

# Developments in the Dairy Cattle Breeding Industry

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## 1. Introduction

The dairy breeding industry can be traced to the establishment of AI services, and so has a history of approximately 50 years. While the structure of the industry and its links with other services to the dairy industry (inseminations, milk collection, milk recording, dairy consultancy etc) vary somewhat between countries, it is possible to see some general trends. This paper will focus on the general at the expense of the specific, and I apologise in advance if my comments do not apply in every particular instance. As further qualifications, my comments refer specifically to Holsteins, and they are strongly coloured by experiences in the UK.

## 2. Some History

Most dairy breeding programmes have a national origin, and in some countries can be traced to individual co-operatives within a country. While fresh semen was used, the geographical and numerical impact that a bull could have was quite restricted. Even after the development of frozen semen, demand continued to be for the local product. To varying degrees this situation was maintained by veterinary regulations, which restricted the free movement of semen between countries, and by committee structures that tended to dominate sire and bull dam selection decisions.

While Canadian AI studs achieved some success in exporting semen, especially into pedigree herds, the major

interest in imported semen can be traced to the FAO-sponsored Polish trial, which demonstrated differences in genetic merit between countries (see for example Jasiorowski *et al.*, 1988). This led specifically to a strong demand for US and Canadian semen and embryos from these countries also had a substantial impact on breeding programmes throughout the world.

In addition to the associated services mentioned above (e.g. milk recording, consultancy etc.), each dairy industry came to be serviced by a genetic evaluation unit, whose role was to evaluate bulls and cows in the national milk recorded population. Now we also have INTERBULL bull proofs, currently for production traits, but soon to be extended to type (conformation) traits. These developments are helpful when evaluating bulls from different countries, offering a more comprehensive approach than is possible from conversion formulae between pairs of countries.

## 3. The Present Situation

While the use of imported semen has declined in some countries, commonly after a period when the national programme was heavily based on imported genetics, in countries such as the UK imported semen has become very much an accepted part of the industry.

Table 1 identifies the origin of Holstein bulls currently marketed in Great Britain. Given that the total dairy cow population is only approximately 2.2 million (National Dairy Council, 1997),

the total of over 560 bulls is in itself somewhat surprising. The list includes two major groups of bulls, those with UK production proofs, and those with converted foreign proofs. Almost 60 percent of the marketed bulls come with only converted proof information. Of those with UK proofs, many will have previously been tested elsewhere, and their

semen then marketed in the UK (only a very small number of mainly Canadian bulls were imported into the UK and first tested here). Obviously the UK dairy industry is now heavily influenced by overseas breeding programmes, with only seven percent of currently marketed bulls having been first registered in the UK.

*Table 1.* Holstein bulls currently (September 1998) marketed in Great Britain.

Country of bull registration	Bulls with UK proofs	Bulls with foreign proofs
Canada	88	35
USA	64	176
UK	39	
Netherlands	17	25
Italy	13	21
France	6	40
Germany	3	16
New Zealand	1	18
Denmark	1	2
<b>Total</b>	<b>232</b>	<b>333</b>

The second trend is the growing importance of international links between programmes. This can take various forms. For example, sires to breed the next generation of bulls for testing are now selected from around the world, as to some extent are bull mothers. Secondly, various alliances have developed to market semen from international sources. More importantly, some breeding companies operate testing programmes either across countries or in different countries.

The extent of these developments varies between countries. Nevertheless, they signal a move towards an agribusiness dimension to dairy cattle breeding, which I will discuss in more detail later in this paper. The market place has become more international in its thinking, and more competitive. While not inevitable, it is possible to think of a future industry dominated by 6-10 international

players.

#### **4. The Operation of Breeding Programmes**

The design of most breeding schemes follows that set out by Robertson and Rendel (1950), while Skjervold and Langholz (1964) described the contributions of the various pathways. The key selection decisions involve the choice of bull mothers, and from which sires to breed the next generation of sons for testing. Commonly offspring of foreign dams are sourced as embryos.

