BREEDING GOOD PRODUCERS THAT ARE HARDY COWS

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Production

The annual per-cow production of South Island herds has increased by thirty per cent since 1990, and the trend is accelerating (Figure 1).

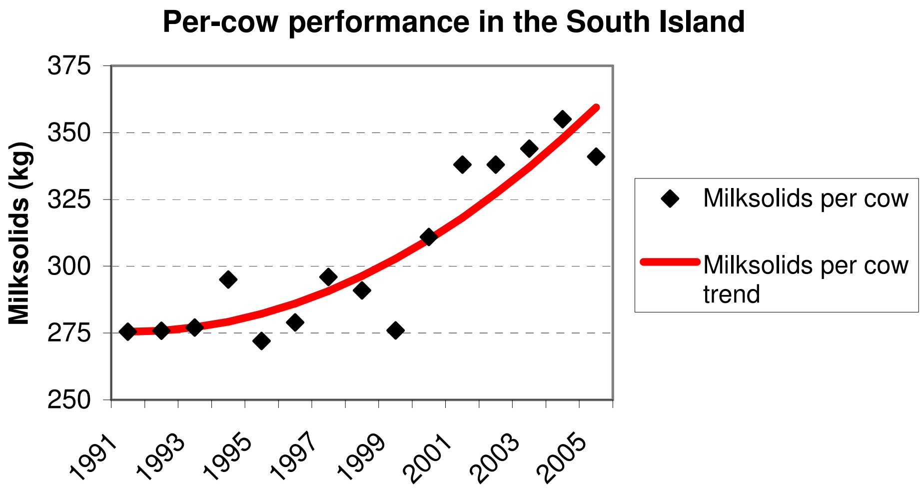

Figure 1: Accelerating improvement in South Island cow performance

Nationally, there has been an extraordinary increase in the number of dairy cows during this period – from 2.4 million cows to 3.9 million. Two thirds of this increase has been in the South Island. Breeding selection directed towards improved milksolids yields has been successful. In particular, genetically improved cows have responded to South Island farmers' management systems that enable the improved cows to express more of their genetic potential for milksolids yields. This is a key determinant of feed conversion efficiency on these farms, achieved by the familiar mechanism of obtaining more kilograms of milksolids production to offset the essentially fixed cost associated with maintaining the body weight of the cows in the herd.

Hardiness of modern cows

Expansion of the national herd by 1.5 million cows in only 15 years does not suggest that there is any fundamental frailty of modern cows at the genetic level, which would endanger survivability and might limit dairy farmers' plans to expand their businesses rapidly.

In fact the average number of lactations per cow has increased from 4.7 in the mid-1990s to 4.9 currently. However, during the rapid expansion of the national herd quite a large number of cows have been retained that would otherwise have been culled for reasons such as elevated milk somatic cell counts or late calving dates. Consequently, more current cows are likely to be carrying non-genetic effects – such as tissue damage from previous infections – than 10 years ago. Farmers also face a greater challenge in operating effective herd reproduction and animal health programs, with much larger numbers of cows being managed per staff member. The multiple challenges lead to increased interest in the place of functional traits in breeding programs.

Functional traits

Functional traits are the characteristics of a cow which increase efficiency – not by higher production but by reduced costs of input (Groen, 2001). Dairy cattle genetic evaluation centres often provide information on functional traits such as:

- Feed efficiency (associated with body size or liveweight)
- Cow fertility
- Udder health (somatic cell score and/or udder conformation)
- Longevity (functional longevity is herd life after correcting for increased herd life arising from high production, because production is excluded from the definition of functional traits)
- Body condition
- Calving difficulty
- Workability (milking speed, temperament, udder conformation)
- Feet and leg problems (conformation, locomotion, and/or lameness incidence)
- Lactation persistency

The New Zealand Animal Evaluation system provides genetic information for all but the last of the traits on this list, as well as many other conformation traits – and estimated breeding values for lactation persistency will soon be available. Directly or indirectly, nearly all these functional traits are included in calculation of the Breeding Worth (BW) index.

