Quantitative aspects of semen imports for South African dairy breeds

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Dairy cattle semen imported from January 1979 to June 1989 consisted of 72% Holstein–Friesian, 13.6% Jersey, 11.5% Ayrshire and 2.8% Guernsey semen. There has been a significant increase in the importation of Holstein–Friesian semen and, to a lesser extent, in that of Jerseys since 1986. An increasing amount of North American Holstein semen was imported during the study period. Almost three-quarters of the imported Holstein–Friesian semen came from only two Holstein lines, viz. Ivanhoe and Chief. Ivanhoe was succeeded by his grandson Elevation and Chief by his son Valiant, which also became successful lines. Owing to semen importations, the Holstein breed of the USA has an increasingly strong influence on the Holstein–Friesian breed in South Africa. The selectiveness of the South African importers by importing semen of mainly two lines could possibly narrow the genetic base of the South African Holstein–Friesian breed in the future, especially if local AI bulls are also related to these two lines. It is recommended that, although standards should be kept high, semen of a wider range of lines should be imported.

Melkrassemeninvoere tussen Januarie 1979 en Junie 1989 het bestaan uit 72% Holstein–Fries-, 13.6% Jersey-, 11.5% Ayrshire- en 2.8% Guernseysemen. Holstein–Friessemeninvoere, en tot 'n mindere mate dié van Jerseys, het 'n sterk styging getoon sedert 1986. 'n Toenemende hoeveelheid Noord-Amerikaanse Holsteinsemen is gedurende die studietydperk ingevoer. Byna driekwart van die ingevoerde Holstein–Friessemen was afkomstig vanaf slegs twee Holsteinlyne, nl. Ivanhoe en Chief. Ivanhoe is opgevolg deur sy kleinseun Elevation en Chief deur sy seun Valiant, wat ook suksesvolle lyne gevorm het. As gevolg van semeninvoere, oefen die Holsteinras van die VSA 'n toenemende sterk invloed uit op die Holstein–Friesras in Suid-Afrika. Die selektiwiteit van die Suid-Afrikaanse invoerders deur semen van hoofsaaklik twee lyne in te voer, kan moontlik in die toekoms die genetiese basis van die Suid-Afrikaanse Holstein–Friesras vernou, veral as plaaslike KI-bulle ook verwant is aan hierdie twee lyne. Alhoewel standaarde hoog gehou moet word, word aanbeveel dat semen van 'n wyer verskeidenheid lyne ingevoer word.

Keywords: Dairy breeds, Holstein–Friesian, semen imports.

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Introduction

There is worldwide concern that the lack of genetic diversity and the continued loss of germplasm resources could become a serious problem in dairy cattle breeding (CAST, 1984; Herman, 1981; Barber, 1983). In the USA a continuing trend towards the use of only one breed, the Holstein, has been observed, owing to the superior whole-milk production potential per Holstein cow (CAST, 1984; Herman, 1981; Barber, 1983). This potential has increased by more than 1 800 kg over the last 20 years (Lawlor & Short, 1990). The proportion of Holsteins in the USA dairy cattle population exceeds 70% (Herman, 1981; CAST, 1984) and more than 90% of the cows which are officially milk-recorded in the USA are Holsteins (Miller, 1990).

Extensive exportation of Holstein semen by the USA is due to the superior milk production of Holstein cows and aggressive sales efforts (CAST, 1984; Maijala *et al.*, 1984; Anon, 1989). Consequently, the Friesian populations in Europe and many other countries are being replaced by the Holstein (CAST, 1984; Colleau & Tanguy, 1984; Maijala *et al.*, 1984; Avon, 1990). Initiated by concern for a similar situation in South Africa, this study has been undertaken to determine quantitative aspects of semen importations for South African dairy cattle populations. The extent to which preference for certain lines could be responsible for a narrowing of the genetic base of the Holstein–Friesian breed in South Africa has also been studied.