One recent change has been to larger progeny groups. Much early research focussed on optimum progeny size for maximising genetic progress, commonly for a given test capacity. However it has

been appreciated only quite recently that by increasing progeny group sizes, reliability is increased, as so too is the expected variation among the proofs of a group of bulls. As it is only the extreme few bulls which are marketed (in the Netherlands and the UK it would appear that semen from only about five percent of bulls tested are marketed), a greater “spread” of proofs means that more bulls exceed extreme thresholds. The lead by the Dutch in this area is now being followed elsewhere. Increased progeny sizes also obviously helps in evaluating low heritability traits, notably those associated with fertility and disease occurrence.

The major alternative to progeny testing over the intervening years has been MOET (for Multiple Ovulation and Embryo Transfer), first described by Nicholas and Smith (1983). They suggested that superovulation could be used to produce large groups of full sisters, and selection of bulls could then be based on their sisters’ (family) performance. In the herd structures they examined, the shorter generation interval possible with this approach would offset the lower accuracy of bull evaluation.

A number of MOET schemes were subsequently established, although only the UK programmes (Strathie and McGuirk, 1995) followed the original Nicholas and Smith (1983) design. Despite evidence of a correlation with subsequent progeny test results, sib-tested semen proved difficult to market in the UK in competition with progeny tested semen, commonly from overseas, but also usually of higher predicted genetic merit. The role of the MOET nucleus in the UK has gradually changed to become a test station for potential bull mothers, along the lines of the Delta herd in the Netherlands.

Embryo transfer itself has had a considerable impact on all breeding programmes, enabling fewer cows to be used as bull mothers. While this has

commonly been achieved by conventional superovulation, sometimes on maiden heifers, ovum pick-up from live cows has also been used (Wagtendonk-De Leeuw *et al.*, 1998). The extent to which the average age of bull dams can be reduced depends on the opportunity to retain or buy-back offspring of dams that, when milked, are found to be superior.

## 5. Determinants of Genetic Change

In terms of genetic consequences, those breeding the next generation of bulls now determine both the direction and the rate of genetic progress. At the same time, commercial breeders and farmers decide what they can sell. But while breeding programmes must obviously be in accord with current market needs selection strategy and sourcing procedures reflect future market requirements.

What do farmers obviously be in accord with current market needs, selection strategy and sourcing procedures want? Even here we can see changes, fuelled at least in part by the availability of new genetic information. In a general sense, all breeders and farmers want “production” and “type”, although interpretations of what these terms mean vary both between and within countries, and perceptions can vary over time. However, we are now seeing bull proofs for an increasing number of traits that are thought to be associated with profitability. This list would include somatic cell counts, longevity, daughter fertility, and, in some countries already, incidences of specific diseases.

Let me illustrate some of these developments with reference to the UK, and consider how breeding organisations appear to respond.

Consider firstly production traits. In the UK, after a period of confusion following the introduction of milk quotas in the 1980s, the launch of a production index (PIN) in the early 1990s did much to

clarify the need to improve production and with it overall efficiency. PIN uses the Predicted Transmitting Abilities (PTAs) for the production traits, gives differential weights to Protein and Fat, with a negative weight to carrier (Milk). It is similar in intent to INET (the Netherlands) and INEL (France). The weights used reflect the market prices for the milk constituents, feed and quota costs, while the negative weight given to carrier reflects the relatively high proportion of the milk used for processing, as well as transportation and cooling costs.

In the UK, PIN figures prominently in semen marketing, and bull rankings on PIN are frequently promoted. However, bearing in mind that PIN reflects the expected difference in daughter profitability per lactation, there is still quite wide variation in the PIN values for bulls currently (September 1998) marketed (Figure 1).

The UK market has also traditionally shown a strong interest in type. The justification for this is based

- (1) in part on the fact that “good type” means higher prices for surplus stock in the pedigree sector, and
- (2) a more general view that functional type traits, associated with feet and legs and
- (3) udders and teats, are associated with better longevity and lower levels of involuntary culling or wastage.

Whatever the rights and wrongs of these beliefs, an insistence that a bull has a standardised Type Merit proof of at least +1 (top 16% of the population) has almost become a minimum requirement across the whole UK industry, whatever other merits the bull may have.

In a very real sense, these sorts of requirements still drive the sourcing standards of the major breeding companies looking to supply the UK market. The hope would appear to be that if these overall objectives are met, then the variation among the bulls tested at a particular time will throw up individual animals which meet particular needs. Easy calving sires for use on heifers would be a good case in point.

