THE AUSTRALIAN DAIRY HERD IMPROVEMENT SCHEME

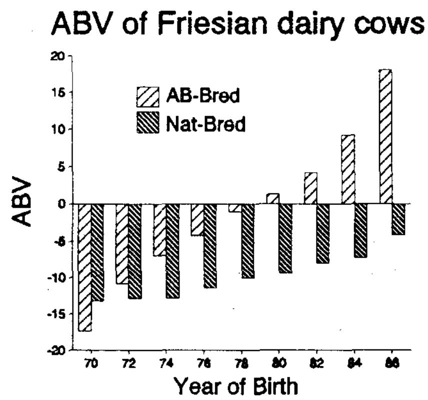
L P JONES

ADHIS c/o DARA
P.O. Box 500,
East Melbourne 3002

INTRODUCTION

ADHIS is responsible for calculating Australian Breeding Values (ABVs) for a number of production, type and workability characters each year.

An indication of the genetic improvement of the dairy population can be seen from a plot of ABVs of cows by year of birth. This is not an exact measure of the genetic improvement but gives some indication of the level of change. It is clear from the figure that there has been rapid change in the last decade. The change has been greatest amongst daughters from artificial breeding but there has also been some improvement in the natural-bred population. A check of the numbers of daughters for each bull shows that farmers are only interested in using semen from bulls with high ABV.



Factors influencing the rate of genetic change of Australian dairy cattle include:

high level of herd recording for herd management,
relatively cheap artificial breeding,
use of imported genotypes either directly or as sires of young bulls,
progeny testing,
use of ABVs in purchasing semen,
ADHIS

1. Herd recording has been used for many years and is used by many farmers for management reasons. Production is recorded for about half of the Australian cows. The number recorded fluctuates with the level of prices for the industry as herd recording represents an important cash cost to farmers. This has provided a large source of data to compute breeding values with little extra cost. Until recently, only about half the recorded cows had sire information on file , and were not used to compute ABVs. This suggests that most farmers record production for their own herd management, rather than to contribute to genetic improvement of their breed.

2.With modern technology, the basic cost of semen collection is low. The major cost to the AB industry is keeping bulls awaiting possible collection, once their genetic merit is known. About 20 bulls could supply the total semen requirements in Australia, but there are about 1000 bulls at AB centres awaiting proofs, as a bull is about 5 years of age when its first ABV becomes available.

3. Most young Friesian bulls are sons of North American bulls. The importance of North American genes has increased with ABVs as most bulls with high ABVs have been sons of Canadian or US bulls. Semen from North America is now competing with semen from local centres. A similar change is likely to occur with the Jersey breed as a few North American bulls have had high ABVs.

4. Over 200 young bulls are progeny tested each year in Australia. These are highly selected on pedigree. Only a few of these will be good enough to be part of the proven teams. The average merit of young bulls is so high the farmers can use progeny test semen with little worry especially if they use several young bulls.

5. Farmers are now only interested in bulls of high ABV. Bulls with low ABVs for production soon become hamburgers.

6. I believe that ADHIS is contributing to the genetic change in the population. Farmers can now buy semen with confidence and have a large choice of bulls.

TRAITS

Production: ADHIS released its ABVs of bulls for milk, fat and protein production, as well as for fat and protein per cent in January 1983, using a sire model. In 1984, we changed to an animal model, warts and all. In this model ABVs of bulls and cows are computed simultaneously. In 1990, there were 1.1 million cows in the Friesian analysis and 0.4 million in the Jersey analysis.

Other traits: ABVs are produced using a sire model for:
- milking speed, temperament and likeability,
- survival,
- type (30 characters),
- calving ease, but at present the amount of data is limited.

All the above ABVs are produced annually with an aim to release them in early July.

Preliminary breeding values (PBVs). Analyses of data for current young cows are run in December and March to get preliminary estimates of genetic merit (PBVs) for young bulls. These PBVs are sold to the AB centres to allow for preliminary culling or preparation for semen collection. This enables the demand for semen for outstanding young bulls to be met when ABVs are available. The previous years' ABVs are used for proven bulls. The correlation between the PBV and the final ABV of young bulls is about 0.95 so they are valuable information for the industry.

CURRENT MODEL

Main features of the current model are :

All lactations are used, with less weight for later lactations.

Use is made of individual test day data to include lactations in progress and to maximise the heritability.