Liveweight

Feed demands for body maintenance increase with liveweight and impose associated costs. New Zealand's across breed evaluation system requires that these costs are recognised when evaluating the overall expected efficiency of dairy cows because of the large differences in body size between breeds. Some recent survey work indicates that farmers do not often volunteer liveweight when asked to nominate only five traits for inclusion in a selection index. The researcher has drawn this finding to the attention of the New Zealand Animal Evaluation Limited directors (Scott Townshend, unpublished data). It is worth noting that farmers' comparisons of productive efficiency – between cows in their own herds – are much more accurate if they submit liveweight data for use in the Animal Evaluation system. The emerging technology of walk-over dairy weighing systems promises to revolutionise data collection for this important functional trait.

Cow fertility

If cow fertility is not included in the breeding objective, then there is a tendency for genetic decline in reproduction as an unwanted side effect of selection for production. This genetic effect is likely to be small across a time period like 10 or 15 years, because the antagonistic genetic relationship between reproduction and milksolids is quite weak – although it is somewhat stronger between reproduction and milk volume. Cow fertility has only recently been included in our national breeding objective. Some gradual genetic deterioration in cow fertility did take place in the years after 1989.

The units for cow fertility breeding values are percentage likelihood of a cow to re-calve in the first 42 days of the herd's calving period. Comparing cows with fertility breeding values of +5% (high genetic merit) with cows with breeding values of -5% (low genetic merit) you can expect 10 more high merit cows per hundred to calve in the first 42 days of the herd's calving period – if they are managed together, are the same age, and are given the same opportunity to get in calf. The average cow fertility breeding values for New Zealand cows, grouped by their year of birth, are shown in Figure 2.

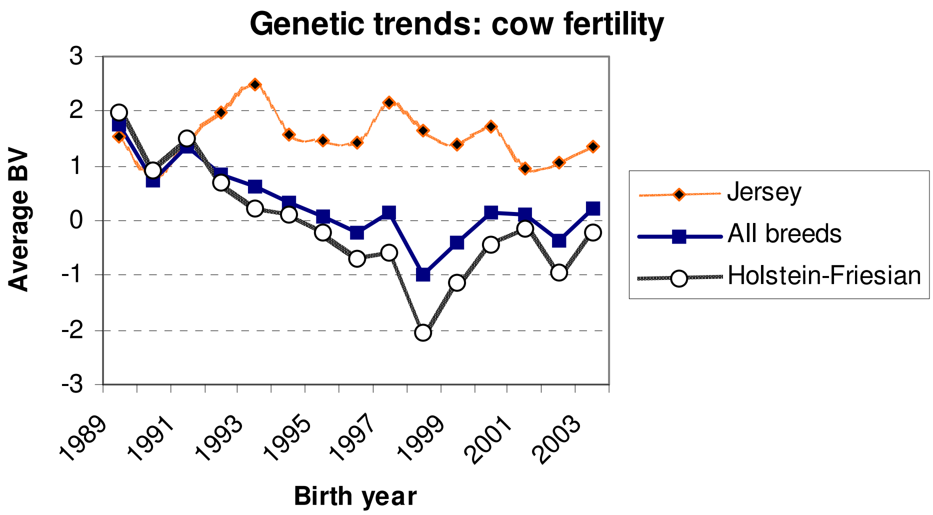

Figure 2: Genetic trends for cow fertility

Inspection of Figure 2 suggests that decline in the genetic merit for cow fertility has occurred, but by itself cannot explain a drop in re-calving rate in a typical herd of any more than 2% across a 15 year period. Any larger problems that farmers are having with herd reproduction arise from management changes as herd sizes expand, and from seasonal factors that can affect feed quantity and quality around mating time. Figure 2 also shows that the main contributing genetic change was the drop off in genetics for cow fertility in Holstein-Friesian cows occurring across the birth years 1990-1999. During that period the percentage of overseas Holstein in black and white cows increased from 12 to 40 percent. Three noteworthy developments since then are:

