into account in the breeding program and all animals included in the breeding program will be tested. An eradication/handling plan will be used depending on individual diseases/defects.

- **Purity of the breed**
  VikingJersey aim higher than official EU and National herd book rules. VikingJersey will only market bulls with more than 99.5% Jersey genes.

- **Market share**
  VikingJersey semen sales in home market is to be at least 25% of the total semen sales in 2015 - **AIM 25:25.**

Appendix 2

AJCA Pedigree Recording and Registry Status

Effective March 11, 2017, updated March 10, 2018

The *Rules for the Registration and Transfer of Jersey Cattle* define the programs and procedures approved by the Board of Directors for recording animals in the permanent database of the American Jersey Cattle Association (AJCA). The following information is required:

(a) birth date of the animal,
(b) permanent identification in the form of tattoo in the ear or AJCA-approved double-matching tamper-evident eartags, and
(c) parent information *(pedigree)*.

The Association records descendants of animals registered in the AJCA Herd Register through rules for the Herd Register and Generation Count system. As required, prefix and suffix designations will be added per AJCA rules. The Association also records registered Jersey cattle imported from countries having recognized herd books.

Herd Register

Animals with Herd Register (HR) status have seven (7) or more unbroken generations of known Jersey ancestors that are recorded by the Association. The Association issues a green-bordered *Certificate of Registration* for these animals.

Generation Count Recording

The Association also records:

(a) animals that exhibit the characteristics of Jersey cattle but lack complete documentation of parentage, and
(b) animals that have one known and AJCA-recorded Jersey parent and a parent of another breed.

With the continued use of AJCA Herd Register status bulls, progeny will progress to HR status *(see Tables 1 and 2, reverse)*.

1. Females are recorded at all Generation Counts.
2. Generation Count {1} is assigned to the female that has one known parent (either sire or dam) recorded by the AJCA. The other parent may be completely unknown or of another breed. If both parents are unknown, the animal may be qualified for recording by being genotyped *(see notes, Table 1)*.
3. Bulls are recorded starting at Generation Count {3} with the stipulations that the bull be genotyped and have a Breed Base Representation (BBR) value of 87 or greater and that its sire and dam are also genotyped *(see notes, Table 2)*.
4. The numerical designation of progeny will increase by one (1) from the Generation Count of the sire or dam, whichever is lowest *(refer to tables)*.
5. Progeny of Generation Count {6} parents have Herd Register status and do not have a suffix in their registration names.
6. When an unknown animal or animal of another breed is introduced to an animal's pedigree, the Generation Count will be reset to start at {1}.

The Generation Count suffix is an integral part of the animal name. The gold-bordered *Certificate of Identification* is issued to animals recorded at Generation Counts 1, 2 and 3. Generation Count 4, 5 and 6 animals are issued the green-bordered *Certificate of Registration*.

Table 1. AJCA Recording System for Females, effective March 12, 2016

	Generation Count of Sire						
	UR	{2}	{3}	{4}	{5}	{6}	HR
Dam Status	**Generation Count of Offspring** *(see Notes)*						
UR	UR or {1}*	{1}	{1}	{1}	{1}	{1}	{1}
{1}	{1}	{2}	{2}	{2}	{2}	{2}	{2}
{2}	{1}	{3}	{3}	{3}	{3}	{3}	{3}
{3}	{1}	{3}	{4}	{4}	{4}	{4}	{4}
{4}	{1}	{3}	{4}	{5}	{5}	{5}	{5}
{5}	{1}	{3}	{4}	{5}	{6}	{6}	{6}
{6}	{1}	{3}	{4}	{5}	{6}	HR	HR
HR	{1}	{3}	{4}	{5}	{6}	HR	HR

Female recording starts at Generation Count 1, either (a) by pedigree listing a known and AJCA-recorded Jersey parent; or (b) qualified by genotyping.

* Recorded with prefix UR unless qualified by genotyping to be recorded with GC {1}.

Prefixes and Suffixes Assigned by Rule

All animals having one (or more) ancestor(s) of another breed within six (6) generations shall have the letters "JX" included in their names as a prefix.

The following letters shall be included in animal names as a suffix as applicable: "ET" for animals produced through embryo transfer, "ETS" for animals resulting from split embryos, and "ETN" for animals resulting from nuclear transfer (cloning); "P" for polled animals with one polled parent, "PP" for animals determined to be homozygous polled by testing, consistent with their pedigree; "LL" for declared carrier of Limber Legs, and "RVC" for declared carrier of Rectovaginal Constriction.

Unregistered (UR) Recording

Animals with permanent identification that are not qualified to be recorded in the Herd Register or with a Generation Count are recorded with letters "UR" included in their name as a prefix. The *Certificate of Identification* is issued to the owner.