Materials and Methods

The information regarding the semen importations of four South African dairy breeds, viz. Holstein–Friesian, Jersey, Ayrshire and Guernsey, from January 1979 to June 1989 was analysed and yearly trends were studied. Data regarding semen imports were obtained from the Taurus Stock Improvement Co-operative and the Registrar of Livestock Improvement. Each record contained the following information: name and breed of bull and country from which semen was imported, number of doses imported, name and address of importer and the date and reference numbers. The number of calves of foreign sires registered between January 1980 and January 1990 was obtained from the SA Stud Book and Livestock Improvement Association.

The breed known in the USA and Canada as the Holstein, and in Europe as the Friesian, originated from the same breed in the Netherlands (Schwarz, 1974). The South African strain, which also has its roots in the Netherlands (Cilliers, 1964; 1978), was known as the Friesland up to 1990 and is currently known as the Holstein–Friesian. In this study, animals of

European, North American and South African origins will thus be referred to as Friesian, Holstein and Holstein–Friesian respectively.

As dairy cattle semen imports were dominated by Holstein–Friesian imports, these imports were investigated in more detail. The pedigrees of the 607 Holstein–Friesian bulls involved were compiled as completely as possible, on the paternal and maternal sides, from the available data. Certain Holstein ancestors, which were common in several pedigrees, were identified. These ancestors have, for the purpose of this study, been referred to as 'lines', e.g. all 237 bulls which were descendants of the bull Osborndale Ivanhoe have been considered part of the Ivanhoe line. A bull could have descended from two lines at the same time, i.e. one line on the paternal side and another on the maternal side.

Zero to four generations separated the bulls from which semen was imported and the four most important ancestors. The Holstein–Friesian bulls, from which at least 200 doses of semen had been imported during the study period, were ranked according to the number of doses imported. This list comprised 200 bulls or roughly one-third of the total number of bulls. The percentage of genes which the four most important ancestors have in common with these 200 bulls, was calculated according to the Holstein Association of America (1990), viz:

$$\text{Percentage genes in common} = [1 \text{ (if the bull appears on the list)} + 0.5 \times \text{(number of sons)} + 0.25 \times \text{(number of grandsons)} + 0.125 \times \text{(number of great-grandsons)} + 0.0625 \times \text{(number of great-great-grandsons)}] / 200 \quad (1)$$

The percentage of genes that two related bulls have in common depends on the number of generations which separate them, as 50% of a bull's genes are identical to those of his sire and 25% to those of one of his grandsires.

The percentage of genes in common was determined for the Holstein–Friesian breed only. The number of doses imported from the five most popular bulls as percentage of the total number of doses imported, was calculated for all dairy breeds.

To allow for an overall picture of the influence of imported semen on a potential reduction in the genetic variance, the percentage of imported semen in relation to all semen used in South Africa was calculated per breed for each year of the study period as follows:

$$\text{Percentage semen imported} = \text{(doses imported)} / \text{(doses sold locally + doses imported)} \quad (2)$$

It is generally accepted that an unknown percentage of semen is lost due to wastage, cows being inseminated more than once, etc. The number of doses from local AI bulls sold, was obtained from Dicks (1989).

Results

Holstein–Friesian semen importations dominate the import market for dairy cattle semen (Table 1). Imported dairy cattle semen for the period studied comprised 72% Holstein–Friesian, 13.6% Jersey, 11.5% Ayrshire and 2.8% Guernsey semen.

Since 1986 there has been a considerable increase in the amount of Holstein–Friesian semen imported and, to a lesser extent, in the amount of Jersey semen imported (Figure 1). Semen imports for the Ayrshire and Guernsey breeds have remained static for the period studied. On average, 2580 and 663 doses of semen were imported per year for the Ayrshire and Guernsey breeds respectively.

Between January 1979 and June 1989, 89.5% of the 176 172 doses of Holstein–Friesian semen imported was Holstein (Table 2), while 78.3% of the total number of bulls and 87.1% of the total number of calves registered, were Holstein (see Table 2).

