1 Improving through breeding

Breeding has been responsible for a large proportion of progress made by UK dairy herds since the 1970s in increasing milk production levels. Improvements made through breeding are far less obvious than those achieved by changes in either feeding or management.

However, they are permanent and are compounded through each succeeding generation. Breeding can be instrumental in improving profitability and efficiency, especially in an agricultural climate that is coping with escalating environmental, welfare and financial pressures.

Farmers must strive to breed cows better suited to the needs of modern milk production. These cows need to have an inherent longevity and recently, greater emphasis has been placed on fertility and health traits as we endeavour to breed a cow that ticks all the boxes.

Any improvements in breeding must, of course, be matched by improved feeding and management to ensure that the potential in an animal is both realized and, more importantly, optimised.

What's in this section?

- Establishing the value of breeding
- Identifying key priorities for herd improvement
- Developing a clear improvement approach.

Contents

The Breeding+ Five-step Improvement Plan provides at-a-glance guidelines to raising your herd profitability through breeding.

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A summary of the section

- The pressures placed on dairy cows by the demands of modern milk production are likely to continue to increase in the future, although external factors will also be important
- Genetic improvement has been responsible for around half the annual increase in milk, fat and protein yields achieved by the main UK dairy breeds over the past 20 years
- Despite concerns voiced over longevity in recent years, genetic trends highlight a steady improvement in this important characteristic in almost all breeds
- While breeding may have a valuable role in improving fertility, most fertility problems are considered by many to be related more to the way cows are managed and fed than to their actual genetic make-up. Recent advances, such as the Fertility Index, now explain the role of fertility in breeding more
- As well as longer-lived and more productive cows, dairy businesses managing larger numbers of cows with fewer people will need more robust animals, that are easier and cheaper to manage. Hassle-free cows are the prerequisite of the modern dairy farmer
- Theoretical genetic studies indicate that selecting for improved Udder Health, Fertility and Lifespan, in addition to production, will be the most profitable future strategy
- Whatever the focus of breeding improvement efforts, industry experience suggests the greatest overall value for most herds will come from a five-step process.

The Pd+ Farm Improvement Programme provides practical advice on improving fertility through better feeding and management and also covers the many new industry tools available to improve heat detection and getting cows in calf. It should be used in conjunction with this and other DairyCo guides as an aid to maximizing cow performance and farm profitability.

See also...

Section 2:	Assessing the tools
Section 3:	Planning your approach
Section 4:	Selecting your sires
Section 5:	Managing your bull semen
Section 6:	Breeding your cows and heifers
Section 7:	Making the most of specialist strategies
Section 8:	Valuing modern breeding techniques

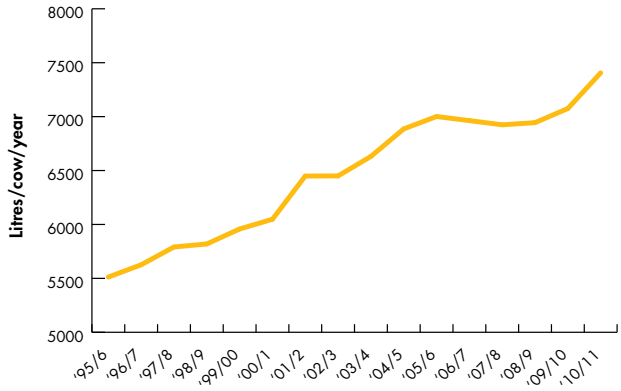
Industry pressures

The demands of modern milk production are putting more pressure than ever on UK dairy herds and their cows.

Average UK milk yields have increased from some 2500 litres/cow/year in the late 1940s to 5000 litres/cow in the early 1990s and from there, at an increasingly rapid rate, to around 7500 litres today **(Figure 1.1)**.

An exception 15 years ago, herd averages in excess of 10,000 litres/cow/year are now no longer remarkable, even on twice-daily milking. Extreme levels of milk production, however, are less common now than they were even a couple of years ago, as people accept that such high levels can have adverse affects on health and fertility. Farmers now strive for optimum production, appreciating that there is a level beyond which increases in yield bring no further financial return, that level in itself being very farm and system specific.