Eligibility for National Awards and Shows

Females with Generation Count 4 or greater are eligible for Honor Roll, Hall of Fame, and National Class Leader recognition, the President's Trophy, Hilmar Cheese Award, Living Lifetime Production Contest and National Jersey Youth Production Contest, and included in calculations of AJCA herd lactation and Jersey Performance Index™ averages.

Animals recorded at Generation Count 4 and higher are eligible for national shows and AJCA-designated regional shows.

Application of Breed Base Representation

Breed Base Representation (BBR) is a genomic trait that assesses the degree to which alleles in an individual animal's genome are in common with the allele frequency of the breed reference group for Ayrshire, Brown Swiss, Guernsey, Holstein and Jersey. The more an animal's genetic make-up resembles its

(continued on reverse)

breed reference group, the higher its BBR for the primary breed. Rules and publication policies for BBR are established by the Council on Dairy Cattle Breeding (CDCB).

Reference Group

The 3,688 A.I. bulls in the Jersey reference group *(April 2018)* were determined by CDCB selection criteria:

1. are genotyped, *and*
2. have daughters with milk evaluations, *and*
3. all 30 animals in the 5-generation breed stack are identified with the breed code Jersey; *and*
4. if born 2000 and later, all ancestors in the 5-generation pedigree are known.

Reference groups are updated annually with the April official genetic evaluations.

Reporting of BBR

CDCB policy is to report BBR values of 94 or greater for one breed as 100. BBRs below 94 are reported as calculated.

BBR is calculated and reported only once for all genotyped animals, unless re-genotyped with a higher density chip.

Understanding BBR

Variation in genomic BBR values is explained by these factors.

Within Breed. Animals whose ancestors have been accurately documented purebreds for many generations often obtain a BBR for the primary breed less than 100, simply due to the calculation procedures.

BBRs in the range of 90 to 97 can reveal the presence of outcross bloodlines. When an animal is unrelated to the North American population or has bloodlines not well represented among the bulls included in the breed reference group, its BBR could well be in the mid-90s.

Common Alleles. Precise percentages of breed sources are not possible simply because animals vary. Also, because there are common alleles across breeds, the contribution from the primary breed could be off by 5% or even more from that derived.

Crossbreeding. A BBR lower than 90 usually indicates evidence of crossbreeding. In some cases, determining whether *crossbreeding* **or** *outcross bloodlines* is the basis for a lower relationship to the breed reference group can be difficult. Mistakes will be made if conclusions are drawn without considering that BBR numbers for the evaluated breeds could vary by as much as 5% from what is expected, and occasionally even more.

BBR is effective at detecting the presence of genetics from other breeds when such other breeds have provided a significant percentage of the alleles. Still, spread in BBR numbers is to be expected. Analysis of BBRs of animals that have three grandparents of breed X and one grandparent of breed Y *(expected breed alleles 75% and 25%)* show primary breed BBRs as low as 70 or as high as 80, simply due to limitations of the method. Some animals will deviate even more due to the random nature of which chromosomes are transmitted from grandparents through their sire and dam.

Breeds Referenced. Five dairy cattle breeds have enough A.I. bulls genotyped to form a breed reference group. The BBR for each animal is determined relative only to these five groups, and even if all of an animal's genes do not come from the referenced breeds.

Pedigree Information. Missing or limited pedigree information may make it difficult to determine whether crossbreeding or outcross bloodlines is the reason for a relatively low BBR.

AJCA Requirements to Record Bulls Having A Generation Count

Males that will have a Generation Count suffix in their names must meet additional criteria in order to be recorded with the American Jersey Cattle Association. These criteria are: (1) a minimum of Generation Count 3; (2) the bull, its sire and its dam must be genotyped; and (3) the bull must have a BBR equal to or greater than 87 *(AJCA Board of Directors action, March 11, 2017)*.

Males that can be recorded with Herd Register (HR) status do not have to be genotyped in order to be registered.

Table 2. AJCA Recording System for Males, effective March 11, 2017

	Generation Count of Sire						
	UR	{2}*	{3}	{4}	{5}	{6}	HR
Dam Status	**Generation Count of Offspring** *(see Notes)*						
UR							
{1}							
{2}		{3}	{3}	{3}	{3}	{3}	{3}
{3}		{3}	{4}	{4}	{4}	{4}	{4}
{4}		{3}	{4}	{5}	{5}	{5}	{5}
{5}		{3}	{4}	{5}	{6}	{6}	{6}
{6}		{3}	{4}	{5}	{6}	HR	HR
HR		{3}	{4}	{5}	{6}	HR	HR

* *Bulls recorded by AJCA according to rules prior to March 14, 2015.*

REQUIREMENTS: Bulls at Generation Counts 3 through 6 will be recorded with the prefix UR until these requirements are met: (a) genotyping resulting in a Breed Base Representation (BBR) value of 87 or greater; (b) genotyping the sire; and (c) genotyping the dam.