The increase in popularity of the Holstein breed in South Africa can clearly be seen in Figure 2. During 1979, only 47.6% of the Holstein–Friesian semen imported was Holstein. This percentage increased to nearly 80% in 1981, and to 98.1% during 1988.

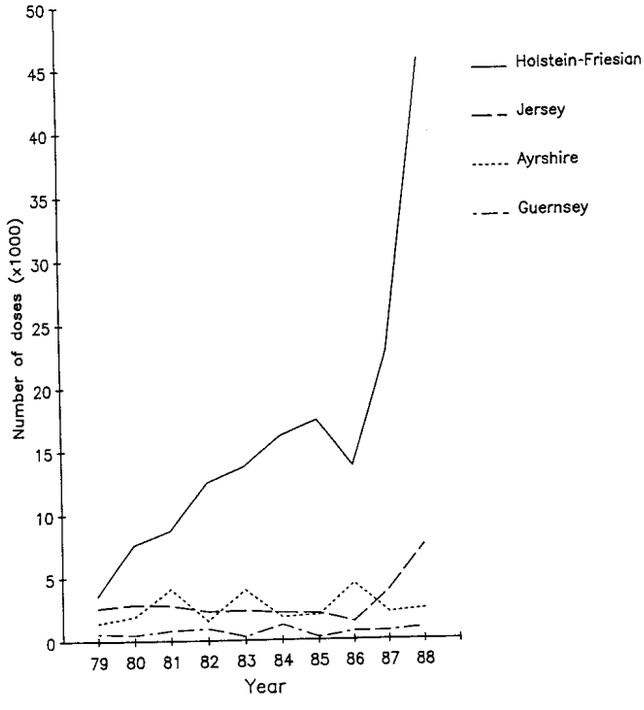

Figure 1 Number of doses of semen imported to the Republic of South Africa between 1979 and 1989 for four dairy breeds.

Table 1 Semen importations for four dairy breeds between January 1979 and June 1989

	Holstein–Friesian	Jersey	Ayrshire	Guernsey
Number of doses imported	176 172	33 346	28 141	6 750
Percentage of total doses imported	72.0	13.6	11.5	2.8
Number of bulls contributing	607	116	59	42
Average number of doses per bull	290	287	477	161
Number of doses as % of total doses imported for:				
Most popular bull	3.2	9.2	9.7	11.9
Five most popular bulls	13.4	32.0	38.2	47.3

Table 2 Imports of semen from Holstein and Friesian bulls between January 1979 and June 1989 and the number of calves from foreign sires registered in South Africa between 1980 and 1990

	Bulls		Doses imported		Calves registered	
	Number	%	Number	%	Number	%
Holstein	475	78.3	157684	89.5	27262	87.1
Friesian	132	21.7	18488	10.5	4044	12.9
Total	607		176172		31306	

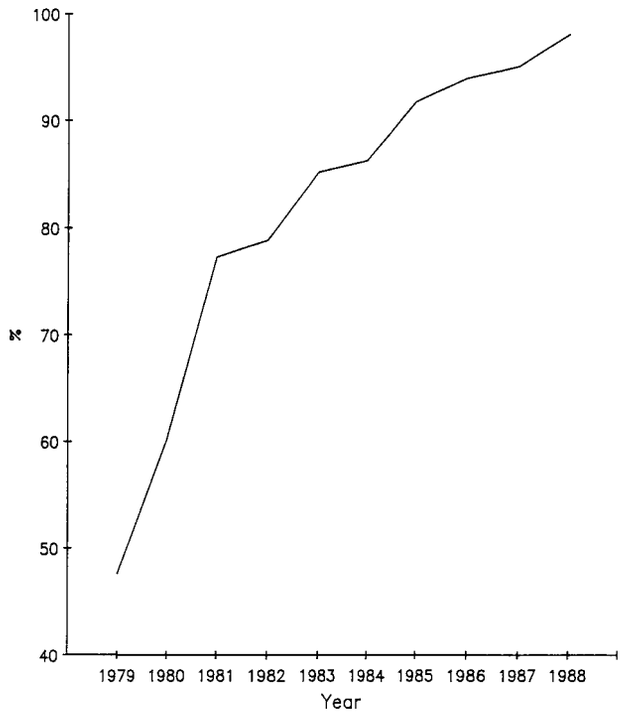

Figure 2 Holstein semen imported from the USA as percentage of total yearly Holstein–Friesian imports.