Records are corrected for within-herd variance to reduce the effects of unequal treatment.

All male relationship links are used but female-female links are used only within herd at present.

Account is taken of overseas proofs where they are available. We exchange proofs with New Zealand, Canada and United States. To date, the accuracy of conversions have been limited by the number of overseas bulls used, as well as suggestions of favoured treatment to daughters of some overseas bulls, but the conversions ensure that first ABVs of young bulls are not seriously in error.

To the best of my knowledge, this was the first use of the animal model in a large dairy population anywhere in the world except that we didn't call it that at the time. It was later that 'animal model' became the buzz word. USA and Canada used the animal model for the first time in 1989. There are fairly minor differences between our model and that used in North America.

DEVELOPMENT

Credit for the level of service provided by ADHIS is due to a number of people:

Farmers, AB personnel, dairy industry officers and geneticists who provided the initial demand for improved methods of genetic evaluation. As herd recording first started in Australia in 1925 and artificial breeding in 1952, there has been a long period of development. We should note that there were reasonable methods of estimating genetic merit prior to ADHIS, but these were mainly used on a centre by centre basis with little opportunity to compare bulls from different centres.

Previous staff of the Victorian Department of Agriculture who did much of the initial programming and liaison with state herd recording schemes.

My predecessor, Geof Robinson, who developed the model used, and who was convinced an animal model was feasible despite many doubters, myself included.

Current and previous members of the ADHIS management committee who have continued to encourage and support me and other staff, even when things haven't gone exactly as planned.

Members of the various committees of ADHIS who have offered ideas and comments. Despite conflicts in the industry, there has been increasing co-operation between groups advising ADHIS.

Other ADHIS staff who have helped improve and promote ADHIS.

Dairy Research and Development Corporation (DRDC) who have provided major funds for ADHIS, a small input still coming from the Victorian Department of Agriculture.

Catalysts that have helped in developing ABVs include:

The development of BLUP methodology encouraged interest in better evaluations. The previous method (Modified Contemporary Comparison) gives estimates closely correlated with the animal model but now the latter is preferred.

Improvements in computer hardware and software have reduced computing costs as well as making possible many calculations that did not seem to be feasible 10 years ago. Services can now be supplied more quickly and cheaply. People are now running on micro-computers, evaluations that were once very difficult on main-frames.

USE BY INDUSTRY

To date we have provided the results to the industry but have left the decisions to the farmer. While the farmers have only been interested in bulls with high production ABVs, they have taken notice of milking speed, temperament and type. In the opinion of some geneticists, they have probably given too much notice to these characters. This has been due partly, because our method of expression in earlier years of ABVS for milking speed and workability was misleading. A few indices have been suggested to farmers to enable them to take note of several characters.

PROBLEMS WITH THE MODEL

There are a few basic assumptions with the model used as with any other model. These are:

Pedigree recording is accurate and reasonably complete. Errors in a cow's pedigree obviously affect her ABV and that of her alleged sire. We check for obvious errors in the pedigree but such errors will still occur. Errors in a sire's pedigree have more effect because of the sire's greater importance. Where pedigree information is lacking, the ABV will be regressed to the population base. As the population has been improving, the ABVs of animals with little pedigree data is likely to be underestimated.

Favoured treatment of some cows can cause errors in ABVs. There is a basic assumption that there is only random environmental variation between animals in a herd-year-season. Records are pre-corrected for age of cow and stage of lactation. Any differences between a particular herd and the state average for these effects will produce some errors. More serious errors occur where any animal receives favoured treatment. This does occur in herds that feed to production. Cows who start lactation at a high level will be fed better and so receive better treatment for the remainder of the lactation. As the effects of favoured treatment may carry to subsequent lactations we reduce the problem by giving greatest weight to early lactations.

Flow-on effects: Where cows receive favoured treatment because of their pedigree then her ABV and that of the sire will be over-estimated. There is some evidence that this occurs. Canadian bulls with high priced semen tend have higher ABVs than bulls with lower-priced semen even when they have a similar Canadian proof. A bull such as Glenafton Enhancer has over 100 sons being proven in Australia. If his ABV is too high then a son's initial ABV will be too high, and will gradually approach its true value. Also, ABVs of daughters will be overestimated, and the daughters will be more likely to be used as dams for contract mating.