Bulls with Herd Register (HR) status are not required to be genotyped before being recorded.

Publication of BBR

The AJCA publishes genomic BBR on pedigree, performance and genetic evaluation reports, and JMS sale catalog pedigrees.

The combination of AJCA registry status and BBR criteria are used to publish primary reports in the *Jersey Genetic Summary* ("Green Book"), as follows:

- *Males:* (a) all Herd Register and also Generation Count 4-6 bulls with BBRs expressed as 100; and (b) all Generation Count 3 bulls and Generation Count 4-6 bulls with BBRs less than 94;
- *Genotyped females:* (a) all Herd Register and also Generation Count 4 and greater with BBRs expressed as 100; and (b) all Generation Count 3 females and Generation Count 4-6 females with BBRs less than 94;
- *Non-genotyped females:* (a) all Herd Register; and (b) Generation Count 3 through 6.

Bulls must have their own genotype and have a BBR to be included in lists of *Active & Foreign Bulls Marketed in the U.S.*

For More Information

contact your AJCA-NAJ Area Representative or call AJCA Herd Services at 614/861-3636 (Monday through Friday, 8:00 a.m. – 4:30 p.m. Eastern), or email records@usjersey.com.

Technical information on Breed Base Representation (BBR) was provided by the Council on Dairy Cattle Breeding.

Schedule of Acronyms and Definitions

A2 milk	Milk not containing the A1 variant of ß-casein
aAa animal analysis	A sire selection programme which aims to achieve optimum balance among a cow's different features through visual appraisal of her parents
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
AI	Artificial Insemination (the alternative to Natural Service)
AJCA	American Jersey Cattle Association. The breed society in the USA
ß-casein	The second most abundant protein in cows' milk. It can be divided into 12 variants
BLUP	Best linear unbiased prediction. A statistical technique used to eliminate unwanted variation when estimating the breeding value of an animal
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)
COGENT UK	A UK-based semen company
Contract mating	An agreement (often with a semen company) to purchase a bull calf from a named cow owned by a breeder
Contemporary comparison	An outdated bull evaluation system which averaged the amount by which a bull's daughters differed from their contemporaries by other sires. Replaced by BLUP
Cow family	A naming system used by breeders when registering successive generations of cows in a herdbook. Females are usually given the same name (with a numerical suffix) as the original ancestral cow
Daughter-dam comparison	Another outdated bull evaluation system which averaged the amount by which a bull's daughters differed from their dams, for example, in milk yield
DNA	Deoxyribonucleic acid. A thread-like chain of nucleotides carrying the genetic instructions used in the growth and reproduction of living organisms. 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

EBV	Estimated Breeding Value. Twice the amount by which an individual's progeny (from random mates) are expected to differ from the population average
Elite herd	Name given to the popular herds which supply breeding stock, mainly bulls, to other herds in the breed, and thus control the breed's direction
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
Genes	See DNA
Genomic selection	Selecting breeding stock based upon information obtained through analysis of their DNA
Haplotype	See DNA
Herd Book	The official register of all approved animals in a breed
HUK	Holstein UK. The breed society for the Holstein breed
Inbreeding	The result of a mating between relatives (often reduces fitness)
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 group 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
JX	A prefix attached to the name of cattle registered in the American Jersey Cattle Association which have an ancestor which was not itself registered. See Appendix 2
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
Multiplier herd	Name given to herds which depend for their genetic progress on breeding stock purchased from a group of elite herds which control the breed's direction

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
Nucleus herd	The same as an elite herd, but often applied within a breeding company
PIN	Profit Index. An earlier overall index now replaced by £PLI
£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
Proof	A common term for the predicted breeding value of an animal, expressed as its PTA
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
Red Tractor Assurance	The foremost assurance scheme for UK farms and food producers
Reference population	The collection of animals (usually daughter-proven bulls) which is used to establish the associations between the SNPs from genomic analyses and production data
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
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
Second crop daughters	The main group of offspring which a proven sire produces after his first test daughters in a progeny test-based programme
Sexing Technologies	The US-based company which holds the original semen-sexing licences and is now expanding to embrace other services such as genomic testing and semen (Cogent) and embryo supply
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 (ear tissue, semen, hair follicle) can give direct insight into an individual's breeding value, independent of any performance data from itself or its relatives. A SNP-chip is made to hold the DNA which can then be read. The SNP-key translates the DNA sequences and turns them into a genetic index
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)
States	The Government of Jersey
USP	Unique selling point