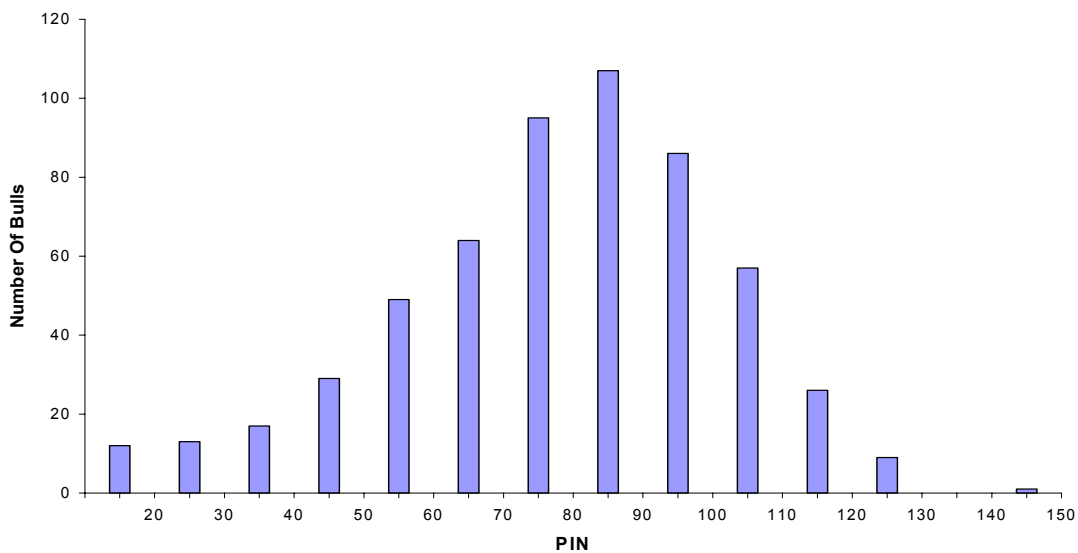


Figure 1. The distribution of PIN values for bulls currently (August 1998) marketed in Great Britain.

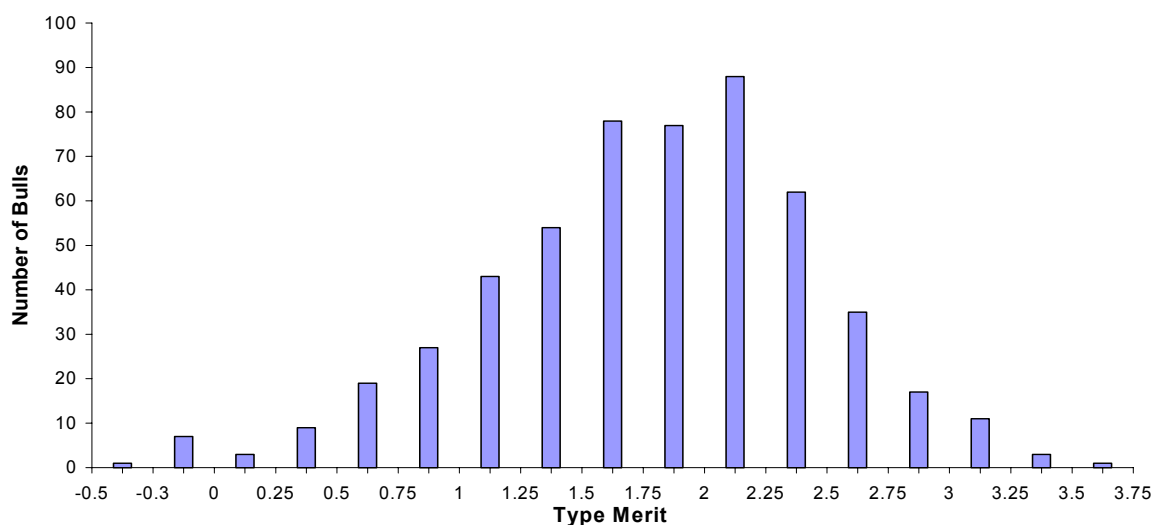


Figure 2. The distribution of standardised type merit proofs (PTAs) for bulls currently (August 1998) marketed in Great Britain.