- the Holstein percentage in the pedigrees of black and white cows has stabilised around 40 percent, so the increasing Holsteinisation of the 1990s has not continued
- the least well suited Holstein genetics for cow reproduction in seasonal dairying no longer feature in the ancestry of black and white bulls graduating from progeny testing, and
- relatively favourable genes for cow reproduction present in the Jersey breed have been disseminated more widely in the national herd.

Now that cow fertility is included in the BW index, genetic selection is expected to lead to 0.34% annual improvement in cows' ability to become pregnant in the first 42 days of the herds as we move into the future (Pryce et al., 2006).

This analysis shows that New Zealand farmers will have to continue to emphasise herd reproduction management as the main factor affecting performance. You can see that this is true from the fact that herd breeding values for cow fertility vary across only a small range of 5%. This small range is in marked contrast with the range of herd reproduction levels, where the average of the top quartile of herds is 78% of cows pregnant in the first 42 days of mating, compared to 57% for the bottom quartile of herds.

By international standards New Zealand farmers are highly skilled at managing their herd reproduction, and they work with cows that are uniquely suited to seasonal dairy farming. Sustainable seasonal dairy farming relies on achieving average calving intervals very close to 365 days. Amongst countries reporting calving intervals, only New Zealand achieves this fundamental requirement for seasonal dairying (Figure 3).

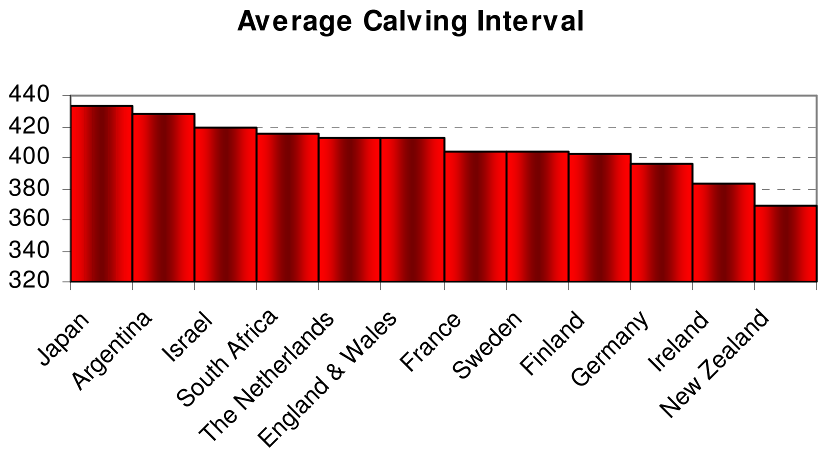

Figure 3: Average calving interval in dairying countries (Source: International Committee for Animal Recording)

Udder health

Udder health in New Zealand dairy cows is commonly monitored by tracking somatic cell counts in milk (SCC). This is another characteristic of cows where genetic selection for milksolids production can lead to a moderately unfavourable SCC outcome as an undesirable side effect. The comments about cow fertility apply also to udder health. Selection for milksolids yield has been moderately unfavourable for milk somatic cells. Recent genetic trends are shown in Figure 4.