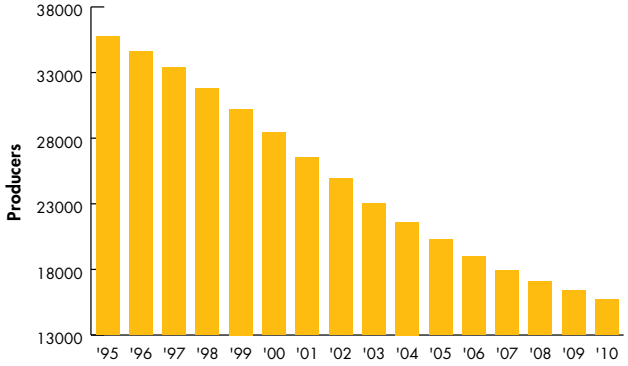
Figure 1.1: Average UK milk yields (1995-2010)



Source: Defra.

At the same time, these increasingly high-yielding cows are being kept in larger herds and managed by fewer people. Certainly, the trend for larger units, encompassing economies of scale, shows no sign of abating. Large dairy businesses rely on management expertise but they, as with all producers, struggle to cope with the margins available from the modern milk market. Shortages of skilled labour are also fuelling this trend, as is the acceleration in the number of farmers leaving the industry for both family and economic reasons **(Figure 1.2)**.

Figure 1.2: UK producer numbers (1995-2010)



Source: SEERAD, DHI and DARD.

Further pressure is being brought to bear by growing public and legislative demands for assurances on animal health and welfare as well as milk hygiene and safety.

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Industry analysts have no doubt that the pressure on UK dairy herds for ever-greater productivity will grow in the years ahead as a result of:

- Increasing animal health, disease and welfare assurance requirements
- Increasing environmental legislation and concerns
- Declining levels of Single Farm Payments
- Declining EU butter and SMP support prices
- Continuing price pressures from multiple retailers
- Increasing fuel, fertiliser and other input costs
- Increasing labour shortages
- Increasing food quality assurance requirements.

UK dairy herds need to be more business orientated as consumers and retailers continue to apply pressure both directly and indirectly on both inputs and return.

Breeding trends

Assessing production changes

All the main UK dairy breeds have increased annual milk, fat and protein yields in recent years, through a combination of breeding, feeding and management.

This rate has fallen recently due to the previously mentioned swing to longevity at the expense of continued pressure to increase yields. Also, as the economic returns on milk production have fallen, there has been less inclination to increase yields further due to the extra cost of inputs associated with this.

Estimates of the genetic improvement achieved in the same populations reveal that, on average, about half the actual production progress can be ascribed to breeding **(Table 1.1)**. This equates to around 70% of the maximum possible theoretical rate of genetic progress.

Figure 1.3: Yield 1977-2006 (year of birth) milk genetics vs. heifer yields)

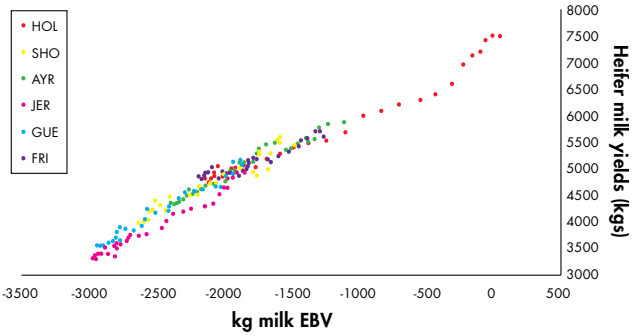


Figure 1.3 shows that as genetics have improved for milk, so the phenotypic yields have improved. This improvement is consistent over breeds and shows why we see the yield differences between breeds that we do.

The UK dairy cows of today are very different from those of 20-30 years ago, mainly due to increasing use of North American genetics.

Table 1.1: Annual increases in UK heifer breeding values for yield by year of birth (1997-2007)

	Milk		Fat		Protein		PIN	
	97-07	02-07	97-07	02-07	97-07	02-07	97-07	02-07
Ayrshire	60	89	2.4	3.3	1.9	2.8	1.8	2.5
Brown Swiss	61	51	2.0	1.7	1.8	1.4	1.5	1.2
Friesian	47	45	1.9	2.1	1.6	1.8	1.5	1.8
Guernsey	37	27	2.2	2.6	1.1	1.0	1.3	1.5
Holstein	77	55	2.8	2.5	2.1	1.5	1.9	1.5
Jersey	44	44	2.4	2.1	1.8	1.6	1.9	1.6
Montbeliarde	68	75	2.5	3.0	2.0	1.9	1.8	1.8
Shorthorn	46	63	1.7	2.6	1.6	2.2	1.4	2.0

For all breeds, the rates of genetic gain for production have accelerated again over the last 10-year period, mirroring the increasing pace of yield improvement **(Figure 1.4)**.