Popular Holstein lines identified, with the common ancestor in parentheses, were: Astronaut (Paclamar Astronaut), Bootmaker (Paclamar Bootmaker), Chief (Pawnee Farm Arlinda Chief), Elevation (Round Oak Rag Apple Elevation), Ivanhoe (Osborndale Ivanhoe), Kingpin (Whirlhill Kingpin), Matt (No-Na-Me Fond Matt), Rockman (Seiling Rockman), Sovereign (ABC Reflection Sovereign), Standout (Sunnyside Standout Twin), Starlite (Roybrook Starlite), Telstar (Roybrook Telstar) and Valiant (SWD Valiant). Of these lines, the Ivanhoe and Chief lines were the most successful. They have given rise to the Elevation and Valiant lines. Osborndale Ivanhoe is the maternal grandsire of Round Oak Rag Apple Elevation and Pawnee Farm Arlinda Chief is the sire of SWD Valiant.

As can be seen from Table 3, 237 bulls from which semen was imported, were related to the Ivanhoe line and 177 to the Chief line. However, 82 bulls were related to both the Ivanhoe and Chief lines and they are thus represented in both the Ivanhoe and Chief groups in Table 3. The number of bulls related to Ivanhoe and/or Chief lines was calculated as follows: (237 Ivanhoe bulls) + (177 Chief bulls) – (82 Ivanhoe and Chief bulls) = 332 bulls. Equally, 74.1% of imported Holstein–Friesian semen came from the Ivanhoe and/or Chief lines.

Approximately 30% of the total number of doses imported came from the Elevation line and 17% from the Valiant line. As Elevation is a grandson of Ivanhoe, the Elevation line is

Table 3 The number and percentage of bulls of the two most popular lines from which semen was imported, *i.e.* Ivanhoe and Chief, and the doses imported and calves registered of these lines. The lines formed by their grandson and son, Elevation and Chief respectively, are also included

	Bulls		Doses imported		Calves registered	
Line	No.	%[a]	No.	%[a]	No.	%[a]
Holstein–Friesian total	607	100.0	176172	100.0	27262	100.0
Ivanhoe	237	39.0	96149	54.6	16149	51.6
Chief	177	29.2	87515	49.7	13420	42.9
Ivanhoe and Chief[b]	82	13.5	53120	30.2	7880	25.2
Related to Ivanhoe and/or Chief[c]	332	54.7	130544	74.1	21689	69.3
Elevation (grandson of Ivanhoe)[d]	152	25.1	52388	29.7	9354	29.9
Valiant (son of Chief)[e]	65	10.7	30010	17.0	3507	11.2

[a] Percentage of total number of Holstein–Friesian bulls, doses or calves.

[b] Related to both the Ivanhoe and Chief lines, *i.e.* on paternal as well as maternal sides. This group is represented in the Ivanhoe line and the Chief line.

[c] Calculated as (Ivanhoe) + (Chief) – (Ivanhoe and Chief). The (Ivanhoe and Chief) group was deducted, otherwise it would have been counted twice.

[d] This group is included in the Ivanhoe line.

[e] This group is included in the Chief line.

included in the Ivanhoe line. Likewise, the Valiant line is included in the Chief line in Table 3.

The percentage of genes that Pawnee Farm Arlinda Chief, Round Oak Rag Apple Elevation, SWD Valiant and Osborndale Ivanhoe have in common with the 200 bulls from which most of the semen was imported during the study period, was calculated [eqn. (1)] to be 11.0%, 10.3%, 8.1% and 6.3%, respectively. These percentages cannot be added as, for example, half of the genes which SWD Valiant has in common with these 200 bulls are also the same genes which his sire Pawnee Farm Arlinda Chief has in common with them.

The owners of cattle from the Jersey, Ayrshire and Guernsey breeds tend to import a high percentage of semen from popular bulls. Between 9 and 12% of the doses imported for the three minor breeds were of semen from the most popular bull of that particular breed (Table 1). Nearly 50% of Guernsey semen imported came from five bulls only.

The percentage of registered calves from imported semen of the different Holstein–Friesian lines, follows the same trend as the percentage doses imported (Tables 2 & 3). The number of calves registered per sire varied considerably between all dairy breeds. Not all the calves born were registered. The ratio of males to females registered was 1:4 for the top 20 Holstein bulls and 1:2 for the top 10 bulls of the other dairy breeds.

Holstein–Friesian, Jersey, Guernsey and Ayrshire breeders imported on average 3.5%, 4.1%, 4.7% and 11.9%, respectively, of the semen used locally during the study period. The percentage semen imported in relation to all semen used for both Ayrshire and Guernsey breeds was highly variable, following the general trend of semen imports (Table 4).

Holstein–Friesian breeders imported only 1% of the semen used in 1979. This percentage increased slowly to 4.4% in 1987, but it nearly doubled to 8.3% in 1988. However, it appears that Jersey breeders have become less dependent on semen imports; 4.9% of doses used in 1979 were imported, but thereafter the percentage slowly decreased to 1.9% in 1986. Jersey semen importations then increased sharply to 8.3% within two years (Table 4).

Discussion

Semen importation to the Republic of South Africa is a valuable tool whereby the improvement of local dairy breeds is facilitated. It could, however, result in merely augmenting overseas breeds locally, should the imported semen not be used in an organized and constructive breeding programme. It is assumed that South African-bred animals, with certain genes which were acquired for adaptation to local conditions through generations of local breeding, are discarded and indeed discriminated against.

Holstein–Friesian semen importations dominate the South African import market for dairy cattle semen, as 72% of all semen imported during the study period came from this breed. There have been considerable increases in Holstein–Friesian and Jersey semen importations since 1986. According to Du Preez (1990) the increase in Holstein–Friesian imports, together with a 26% increase in members eligible to import semen, coincides with the founding of six new semen agencies in South Africa. The American and Canadian agencies in particular have very successful marketing strategies. This could possibly explain the increase in Holstein–Friesian and Jersey semen importations, but it apparently had no effect on Ayrshire or Guernsey semen importations.

Some dairy breeders have traditionally regarded imported animals as 'better' than South African-bred animals (Cilliers, 1964; Allan, 1987). Before artificial insemination was employed, Friesland bulls were imported mainly from the Netherlands. A variety of popular bulls were imported, and no line- or type-breeding was practised (Cilliers, 1964). The situation has changed completely. Mainly Holstein semen of certain bloodlines are presently being imported. During 1979 only 47.6% of the Holstein–Friesian semen imported was Holstein compared to 98.1% in 1988. During the study period, almost 75% of the semen imported was from two bloodlines only.

Restrictions placed on semen imports by the South African Holstein–Friesian Association ensured that only semen from bulls with the highest genetic merit has been imported. This is probably one of the reasons why almost 75% of the imported

Table 4 The number of doses imported and the percentage semen imported in relation to all semen used for four dairy breeds

	Ayrshire		Guernsey		Holstein–Friesian		Jersey	
Year	Doses imported	%[a]	Doses imported	%[a]	Doses imported	%[a]	Doses imported	%[a]
1979	1391	10.4	573	5.5	3593	1.1	2569	4.9
1980	1912	11.5	447	3.8	7634	1.9	2831	4.6
1981	4121	21.1	795	5.9	8767	2.1	2741	4.0
1982	1519	7.3	934	6.1	12533	2.7	2257	3.1
1983	4032	16.5	271	1.9	13768	3.0	2311	3.2
1984	1813	7.5	1185	7.1	16174	3.1	2124	2.8
1985	1948	7.8	175	1.1	17397	3.4	2070	2.8
1986	4508	18.0	656	4.6	13711	2.9	1390	1.9
1987	2145	8.9	650	4.5	22813	4.4	3912	4.7
1988	2407	10.0	941	6.7	45754	8.3	7486	8.3
$\bar{X}$	2580	11.9	663	4.7	16214	3.5	2969	4.1