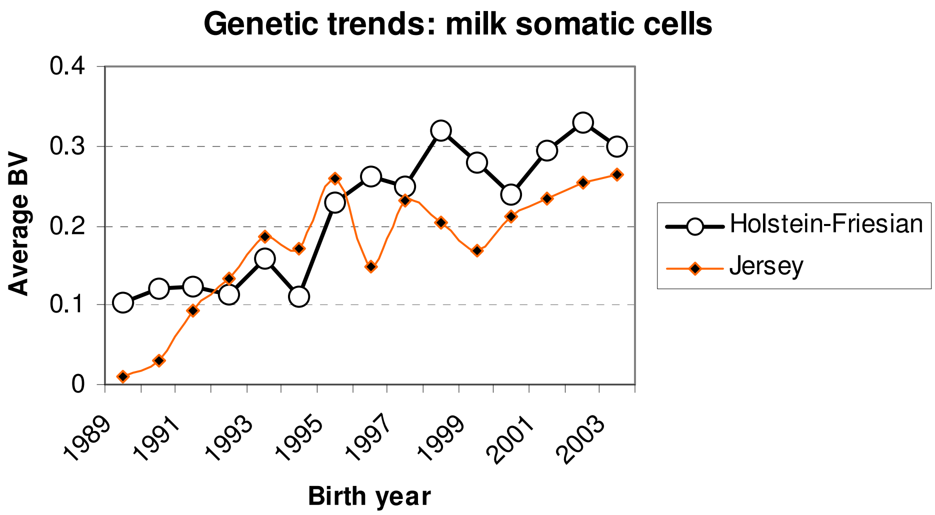

Figure 4: Undesirable recent genetic trends for milk somatic cells

The upward genetic trend for milk somatic cells has been undesirable. The units for reporting the estimated breeding values give an approximation that 0.3 increase corresponds with about 40,000 SCC increase in typical circumstances. Since the inclusion of milk somatic cells in the BW index, the unfavourable genetic trend will be reversed – with BW selection expected to bring about an annual reduction of around 3,000 SCC in the future.

Functional longevity

Longevity has direct consequences for the profitability of dairy cows, and warrants direct inclusion in dairy farmers' breeding objectives. However, it is a complex trait that depends on the cow's production, fertility and health, and some physical and management characteristics.

Functional longevity is the ability of the cow to delay culling for reasons other than low production. It is calculated by correcting total longevity for the effect that higher production has on increasing the length of time cows are retained in herds. In New Zealand, this concept is extended to calculate a breeding value known as 'residual survival'. Residual survival is defined as "herd-life after accounting for the genetic effects of production, liveweight, milk somatic cells and fertility on herd-life". Residual survival is calculated to avoid double counting effects in the Breeding Worth (BW) index – and measures the expected ability of a cow to resist culling for reasons other than traits included directly elsewhere in the index. Over the past 20 years the genetic trend for residual survival has been positive, indicating improvement in the workability and conformation attributes of the cows.

Body condition

Genetic selection for increased milksolids production has resulted in cows that can mobilise body condition to support lactation, even to their own detriment (Roche, 2005). Estimated breeding values for body condition of daughters at day 60 of the first lactation are now available for New Zealand dairy sires (www.aeu.org.nz/page.cfm?id=74; last accessed 19 April 2006). Inspection of these breeding values shows a wide range amongst currently available sires, with some greater than + 0.3 and others lower than - 0.4. This spread of greater than 0.75 of a Body Condition Score (BCS) amongst the elite sires shows that selection against excessive body condition loss is possible, while maintaining good progress in improving production.

BCS is an important indicator trait for the genetic evaluation of cow fertility. In this way, BCS is indirectly included in the BW index, and BW selection is expected to arrest the decline in BCS that was reported by Dexcel researchers, comparing recent and previous strains of black and white cows (Macdonald et al., 2005). In future a very small increase in BCS at day 60 of the first lactation can be expected as a result of BW selection.

Conformation and longevity

Conformation traits in the Animal Evaluation system are used to help predict the remaining herd life for cows that are still alive – cows that are no longer alive have a completed herd life record, and no prediction is required. Conformation traits consequently have an indirect impact on the BW index via the residual survival trait included in the index. All the conformation traits are used as longevity predictors for the cows that are still alive, but many of them have only a very small impact.

Research has identified the four conformation traits that are most genetically associated with longevity in New Zealand herds. These are capacity, fore udder, udder overall, and dairy conformation (Winkelman et al, 2000). However, the associations are not very strong.