I see little evidence as yet that breeding companies are responding specifically to any of the more recent proof information now available in the UK. For example, Somatic Cell Count proofs were first published in 1998, based on UK daughter test results. Correlations with comparable proof information from other countries are very high, and conversion formula, bulls can be used to compare bulls from different supplying countries.

If we look at SCC proofs (both UK and converted) for currently marketed bulls, we can see that there is very wide variation, with the x axis reflect the expected percentage change in daughter cell counts, relative to the national base (Figure 3).

An obvious question posed is how much attention farmers should give to SCC proofs when buying semen. SCC proofs are of potential interest because of

- the penalty system for bulk tank test results,
- the high genetic correlation of SCC with clinical mastitis, a trait not routinely recorded in the UK,

- the anticipated adverse effect of high counts on a cow's own milk production, and
- the combined effect that these factors will have on the likelihood that an animal will be culled.

General advice to farmers has been to choose bulls that are below average (i.e., are expected to lower cell counts in their daughters), but this ignores possible opportunity costs. A more precise answer depends on the economic importance of SCC, relative to the other traits that ought to be included in a herd's breeding objectives.

Research on this topic is continuing in the UK. However, it is already clear is that the relationship between a change in bulk tank cell counts and the expected price benefit and is not linear (Veerkamp *et al.*, 1996). For herds with either extremely high or low cell counts, it matters little what bull they use, as the herd will not change price bands. But at intermediate cell counts, small changes can have a large effect. Such patterns make general recommendations difficult if not impossible.

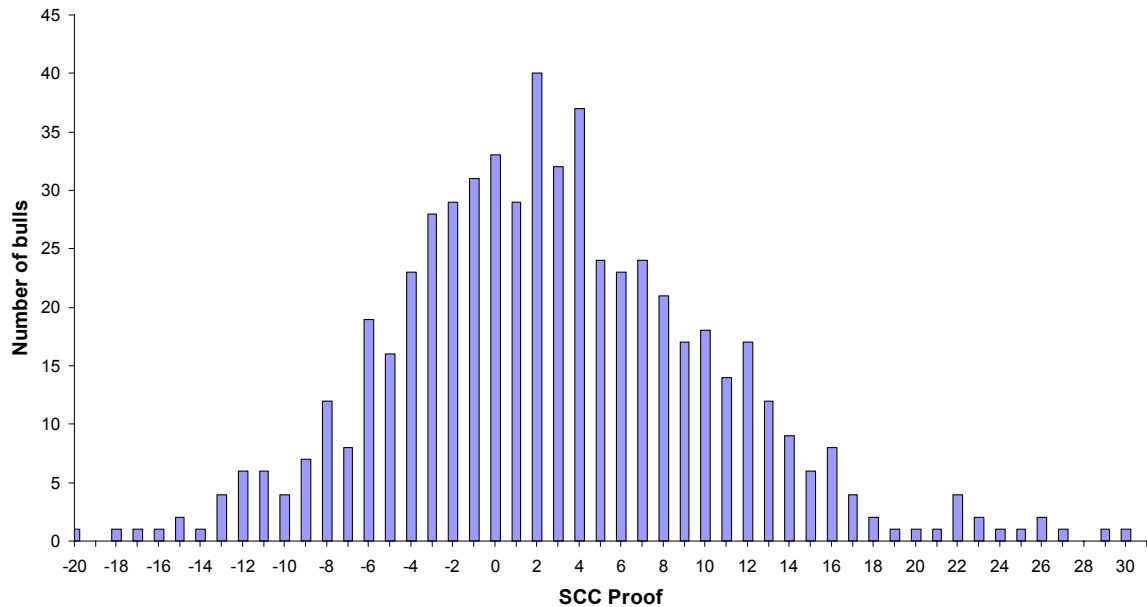


Figure 3. Distribution of proofs for SCC for bulls currently marketed (August 1998) in Great Britain.

The case of SCC perhaps illustrates some more general points. It is interesting that attention to these proofs is directed towards the semen purchaser, even though their selection decisions can only have short term genetic effects. Longer term trends are dictated by the breeding decisions made by the breeding companies. If they ignore SCC information when choosing say bull sires, then, in the absence of more direct information on mastitis incidence, and with continuing pressure on high production and overall type, the long term trend in SCC is likely to be adverse. In targeting semen buyers, the hope is that their buying patterns will in time impinge on company breeding objectives. However, this rather roundabout approach may take considerable time to correct undesirable genetic trends.

