# The genetic structure of the Jersey breed in South Africa

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*Received 18 February 1987*

An analysis of the pedigrees of a random sample of 100 South African-bred first-calf Jersey heifers registered in 1985 showed that most breeders have concentrated on a closely interrelated group of *Marlu* animals and their descendants. Of the 17 young bulls under progeny test during 1985, nine were grandsons of *Milestone Generator*. The levels of current and long-term inbreeding were only 1% and 4% respectively. In spite of an on-going programme of progeny testing, the generation interval was only 35,3 months in comparison with approximately 50 months at several earlier stages of breed development when pedigree selection and natural service were used.

'n Ontleding van die stambome van 'n ewekansige monster van 100 Suid-Afrikaansgeteelde eerstekalf-Jerseyverse wat in 1985 geregistreer is, het getoon dat die meeste telers op 'n nouverwante groep *Marlu* diere en hul afstammelinge gekonsentreer het. Van die 17 jong bulle wat gedurende 1985 getoets is, is nege die kleinseuns van *Milestone Generator*. Die peile van huidige en langtermyn-inteelt is onderskeidelik slegs 1% en 4%. Ten spyte van 'n voortgesette program van nageslagtoetsing is die generasie-interval slegs 35,3 maande in vergelyking met ongeveer 50 maande by verskillende vroeër stadia van rasontwikkeling toe stamboomseleksie en natuurlike dekking in gebruik was.

**Keywords:** Jersey cattle, breed structure, progeny testing, inbreeding, generation interval

## Introduction

Selection on the basis of the results of the progeny testing of dairy bulls has been considered for many years to be the most effective method for the genetic improvement of milk yield and milk constituents. When a bull has been proven to be superior in these respects the intention is to use him by means of artificial insemination on cows not involved in the testing of bulls. This is done not only to reap the maximum economic benefit from the progeny testing programme, but to breed sons from cows of above-average producing ability, to be tested in their turn. When there is a choice among proven sires, breeders tend to concentrate on the best ones and this leads to a narrowing of the genetic base of a breed. This is a problem which arises from breeder reaction to the results of sire evaluation. Because breeders are usually more interested in their own breeding programmes than in those of others, there is a danger that too many breeders will concentrate on too few sires. It is, therefore, necessary to periodically monitor the genetic structure of a breed.

## Materials and Methods

This analysis concerns the structure of the Jersey breed in South Africa from which the first-calf heifers registered in 1985 were bred. Heifers were used because they are more representative of a breed, being subject to less intensive selection than bulls. A random sample of 100 such heifers was drawn with the aid of the computer facilities of the South African Stud Book Association. In order to estimate the effective numbers of herds contributing sires, grandsires and great-grandsires in the male line, the required information was collected for each heifer in the sample. The herd in which each male ancestor was bred was specified by the appropriate prefix or suffix. The method of analysis was that of Robertson (1953). To estimate the percentage contributions of these ancestors to the genes carried by the sample heifers, a full pedigree was drawn up to the grandparental generation for each heifer. A single line was then drawn from the pedigree of each grandparent, the sire or dam in each generation being determined according to a table of random numbers. Such sample lines were continued for six to eight generations. The method of analysis was that of Wright & McPhee (1925) and this served also to provide estimates of the current and long-term coefficients of inbreeding. The results are compared to those of similar analyses by Laubscher & Allan (1958) and Allan (1959, unpublished).

## Results and Discussion

### The effective number of herds contributing sires, grandsires and great-grandsires in the male line

Prior to the widespread use of artificial insemination in conjunction with national bull testing schemes, Robertson (1953) showed that a pyramidal structure consisting of three strata had developed in the Friesian breed in Britain. This was the result of the policy of breeding and selling bulls. He quantified this phenomenon by defining and measuring the effective numbers of herds supplying sires, Hs, grandsires, Hss, and great-grandsires, Hsss.

This form of analysis was applied to the Jersey breed in South Africa using a sample of 100 heifers registered in 1959 (Allan, unpublished) and to the 1985 sample under consideration. The two sets of results are given in Table 1.