Holsteins have, however, moved from the breed with highest genetic gain for production (measured in PIN) to one of the least during the last five years. This is a direct consequence of moving towards emphasis on 'fitness' in breeding objectives and away from purely selecting for improved production.

Such improvements in yield potential can, of course, only be realised in practice through parallel improvements in feeding and management.

Parallel trends for milk fat percentages reveal a more mixed picture **(Figure 1.5)**. One area of interest is the reduction of fat percent for the Jersey, a breed recognised for its high components. As a breed, it has made big improvements in milk yield over recent years but this has been alarmingly at the expense of its constituents.

Figure 1.4: Genetic trends for UK cows – milk (kg)

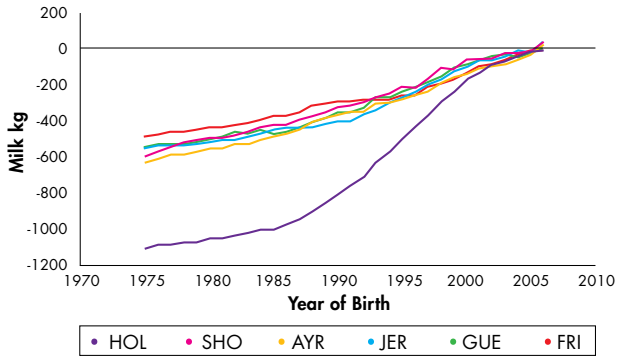
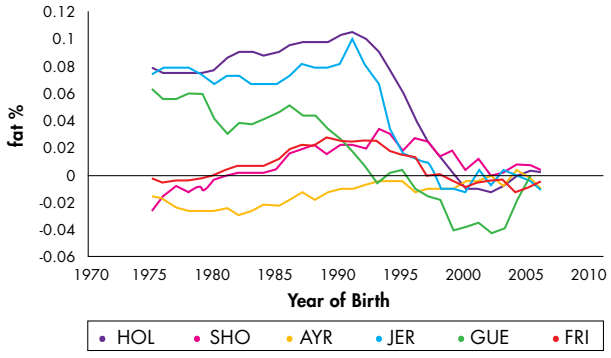
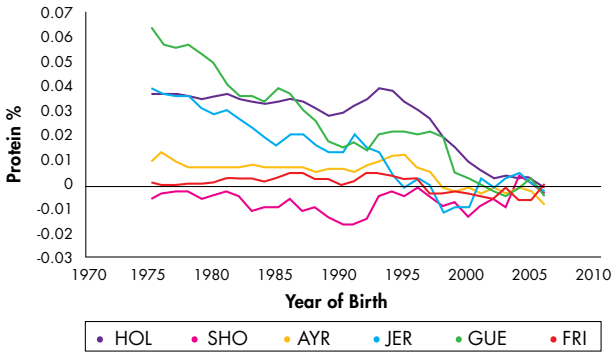


Figure 1.5: Genetic trends for UK cows – fat (%)



Milk protein percentages saw genetic erosion in the mid-1990s, although there is some evidence that this is levelling-off in most breeds recently **(Figure 1.6)**.

Figure 1.6: Genetic trends for UK cows – protein (%)



The genetic changes in fat and protein percentages are, of course, not surprising in view of the well-established negative genetic link between milk solids concentration and yield **(Section 2)**.

Assessing longevity changes

Despite concerns voiced over longevity in recent years, genetic trends highlight a steady improvement in this important characteristic in almost all breeds

The genetic trend for UK cow lifespan has actually been fairly flat and has seen a small increase in recent years.

This trend is reflected in the steady increase recorded in pedigree Holstein Friesian herd life in recent years to an average of 3.5 lactations/cow in 2006, while production rose to average just over 8000 litres/cow/year.

This data dispels the myth that higher-yielding cows have shorter productive lives.