[a] Percentage semen imported in relation to all semen used.

semen came from two lines only, viz. Ivanhoe and Chief, as only 298 of 4812 (6.2%) AI-proven bulls in the USA qualified for semen export to South Africa during 1990. Most of these bulls were related to the Elevation and Chief lines (Du Preez, 1990).

Since genetic progress is attained by the judicious use of only the best sires, it should be expected that the best sire lines are frequently being used. Each reduction in the number of sires within a breed, however, tends to reduce heterozygosity and thus poses an ever-increasing challenge for the breeder (Herman, 1981). A further narrowing of the genetic base is caused by embryo transfer, which reduces the number of effective female breeders (CAST, 1984).

Inbreeding, i.e. when a bull is related to the same line on paternal as well as maternal side, was not often found in the pedigrees of the Holstein–Friesian bulls and therefore inbreeding coefficients were not calculated. According to Hudson & Van Vleck (1984), 12.1% of Holstein AI bulls in the USA were inbred, and the average inbreeding of all AI bulls was 0.35%. The average inbreeding of the inbred bulls amounted to 3%. According to Hudson & Van Vleck (1984), the relationships among sires do not indicate that inbreeding will decrease, but there is no cause for concern over passive inbreeding. Although the Holstein bulls from which semen is imported are not highly inbred, the selectiveness of South African importers by importing semen of mainly two lines could possibly narrow the genetic base of the South African Holstein–Friesian breed in future, especially if local AI bulls are also related to these two lines.

The number of calves registered per sire varied considerably as semen is sometimes stored indefinitely. Not all the calves from semen imported during 1988/89 were thus registered by January 1990. The ratio of bull calves to heifer calves registered in South Africa is approximately 1:4 for the Holstein–Friesian and 1:2 for the other dairy breeds. More bull calves are thus registered in South Africa than in the USA where the ratio male:female is 1:13 for all dairy breeds (Herman, 1981). The demand for dairy bulls in the USA is not high, due to the more widespread use of artificial insemination in dairy herds.

Although the average percentage semen imported in relation to all semen used of the Holstein–Friesian, Jersey and Guernsey breeds appears to be small, imported semen may only be used on registered animals and no crossbreeding with imported semen is allowed. Approximately 185000 or 20% of Holstein–Friesian cows are registered and approximately 85% of the registered Holstein–Friesian births are bred by AI (Du Preez, 1990). It could thus be accepted that a large percentage of registered Holstein–Friesian cows are artificially bred. The amount of doses imported in 1988 indicates that approximately 25% of registered Holstein–Friesian cows were inseminated with imported semen, although an unknown percentage doses were probably stored or wasted. The increase in Holstein–Friesian and Jersey semen imports in 1988, may possibly indicate greater dependency on semen imports in the future for these two breeds. The Ayrshire was approximately three times more dependent on imported semen than the other dairy breeds.

Imported semen may also have a large indirect effect on the population, should it be used to breed local AI bulls. Semen of local AI bulls may be used on commercial as well as registered animals and an estimated 50% of all dairy cows in South Africa are artificially inseminated (Schutte, 1991).

It may therefore be concluded that the genetic variability of the Holstein–Friesian in South Africa, as in other parts of the world (CAST, 1984; Colleau & Tanguy, 1984; Maijala *et al.*, 1984; Avon, 1990), could be narrowed, mainly due to the influence of the North American Holstein. Semen imports are advantageous and necessary, but should be carried out with a view to ensure and keep intact a broad base of the best genetic material.

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