In 1959 most South African Jersey breeders used natural service. From the first column of figures it would appear that a relatively large number of herds was involved in each stratum, i.e. approximately 30 top stud herds and 70 multiplier herds. This represented a

**Table 1** Effective number of herds contributing sires, grandsires and great-grandsires in the male line of South African-bred Jersey heifers registered in 1959 and in 1985

| | 1959 | 1985 |
|---|---|---|
| Hs | 69 (31)[a] | 24 |
| Hss | 38 (3) | 15 |
| Hsss | 23 (2) | 3 |

[a] The 1959 figures in brackets are explained in the text

relatively broad genetic base to the breed in South Africa. However, at that time importation was fashionable so that many of these herds were, in fact, in other countries. The apparent structure was, therefore, not representative of South Africa. To get a clearer picture of the dependence of the breed in South Africa on importation, the overseas herds were grouped together in each stratum as one 'herd'. This procedure yielded the figures in brackets. They show that in the 1950s most of the top stud breeders in South Africa used imported bulls and that they represented, effectively, only 31 multiplier herds. The 1985 figures show that the introduction of artificial insemination in conjunction with an on-going national bull progeny testing scheme, which allows breeders the freedom to determine their own breeding policy within the limits of the scheme, has considerably reduced the effective numbers of herds supplying sires, grandsires and great-grandsires. Virtually all the herd prefixes appearing in the Hss level are included in the Hs level. Marlu accounts for 60% of the great-grandsires appearing in the male lines of the pedigrees of heifers registered in 1985 with no other herd contributing more than 10%. A pyramidal structure, typical of many breeds of farm livestock in other countries prior to the introduction of progeny testing and artificial insemination, has, therefore, never been a characteristic of the Jersey breed in South Africa.

## Percentage contributions of ancestors to the genes carried by heifers registered in 1956 and 1985

Estimates of the percentage contributions of specific animals to the genes carried by samples of heifers were obtained by determining the percentages of random lines in four-line pedigrees which traced back to such animals. The results are given in Table 2.

*Golden Fern's Noble*, *Jersey Volunteer* and *You'll Do's Volunteer* were grandsire, sire and son, whilst *Sybil's Gamboge* was the grandsire of *Oxfordia's Lad*. There is a similar grandsire, sire and son relationship between *Sparkle Supreme*, *Marlu Milestone* and *Milestone*

**Table 2** Animals making the most important percentage contributions to the genes of South African-bred Jersey heifers registered in 1956 and in 1985

| 1956 | | 1985 | |
|---|---|---|---|
| *Golden Fern's Noble* | 10,0 | *Sparkle Supreme* | 13,0 |
| *Jersey Volunteer* | 10,0 | *Marlu Milestone* | 16,0 |
| *You'll Do's Volunteer* | 9,0 | *Milestone Generator* | 16,0 |
| *Sybil's Gamboge* | 8,0 | *Marlu Milady* | 9,0 |
| *Oxfordia's Lad* | 6,0 | *Marlu Fashion's Legend* | 6,0 |