Assessing fertility changes

A number of studies have highlighted the decline in UK dairy fertility over the past 30 years **(Table 1.2)**.

Table 1.2: Fertility changes in the UK dairy herd

Measure	Early 1980s	Early 2000s	Early 2010s
Calving Interval	384 days	410 days	420 days
First Service Pregnancy Rate	55%	40-42%	40-42%

DairyCo Pd+ programme 2010

Furthermore, data from England, Ireland and North America clearly show fertility decreasing over the years, as the genetic potential for milk yield has increased.

Studies in the USA suggest an increase of one day in the Calving to Conception Interval for every 100kg increase in lactation milk yield.

Other studies, however, reveal that reduced fertility is by no means an inevitable consequence of increased genetic merit for milk production.

This is confirmed by the fact that some high-yielding, highly productive herds are able to maintain excellent fertility.

Equally, research has found no evidence for any decline in heifer fertility with increasing genetic merit.

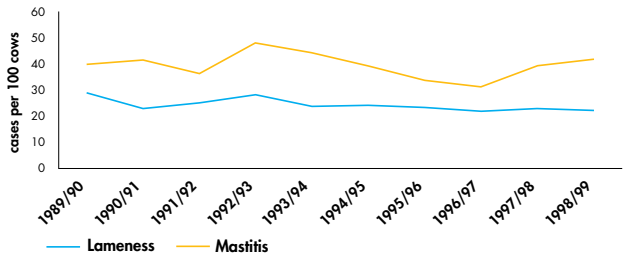
While most fertility problems are considered to be related more to the way cows are managed and fed than to their genetic make-up, in fact, breeding has a valuable role to play in improving fertility. Management improvements are explored in more detail in the Pd+ Farm Improvement Programme.

Assessing health change

While there is considerable anecdotal evidence of increasing levels of lameness and mastitis in UK dairy herds in recent years, this is not borne out by studies to date.

Analysis of some of the best available UK herd health data reveals no sustained increase in the incidence of either lameness or clinical mastitis over the 10 years to 1998/99 **(Figure 1.7)**.

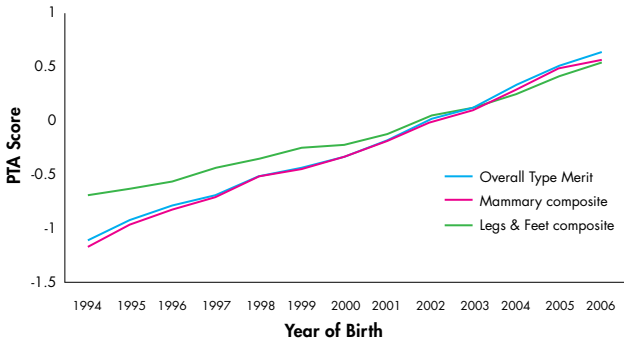
Figure 1.7: Trends in production diseases in UK dairy herds



Source: DAISY Research Report 5: The cost of poor fertility and disease in UK dairy herds (trends in dairy herds over 10 seasons); Esslemont and Kossaibati, 2002.

Type records for pedigree Holstein Friesian cattle show marked increases in average genetic ratings for legs and feet and udders over a similar period **(Figure 1.8)**.

Figure 1.8: Holstein Friesian breed improvement trends (1994-2006)



The improvements in legs and feet and udders achieved over recent years seem to have been sufficient to offset the increased pressures caused by more intensive production, resulting in little visible change in lameness or mastitis levels. Figure 1.8 shows that there has been a 1.8 gain in standard deviations for mammary composite PTA and a 1.2 standard deviation improvement in legs and feet composite over the same period (1994 to 2000).

The value of breeding

While the rates of genetic gain achieved for various dairy traits over the years are relatively easy to calculate, putting a financial value on changes achieved through breeding in an individual herd is far more difficult.

Breeding changes involve a number of different components – potentially positive and negative.They also take place over an extended period of time and through several generations of animals.

This makes it almost impossible for most herds to put a monetary value on gains made through improved breeding.

In marked contrast, the additional profitability achieved through more direct and immediate feeding and management improvements is far easier to estimate and monitor.

Valuing breeding improvement

Long-term University of Edinburgh/SAC investigations comparing cows bred for maximum improvement in fat and protein production with those maintained at the average genetic level under identical feeding and management regimes, give a good insight into the value of improved breeding **(Table 1.3)**.