Secondly, any serious evidence that the economic benefit of any trait, such as SCC, is not the same for all herds increases the perceived need for customised indexes (Bowman *et al.*,

1996). Pressure in this direction will grow with bull proofs for more traits. Daughter fertility is another trait where a common economic value is unlikely, as it will vary with milk yields and herd lactation and calving patterns. Whilst we may take comfort in the robustness of indexes, farmers are often uncomfortable with global indexes, preferring instead to emphasise how their needs differ from the norm. AI companies also tend to give overall profit indexes at best a cautious welcome, sensing that farmers will still use independent culling levels on the increasing numbers of component proofs, to further reduce the number of bulls which are acceptable to their herds needs. Whether the introduction of customised indexes will help or hinder rational selection decisions by semen buyers remains to be seen. How they might affect breeding decisions by the companies is also unclear.

## 6. Breeding Programmes in the Future

I have already commented on the tendency of breeding organisations to take greater control over one aspect of their programmes, that of cow selection. Assessments based on performance in a nucleus herd should minimise problems of slippage, as defined as the average difference between parental average merit and final progeny test, which presumably is the result of an inflated dam proof due to preferential treatment (see McGuirk *et al.*, 1997). There is also UK evidence that offspring performance is more accurately predicted when dams are tested in a nucleus (B.J. McGuirk, unpublished data).

The use of nucleus herds facilities has often been associated with “in-house” genetic evaluations”, which of course can be done whenever they are required, and using whatever models and parameters are thought to be appropriate. When carried out prior to an official proof release, but on the same data, this enables superior bulls to be brought back early for semen collection.

In Genus we took this one step further, to better monitor our progeny testing programme. This currently spans over 2500 herds, for which we receive daily feeds from a milk recording organisation, which describes all inseminations, calvings and milk test results in these herds. This helps spot identification errors, provides an operational log for all relevant events in the programme, an early warning of semen distribution problems, and an indication of when we can anticipate initial proofs. If the programme could be organised around fewer herds, then it is possible to think of further steps along this path. For example, DNA samples could be collected from all calves, to verify parentage and possibly use Marker Assisted Selection. The traits recorded would be those demanded by the breeding organisation. Farmer members

could be rewarded financially or possibly through better management information.

But such operational enhancements and possibilities should not disguise some of the fundamental difficulties currently faced by breeding organisations. They essentially have only one product to sell, proven bull semen, and the revenue of the small proportion of bulls returned to the market has then to pay for the cost of the testing programme. Marketing of young bull semen can be risky, if it is priced below the cost of frozen bull semen. And without cheap and effective cloning, there is little opportunity to diversify into, say, the production of crossbred heifers.

Currently the breeding objectives followed by each breeding organisation are similar, and these are determined by what the market is prepared to buy. While the emphasis on traits may vary somewhat between countries, companies wish to supply a global market. Looking at this question from a scientific rather than a commercial perspective, evidence of appreciable genotype\*environment interactions would suggest a role for niche marketing. While the larger breeding organisations may to some extent market specific bulls at different markets, they have generally been selected as products from within one programme, rather than the result of pursuing different breeding schemes. Large players, possibly benefiting from economies of scale and an international brand image, are naturally then reluctant to then specifically develop product for particular production systems or climatic conditions.

All of the above is borne out by the similar lists of bull sires used by the different breeding organisations, and by the similar breeding of bull mothers. While numerous people have pointed out the implications that this for inbreeding, it also means a lack of product diversification among the competitors.

As Bichard (1997) has pointed out, product differentiation is discouraged by the public availability of bull proof information. With the parallel problems of over capacity in semen availability, the demand by the market for proven bull semen, the cost of progeny testing and the low proportion of proven bulls that meet “standards”, breeding companies will face challenging times.

Bichard (1997) has suggested that cattle breeding organisations could come to resemble pig breeding companies. Certainly increased scale and sophistication are needed if we are to see the full exploitation of expensive gene mapping and cloning technologies. However, what keeps the industry structure relatively stable is the calculation and publication of genetic information on the available bull population.

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