The degree of genetic relatedness between traits is known as “genetic correlation”. Genetic correlation is reported in numbers from -1 through zero to +1. Where genetic correlation between two traits is zero, selection for one of the traits will have no consequence for genetic change in the other trait. However, where the genetic correlation between two traits is noticeably different from zero selection for one of the traits will have consequences for genetic change in the other trait – and the bigger the difference from zero the larger these consequences will be. Genetic correlations can be put to practical purpose if an important characteristic of cows (such as reproductive efficiency) is only partially observed early in the cow’s herd life, but is strongly genetically related to a characteristic that is readily recorded early in the cow’s herd life.

Genetic correlations between some traits in the New Zealand dairy cattle population are shown in Table 1.

Table 1: Genetic correlation between traits

Traits	**Genetic Correlation Between the Two Traits**
Milk Yield & Protein Yield	0.85
Milkfat Yield & Protein Yield	0.70
Body Condition Score & Submission Rate	0.50
Milk Yield & Liveweight	0.28
Body Capacity & Survival to 5th lactation	0.20
Udder Overall & Survival to 5th lactation	0.18
Body Condition Score & Milkfat Yield	0
Milk Somatic Cells & Submission Rate	-0.15
Milk Yield and Submission Rate	-0.22

Inspecting Table 1, it is apparent that even the conformation traits that are the best predictors of herd life – such as body capacity and udder overall – are not very accurate predictors of survivability.

Management traits and workability

Farmers score four management traits relating to the cow's acceptability at milking time and breeding values are published for adaptability to milking, shed temperament, milking speed and overall opinion. In general, these traits are more powerful than the conformation traits for predicting longevity. Like the conformation traits, they have an indirect impact on the BW index via the residual survival trait included in the index. There has been some genetic improvement in all the workability traits, and in the udder overall trait (Figure 5).

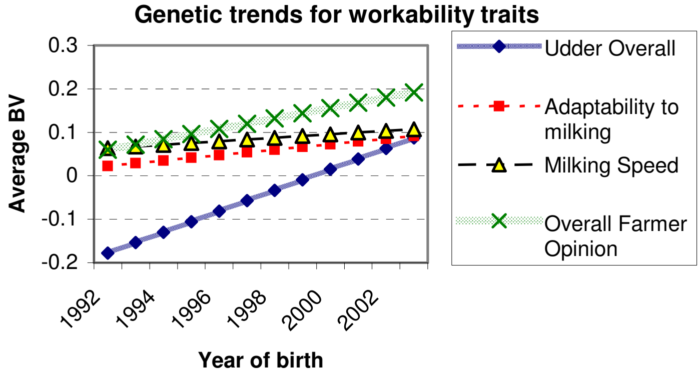

Figure 5: Favourable recent genetic trends in workability traits

Calving difficulty

When heifers and cows have a difficult calving there are costs to farmers beyond the associated production losses. In the Animal Evaluation system the effect of bulls in causing calving difficulties for the heifers and cows bearing their calves are reported as calving difficulty breeding values. Bulls' calving difficulty breeding values compare the percentage of assisted calvings expected when they are mated to yearling heifers – the higher the BV, the higher the expected percentage of assisted calvings. The average BV of sires born in 1985 is set to zero and all breeds are evaluated together – as they are for all animal evaluation breeding value estimates. Although the calving difficulty BV is expressed in terms of assisted births in first-calving heifers, the BV can also be used to identify bulls that are expected to cause increased rates of assisted calving for cows carrying the bull's calves.

There is a very pronounced breed difference for the direct sire effect on calving difficulty (Figure 6).