Table 1.3: Performance of Langhill selected and control lines (1989/90-1991/2)

Performance in first 38 weeks of lactation	High input (low forage)		Low input (high forage)	
	Selected*	Control**	Selected*	Control**
Milk Yield (kg)	7569	6537	6372	5360
Fat (%)	4.19	4.20	4.54	4.47
Protein (%)	3.09	3.19	3.07	3.09
Fat + Protein (kg)	550	481	482	398
DMI (kg)	4803	4603	4149	3948
Efficiency (MJ Milk/MJ feed)	0.418	0.377	0.440	0.374
Liveweight (kg)	610	610	601	590
Condition Score	2.55	2.70	2.45	2.59
Margin over all feed costs (£)	1008	825	914	712

**Selected lines-bred since the early 1970s to bulls with the highestkg fat + protein proofs **Control lines- bred since the early 1970s to bulls with average kg fat + protein proofs. Source: Genetic Improvement of Cattle and Sheep, Geoff Simms, Farming Press, 1998.*

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Compared to their average genetic merit contemporaries, the Langhill work shows that cows consistently bred from bulls with the highest weight of fat and protein proofs:

- Produce markedly higher yields under both high and low input systems
- Need not necessarily produce lower fat or protein percentages
- Have higher intake capacities
- Are more efficient at converting feed energy into milk energy
- Generate substantially higher feeding margins.

Overall, the animals bred for combined weight of fat and protein produced similar yields from 1 tonne of concentrates as their unselected contemporaries did from 2.4 tonnes.

The permanent and cumulative nature of genetic improvement, of course, means that continuous use of higher rather than average merit bulls offers even greater financial benefits over the generations.

The value of good breeding decisions is underlined by the fact that a straw of semen from a good proven AI sire costs little more than one from an average bull. The more important element of this is making sure that the straw of semen is used on the 'right' cow to maximize its effectiveness.

Equally, as many producers have found to their cost, it can take a very long time to overcome a single bad breeding decision; especially when made across a large number of cows. Scale becomes an issue when you are learning from your mistakes.

Although the Langhill study demonstrates the power of selection for production traits, there are, of course, many more factors contributing to overall profitability. A balanced breeding approach, which also considers the important health and fertility traits alongside production, will give even greater benefits.

Improvement priorities

The increase in average milk yields across the UK over the past 25 years is a clear reflection of the emphasis placed on production improvement in dairy breeding.

With the possible exception of fat and protein percentages, it is reassuring that this concentration on breeding for production has not led to a serious deterioration in genetic value for other important characteristics.

In marked contrast to some parts of the world, this is almost certainly due to the better-balanced approach to across-the-board improvement taken by UK herds in their breeding.

Establishing future needs

In its most simplistic terms, producing a set amount of milk from as few a cows as possible means lower overall herd feed requirements and lower replacement costs, as well as lower labour, machinery and building needs.

Importantly too, it also means a lower environmental impact through reduced herd slurry and methane production.

Modern milk production will therefore inevitably demand an increasing emphasis on fertility, health and longevity, alongside yield in breeding.

When accounting for lost milk production, fewer calves, excessive culling and extra veterinary treatments, the cost of poor fertility in the average-performing 100-cow herd has been estimated at over £25,000/year (Table 1.4).

Table 1.4: The annual cost of poor fertility in a 100 cow herd averaging 7000 litres

Component	Average	Target	Excess over target	Cost per unit (£)	Cost per 100 cows (£)
Calving interval (days)	425	365	60	2.00	12,000
Failure to conceive culling rate (%)	19	6	13	1,000	13,000
Total cost (£/herd)					25,000
Total cost (£/cow)					250
Total cost (p/litre)					3.57

Source: Average NMR performance: Esslemont (personal communication 2010).

Research has been conducted into the advantages and disadvantages of a 365 day calving interval. It has found that:

- Extensive dairy farms need to capitalise on grass growth and match peak yield with availability of forage
- The recommended calving interval for extensive dairy farms is 365 days
- Intensive dairy farms are characterised by high yielding cows, fed high levels of concentrate and housed indoors for much of the year
- High yields are associated with an increased risk of health and reproductive problems
- In intensive systems, depending on the genetic merit of the cows and their persistency, calving intervals greater than 365 days are acceptable.