A consequence of using the animal model is that errors flow on to relatives and even competitors. Where a young bull has gone through a progeny test program as an unknown bull there is little worry about his ABV. Where he has received publicity or has been used only in a special part of the industry there may be errors in his proof. We alert producers to some problems by giving the number of daughters and herds for each bull. Everett showed that the bias in proofs of young bulls owned by AB centres in the US was small, but that of bulls owned by syndicates was often overestimated.

Ignoring linkage between dam and daughter, when they are in different herds, means that the pedigree is deficient for some cows. This underestimates the ABV of daughters of top cows if the daughters are sold. This limitation to the model was done to make the model feasible. With improved computers we intend to accommodate such linkages in the future. The limitation has had little effect on ABVs of cows of farmers breeding their own replacements.

PROBLEMS IN ACCEPTANCE AND USE OF ABVS

Bull ABVs for production, milking speed and temperament have been accepted readily. If anything, they may be taken too seriously. A difference of 5 kg for fat + protein ABV between two bulls may not be significant, but the effect on demand for semen will be pronounced. This can have important consequences for semen production centres, whose profitability depends on having a few popular bulls.

Combining ABVs of different characters can be a problem. There has been a tendency to avoid use of bulls with below average ABVs for characters such as milking speed and temperament, even though the frequency of problem daughters is small for some of these bulls. Part of this reluctance has been due to our method of expression of ABVs and it is hoped that changing this will make the characters clearer to farmers.

Type ABVs have presented a few problems. The large number of characters (30) does make it difficult to put weights on the traits. Also the traits are presented in terms of units of genetic standard deviation rather than in the units of measurement. This makes it difficult to predict the likely change in these characters when particular bulls are used. Studies of the effect of type and other characters on survival will assist in deciding their economic importance (Ahlborn-Breier and Wickham 1986, and Beard and Jones 1991).

Cow ABVs have had more problems in acceptance. Some of this has come from anomalies arising when dam and daughter are in different herds. Most problems arise from the fact that the heritability of the characters is less than one. While farmers accept that about 50 daughters are needed to get a reasonable estimate of a bull's ABV, some find it hard to accept that the cow with the highest production may not get the highest ABV. We often get complaints that we give too much weight to pedigree in computing ABV.

On the other hand AB centres have expressed an interest in a predictor of genetic merit for cows, based purely on male pedigree as 1/2 sire + 1/4 maternal grand-sire +... This is the index we would use if the heritability was near zero. This index is also logical if there are concerns that some cows received favoured treatment for any reason. Obviously, such estimates are biased if daughters of particular bulls receive favoured treatment.

IMPORTANT BULLS

There have been a few bulls which have had large impact on the population, especially with Friesians. Most of our population has genes from a Canadian bull, Linmack Kriss King. More recently the most widely used bulls have been sons of another Canadian bull, Roybrook Starlite or his son Glenafton Enhancer.

To date this has not created serious inbreeding problems but indicates the concentration that can occur. Considerable publicity has been given to a lethal gene, citrullinaemia, for which Linmack Kriss King and some of his descendants have been carriers. Such genes should not be economically important unless close relatives are mated. About half the widely used bulls in North American two years ago were sons of either SWD Valiant or Carlin-M Ivanhoe Bell and these bulls will have some impact in Australia through their sons. As the viability of a centre depends on having a few bulls with high ABVs, centres have tended to have bulls of similar background. Fortunately, a few new super bulls have been found that are not closely related to other top bulls .

FUTURE TRENDS

It is clear that the Australian population is following the North American population so that much of the change has been due to migration. This has occurred despite the very different management conditions. In North America, most dairies are feedlot with high levels of production and a short herd life (about 3 lactations). Daughters of these bulls have performed well under pasture conditions and there has been no sign of problems with herd life even though the average herd life in Australia is greater than five lactations.

There is no doubt that the effect of importations will continue as most bulls awaiting proof are sons of North American bulls or are imported. Also, there is a fair amount of imported semen being used commercially. As there is a world-wide surplus of semen, North American semen production centres look to Australia as an important market. In the sort-term this increases the choice available to Australian farmers, but will add to the cost pressures of Australian semen production centres and threaten their viability. The long-term value of continued importations will depend on the presence of genotype-environment interactions.

POSSIBLE DEVELOPMENTS OF ADHIS

There is always scope to improve any system, either to provide new services or to provide the same service more economically. The system will be modified to allow for links with dam and daughter in different herds. This would have been too costly previously, but with newer computers is more feasible.