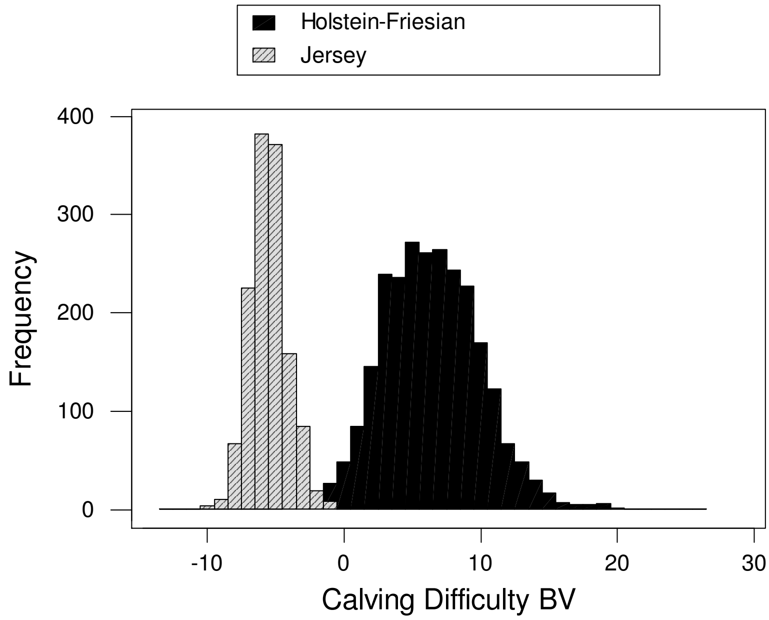

Figure 6: Distributions of bulls' Calving Difficulty Breeding Values

Feet and leg problems

Amongst disease and health problems, mastitis accounts for around 47% of reported problems, feet and leg problems for 20%, and calving difficulty for 13%. Retained placenta and uterine infections at 8%, and metabolic diseases at 7%, are the next most important categories (Xu et al, 2003). This information justifies the inclusion of feet and leg problems as an important functional trait category.

Genetic evaluation of lameness is difficult to conduct directly because systematic recording of lameness data is usually undertaken only with experimental herds. New Zealand research has shown that cows with intermediate curvature of their rear legs survive longer than cows with either sickled legs or straight legs (Berry, 2005). However, this conformation characteristic is not a strong predictor of survivability of New Zealand cows. Further work is needed to find the most useful characteristics of cows to record in progeny testing schemes, in order to provide better genetic information to assist in reducing feet and leg problems.

Lactation persistency

Early lactation is a stressful period for dairy cows, during which their daily output of energy exceeds their ability to consume equivalent energy. Consequently, they are in a state of negative energy balance at this time. Cows that produce a relatively smaller proportion of their total lactation yield in the stressful period during early lactation can be expected to experience less pronounced or less prolonged negative energy balance in early lactation. A possible way to increase total production without increasing the occurrence of disease or reproductive failure is to select for increased lactation persistency in addition to total production. This selection strategy would be associated with flatter lactation curves, which would be well-suited to Fonterra's capacity charge due for introduction in milk supply payments in 2006/07.

Lactation persistency breeding values for dairy sires will be introduced in New Zealand during the 2006/07 dairy season.

BW index

In the BW index, traits with a direct impact on farm profitability are combined together – using economic values calculated in dollar terms to assign relative emphasis to each of the traits. Research for Dairy InSight has estimated approximate expected responses to BW selection.

The expected annual responses to BW selection are 3.8 kg increased milksolids per lactation, 0.2 kg increase in mature liveweight, 0.34 increase in percentage of cows calving in the first 42 days of the herd's calving period, and a reduction of 3,000 SCC averaged across lactation.

It is possible to breed good producers that are also hardy cows. Future improvements will rely on good recording of important functional traits in the crucial progeny testing herds. This is where our cows of the future are initially tested to see that that they are robust enough for New Zealand production systems.

Acknowledgments

I would like to acknowledge the financial contribution of New Zealand dairy farmers to much of the research presented in this paper via Dairy InSight.

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