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Similarly, the total cost of clinical mastitis in an average 100-cow herd has been calculated at over £12,000/year, with lameness costing more than £7200/year **(Table 1.5)**.

Table 1.5: Annual clinical mastitis and lameness costs in the average-performing herd

Disease	Total cost per average case	Average incidence per 100 cows	Total cost per average 100 cow herd
Clinical mastitis	£308	40%	£12,320
Lameness	£279	26%	£7254

Source:- DairyCo 2010.

Longer-lived cows also have an important role to play in raising herd profitability, with annual savings of around £13,500 calculated in a 100-cow herd through reducing the replacement rate from 25% to 15% **(Table 1.6)**. This figure fluctuates greatly in relation to the market value of replacements and the figure has virtually doubled in the last five years as input costs have increased and the availability of replacements has diminished.

Table 1.6: Annual heifer replacement costs in the average-performing herd

Replacement rate	25%	15%
Heifer cost (£/head)	1350	1350
Annual cost (£/100 cows)	33,750	20,250

Source: Average of pedigree and non-pedigree calved heifer valuations given by DEFRA as Bovine TB compensation in England (Feb 2010).

The value of longevity, depends on the extra herd life not being at the expense of either a reduction in individual lactation productivity or an increase in management costs.

As well as longer-lived, more productive cows, dairy businesses managing larger numbers of cows with fewer people will need more robust animals that are easier and cheaper to manage, this has lead to the recent trend for health and fitness breeding objectives.

More robust cows will:

- Cope better with intensive conditions without going lame or getting mastitis
- Get back in-calf rapidly and reliably despite high levels of milk production
- Incur lower veterinary, medicine and AI costs
- Be less time-consuming to manage.

Assessing improvement responses

Genetic studies indicate that selecting for improved udder health, fertility and lifespan, in addition to production, will be the most profitable future strategy.

The rate of production improvement will be markedly less than that achieved by selecting for production alone.

However, reductions in both calving interval and mastitis incidence and increases in lifespan are calculated to increase the annual financial response to breeding by around 80% – giving an advantage of more than £4/cow/year over a production-only improvement strategy **(Table 1.7)**.

Table 1.7: Expected annual responses to different breeding strategies

	Production only	Production + lifespan + mastitis + calving interval
Milk (kg)	103.0	53.2
Fat (kg)	4.56	1.88
Protein (kg)	3.36	1.94
Mastitis (lactation)	0.003	-0.0004
Calving Interval (days)	0.60	-0.57
Lifespan (lactations)	0.0	0.099
Total Response (£)	**5.41**	**9.63**

Source: Returns from Genetic Improvement in Dairy Cattle over a 20 year horizon; Pryce, Simm, Amer, Coffey and Stott; Proceedings of BSAS, 2000.

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Recommended approach

While successful breeding programmes do not require a detailed knowledge of animal genetics, an understanding of the way genetic merit is assessed and expressed in modern dairy breeding is essential if the information available is to be used reliably and cost-effectively **(Section 2)**.

Whatever the focus of breeding improvement efforts, industry experience suggests the greatest overall value for most herds will come from a five-step process.

Breeding+ Five-step Improvement Plan

- **Planning the improvement approach**
  Based on an objective assessment of current herd strengths and weaknesses **(Section 3)**
- **Short-listing a number of proven sires with the right abilities**
  Using the latest independent bull information from the DairyCo Breeding+ website **(Section 4)**
- **Calculating the annual semen requirement**
  Taking into account replacement and pregnancy rates and any semen stocks **(Section 5)**
- **Buying only the semen needed from several short-listed sires**
  Negotiating the best prices, delivery arrangements and flexibility **(Section 5)**
- **Breeding these sires to the best cows and heifers**
  Putting all animals not needed for replacement breeding to a quality beef bull to maximise surplus calf value **(Section 6)**.

The Breeding+ Five-step Improvement plan provides at-a-glance guidelines to raising your herd profitability through breeding

Non-Holstein herds working with very much smaller gene pools will, of course, need to adapt their approach to make the most of their breeds' more restricted genetic resources **(Section 7)**.

The sheer pace of discovery within genetic science at a molecular level is set to provide all breeds with a whole host of new and exciting opportunities for improvement through breeding **(Section 8)**.