To date, ABVs have been supplied individually to industry with only informal indexes suggested by ADHIS staff and others for combining ABVs. The only formal combining of characters has been for a fat+protein ABV. Differences in payment systems between states and between manufacturing versus liquid milk market have reduced demand for an overall index. However with the individual results in the computer it is more efficient if likely indexes are computed either by ADHIS or by semen distribution centres.

Adoption of pricing that more truly reflects the values of milk components has increased the importance given to protein. It is worth considering something equivalent to New Zealand's payment breeding index.

If we get more agreement on the economic worth of workability, survival and type ABVs, an overall index would assist farmers select bulls more effectively than at present where there tends to be independent culling. DRDC is now funding a project to enable development of ABVs for overall profitability.

GENOTYPE x ENVIRONMENT INTERACTION

We have assumed that such interactions are not important. The fact, that bulls selected on the performance of their daughters under feedlot conditions, have produced daughters performing so well under pasture conditions suggest that such interactions are small. Many cows in the Friesian breed would have half their genes of North American origin. There may be genes in our original population that offer some adaptation to our management system. There is a danger that these genes may be lost. Without a fairly large trial it is difficult to demonstrate whether these fears are justified. Goddard (1985) showed that a fairly small interaction is needed to make a selection for our conditions worthwhile. It may be necessary to modify our model to take account of genotype x environment interaction.

EVALUATION ACROSS BREEDS

A number of red breeds are now using bulls from different breeds. A multi-breed BLUP is being developed to enable all animals in these breeds to be compared.Clearly if a demand arises there is no reason we cannot compare cows in all breeds. This would reduce some of the problems with mixed breed herds. At present Jersey x Friesian cows are in a different analysis to Friesian x Jersey cows. It is important to remember that the relative merits of different breeds depend on performance in several characters.

NEW TECHNOLOGY

There is great interest in new techniques of reproduction and molecular biology. The main value of new reproductive techniques is the ability to increase selection differential, especially among females. Developments in physiology and molecular biology allow for more selection on males early in life. The current scheme allows gains made by any techniques to flow into the industry. Bulls with high ABV will be used widely, no matter how the original selection was made. Similarly, if cloning becomes routine we can modify our model to enable clones to be evaluated, provided there is no favoured treatment.

If techniques are used to transfer genes to produce new products, the animals' ABVs for production will still be relevant. The only situation I can think of that the current system would not handle is where changes are due to recessive genes. Incorporation of such genes will be slow and special programs will need to be adopted.

GAINS TO THE INDUSTRY

It is clear that farmers are making use of ABVs. However it is difficult to determine the effect on farm profitability. The dairy cow is an efficient converter of pasture into quality food. At last year's conference, Bryant queried whether further genetic changes would improve this efficiency. High producers eat more. Studies by Bryant (1985) indicate that the higher consumption relative to maintenance has improved efficiency of conversion of grass to milk solids. We hope future changes are also effective. In assessing the economic worth of changes in production, I normally assume that about half the value of the extra production goes to increased profit. Obviously this assumption is very crude. A cheap, if inaccurate, method of estimating feed consumption at pasture would be of major benefit to the industry. Use of a measure of size (Madgwick et al. 1991) or a subjective estimate of size by type classifiers would be of value, but a more direct measure would be more useful in case there are differences in maintenance requirement between high and low producers. Such a measure would also be more acceptable to some producers who find it difficult to accept that a small cow may be more profitable than a large one with similar milk production.

CONCLUSION

ADHIS has helped the dairy industry make better use of available information so that farmers can purchase semen with justified confidence. The need for ADHIS will not be less in the future even with new technologies if the Australian industry is to maintain control of genetic changes. However it will need to be responsive to changes in the industry, especially if we can provide a breeding value for a measure of efficiency and profitability.

ACKNOWLEDGMENT

ADHIS is funded by the Dairy Research and Development Corporation.

REFERENCES

AHLBORN-BREIER, G. and WICKHAM, B.W.(1986) Proc. NZSAP 46:83.
BEARD, K.T. and JONES, L.P. (1991) Proc AAABG 10:
BRYANT, A.(1985) in The Challenge: Efficient Dairy Production:422
EVERETT, R.W.
GODDARD, M.E.(1985) Proc. AAABG 5:51.
MADGWICK, P.A., BEARD, K.T. and GODDARD, M.E. (1991) Proc. AAABG 9: