GENETIC EVALUATION OF HOLSTEIN-FRIESIAN AND JERSEY SIRES USING RECORDS FROM PURE- AND CROSS-BRED PROGENY IN NEW ZEALAND.

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In the name of God the most compassionate the most merciful.

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ABSTRACT

Milk Yield, Milk Fat Yield, Milk Protein Yield and Days in Milk of 72,480 dairy cows of Holstein-Friesian, Jersey and their reciprocal crossbred were analysed. The main objective of this study was to investigate possible use of crossbred progeny records to genetically evaluate sires.

Bulls of each breed were evaluated separately using their purebred, crossbred or both purebred and crossbred progeny. First, crossbred progeny were used without including genetic groups. Secondly, crossbred progeny were used with genetic groups included. Rank correlations for different types of evaluations were calculated. In total, 10 different comparisons, 5 for each breed, were performed. The expected correlation of ranks of sires obtained using different data sets were estimated where applicable.

Reliability and Prediction Error Variance of sire proofs were estimated both by an approximate method and direct calculation. Over-estimation of reliability and under-estimation of Prediction Error Variance by the approximate method was given.

High correlations between ranks of Holstein-Friesian sires evaluated using different data sets were observed, while, the correlation between ranks of Jersey sires evaluated using purebred progeny with ranks of the same sires evaluated using only crossbred progeny was less than expected. Correlations of ranks of Jersey sires evaluated using all progeny with ranks of the same sires evaluated using only crossbred progeny were also low.

After plotting EBVs of sires of each breed obtained using only purebred against EBVs of the same sires obtained using both purebred and crossbred progeny, two lines with slightly different slopes were observed. The reasons for the formation of these two lines were investigated. It was found that the number of effective crossbred progeny of sires was affecting the regression of EBVs of sires obtained using all progeny on EBVs of same sires obtained using only purebred progeny.

It was concluded that crossbred progeny of Holstein-Friesian sires may be used to assist in their evaluation under New Zealand conditions, but, further research is recommended before using crossbred progeny of Jersey sires in sire evaluation.

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DAIRY FARMING IN NEW ZEALAND

1.1- Introduction:

The trend in the dairy cattle population of New Zealand is an increasing proportion of Holstein Friesian cattle and a decreasing proportion of Jersey cattle. Different types of crossbreeding dairy cows in different parts of the world are being practiced, for example, increased exchange of semen to upgrade native low producing cows of some countries with mating to other genetically improved exotic breeds. Therefore, the observed genetic effects in the resulting population might not be solely additive and may contain non additive genetic effects.

Evaluating sires of each breed is usually done using their purebred progeny. Possible use of crossbred progeny of young bulls of progeny testing program can reduce the costs of progeny testing and increase the reliability of estimates.

Reciprocal crossbreeding of two or more breeds in places where farmers intend to keep a combination of these breeds needs the sires of different breeds to be jointly evaluated. This type of evaluation makes direct comparison of sires of different breeds possible. When two sires have equal breeding values for specific traits, farmers would be able to select the sire of that breed which helps them to keep a desirable breed composition of their herds.

Existence of significant number of herds containing both Holstein-Friesian and Jersey cows as well as their reciprocal crossbred progeny in New Zealand provides the opportunity of evaluating sires of these two breeds using different combinations of their progeny and comparing the proofs obtained by different evaluations.

The purpose of this research is to investigate the possible use of crossbred progeny to evaluate bulls of Holstein and Jersey breeds and compare the ranks of sires obtained using different data sets.

However, extending the results of this study to other breeds and/or other countries needs further investigation.

1.2- Dairy Cattle in New Zealand and Their Breeds:

The New Zealand dairy industry started in 1814 by landing a bull and two heifers in the Bay of Islands. Further small importations of cattle took place and in the early decades of the 19th century pioneering efforts resulted in the first signs of trading in dairy produce (Dalton and Rumble, 1985).