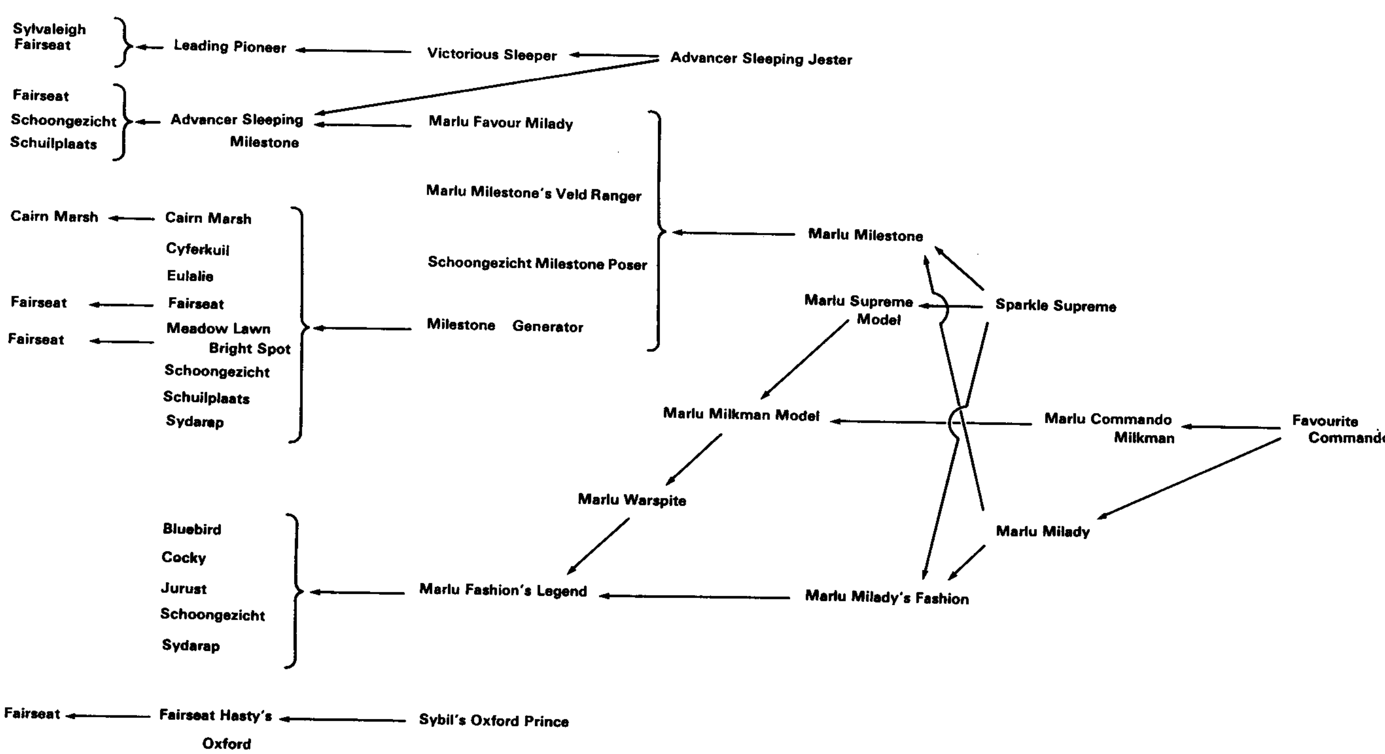


**Figure 1** Structural background to the breeding of first-calf South African-bred Jersey heifers registered in 1985

*Generator*. *Sparkle Supreme* is also the grandsire of *Marlu Fashion's Legend*, whilst *Marlu Milady* is the dam of *Marlu Milestone* and the granddam of both *Milestone Generator* and *Marlu Fashion's Legend*. These close interrelationships between the most important ancestors of the heifers registered in 1985 led to the setting up of a schematic representation of the structural background to their breeding. This is given in Figure 1. The herd prefixes in the first two columns on the left refer to bulls bred in those herds.

The implications of this breeding structure are given perspective by reference to the proposition by Edwards (1959) of the Milk Marketing Board in England 'that two million dairy cattle may be bred annually to 200 sires of known breeding merit without genetic deterioration'. Comment was elicited from a number of leading animal geneticists. Excerpts from the comments of two are pertinent to the South African situation. Robertson referred to the Red Danish breed as it was on 1 January 1958. He pointed out that only 12 proven sires were responsible for more than half of all young bulls on test and that almost all of these 12 had been through the test stations. In his view great care was needed to control this degree of concentration. Lush said that if, for example, 30 proven sires are in use at any one time, preferably not more than five sons of any one sire should be submitted for test and preferably not more than three of them should be selected as proven sires. The principle is to avoid having too many sons from too few sires. The situation in South Africa is that only two bulls, *Milestone Generator* and *Marlu Fashion's Legend*, in the positions of sire, grandsire or great-grandsire have contributed as much as two thirds of the sires responsible for the 1985 heifer registrations. In addition (see Figure 1), these two bulls have very similar pedigrees and a coefficient of relationship of 14%.

## Inbreeding

In the light of the foregoing one might expect the 1985 population to show a significant degree of inbreeding, but this is, in fact, not so. Current inbreeding, defined as that arising from matings between parent and offspring or between sibs, is less than 1%. Long-term inbreeding, defined as that arising from matings between more remote ancestral relatives, which in this case include six to eight generations in most lines, is in the region of only 4%. The equivalent figures for the heifers registered in 1956 (Laubscher & Allan, 1958) were 2% and 5% respectively. It is interesting to note that one or more of the animals in the right hand side of Table 2 appear on the sire's side of 68% of the sampled heifer pedigrees. The equivalent appearance on the dam's side is 41%. However, the same animals do not as yet appear often on both the sire and dam sides of the same pedigree. If there is to be continued testing and selection of descendants of *Sparkle Supreme, Marlu Milestone* and *Milestone Generator*, the coefficients of both current and long-term inbreeding will increase considerably. It was, therefore, worrying to find that, of the 17 young bulls in test during 1985, nine were grandsons of *Milestone Generator*.

**Table 3** Average ages of sires and dams and generation intervals (months) calculated from samples of South African-bred Jersey heifers registered in different years

| Year of sampling | Average age of | | Generation interval |
|---|---|---|---|
| | sires | dams | |
| 1935 | 50,5 | 49,1 | 49,8 |
| 1940 | 55,5 | 48,4 | 51,9 |
| 1945 | 54,2 | 54,4 | 54,3 |
| 1950 | 49,5 | 58,9 | 54,2 |
| 1956 | 49,4 | 53,9 | 51,6 |
| 1985 | 36,1 | 34,5 | 35,3 |

## The grading-up scheme

The current grading-up scheme, which allows for the full registration of heifers after three generations of top-crossing, is proving much more popular than any previous 'appendix' scheme. The number of annual registrations of 'appendix' heifers over the three generations is now approximately equal to the number of registrations of fully pedigreed heifers. This is unlikely to affect the structure of the breed because bulls for test are unlikely to be bred from cows with 'appendix' ancestors. However, it represents an unusually fast rate of increase in breed size and this may make it economically possible to maintain a greater number and variety of proven sires than at present.

## Generation interval

The generation interval is a factor which determines the rate of improvement per unit of time and is expected to increase when sires are selected on the basis of progeny records. This increase is one of the major disadvantages of progeny testing. A simple, practical method of calculation is to determine the average age of parents when their progeny are born. In an earlier study (Laubscher & Allan, 1958) prior to the implementation of large-scale artificial insemination and progeny testing, the generation intervals were calculated at five successive stages of development of the breed in South Africa. The results are included in Table 3. At all five stages the generation interval was in the region of 50 months. It was, therefore, surprising to find that the current generation interval is only 35,3 months. This is 2 years and 11 months. The figure arises from an average sire age of 36,1 months and an average dam age of 34,5 months at the birth of their heifers.

Loubser (personal communication) has pointed out that only 7% of Jersey cows are officially available for mating to young bulls on test. In a breed of limited size, this must restrict the number of bulls which can be tested. It could also imply that breeders are making full use of superior proven sires but this, in fact, is not so. The 100 sample heifers were sired by 75 different bulls. Forty-five of these were younger than 3 years old at the birth of their sampled heifers, 26 were between 3 and 5 years and only four were older than 5 years. Very few of these were AI bulls, most being untested sons and grandsons of *Marlu Milestone, Milestone Generator* and *Marlu Fashion's Legend*. If breeders are made aware of this, it may be possible to induce them to play a more positive role in the progeny testing of young bulls and, at the same time, to derive greater economic benefit from the use of proven sires. The distribution of dam ages is similar to that of the sires, the percentages being 67, 26 and 7 respectively. The reduced average age of dams is probably due, in part, to the influx of 'appendix' heifers and, in part, to stricter culling of older cows as a result of this influx.

## Conclusions

Too many South African Jersey breeders have made use of the tested and untested sons and grandsons of too few superior proven sires. The number of Jersey bulls submitted for progeny testing has been limited. This has been due, in part, to the fact that breeders appear unwilling to make more than a small proportion of registered cows available for the testing of young bulls. They are nevertheless willing to mate a large proportion of their registered cows by natural service to young, untested sons and grandsons of proven sires. If breeders can be made aware of this, it may be possible to induce them to give greater support to the progeny testing programme and thus derive greater economic benefit from it. However, if close inbreeding is to be avoided, bulls with ancestors other than *Marlu Milestone, Milestone Generator* and *Marlu Fashion's Legend* will have to be introduced. It is clear that periodic monitoring of breed structure is necessary.

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