In 1932, about two thirds of New Zealand dairy cows in milk (out of total of 1,292,873) were Jerseys or Jersey grades (NZJCBA, 1932). Over the next sixty years, the breed composition of the New Zealand dairy herd has substantially changed (MacMillan et.al., 1981). A predominantly Jersey herd has become a "Friesian x Jersey" crossbred herd, with inseminations using semen from Friesian sires exceeding 50% of all inseminations since 1970.

Over the 20th century the number of dairy herds in New Zealand has decreased but the number of cows per herd has increased. In 1920-25 the number of herds supplying dairy factories was about 53,000, however, this number decreased to 15,581 in 1979-80. The average number of cows per herd was 56 in 1900-1901 but this increased to 156 per herd in 1979-80 (Holmes, 1984).

In 1953, 100% of artificial insemination (AI) was based on semen from Jersey sires. This percentage decreased over 30 years to 40%, due to substitution of primarily Friesian semen. In 1979, 36% of all dairy herds were mainly Friesian, 37% were mainly Jersey and 28% were mixed of two breeds. The majority of town-supply herds are Friesian because of this breed's ability to produce larger volumes of milk (Holmes, 1984). It was expected that 46% of herds would be mainly Friesian, 32% mainly Jersey and 23% mainly mixed in 1985.

An additional reason that New Zealand dairy farmers prefer Holstein-Friesian to Jersey cows is the ability of this breed to produce more valuable male calves for beef production (Holmes, 1990).

1.3- Production System

The New Zealand dairy industry is currently based on more than two million dairy cows in about 15000 herds, with majority of cows producing 130 to 150 kg of milk-fat per year. The majority of cows calve in springtime (July to September) (Holmes and Wilson, 1987) and the majority of milk (more than 90%) is manufactured into dairy products (Dairy Statistics, 1988-89). About three-quarters of all herds are managed by the owner, with most of the rest being farmed under a share-milking agreement (Holmes and Wilson, 1987).

Share-milking, the practice where someone other than the owner milks the cows for a predetermined share of returns from the property, plays an important part in the New Zealand dairy industry (Newell, 1973).

The average herd size in 1988-89 was 157 cows. However, herds ranged in size from ten cows to more than 1000 cows. The number of herds with more than 300 cows was 644 (or 5% of total herds). This compares with 1.5% of herds in 1980-81 and 0.4% in 1970-71 (Dairy Statistics 1988-89).

In New Zealand the seasons change regularly and are distinct with less sunshine and lower temperature in winter than in summer. Soil is cooler and wetter in winter than in summer. There is seasonal variation in pasture growth rate due to rainfall and temperature changes. Because of the climatic variation and little use of supplements other than hay or silage, dairying in New Zealand is highly dependent on weather conditions.

Two systems of dairy farming are practiced in New Zealand:

i- Town Supply Dairy Farms, in which the cows may calve in spring and in autumn, or throughout the year, and the farm supplies a specified amount of milk throughout the year (Holmes and Wilson, 1987). The farmer is paid per litre of milk supplied (provided that the milk satisfies certain minimum compositional standards, namely 3.25 percent milk-fat, 8.50 percent solids-non-fat). In 1988-89 eight percent of dairy herds (an estimate of 1,151 herds) supplied milk to town milk industry, for domestic liquid milk consumption (Dairy Statistics, 1988-89). Milk is used for consumption without significant processing.

ii- Seasonal or Factory Supply Dairy Farms, in which the cows calve in springtime, do not produce milk in winter and all milk is manufactured into dairy products. The farmer receives payment based on quantity of milk-fat and protein with a penalty for milk volume (Holmes and Wilson, 1987). In 1988-89 ninety two percent of New Zealand dairy herds (an estimate of 13,593 herds) had their milk processed into dairy products by one of 22 factories owned by dairy company cooperatives (Statistics, 1988-89).

1.3.1- Calving Date:

One characteristic of seasonal supply dairy farming in New Zealand is the short calving period. The winter is an important time for maintenance in N.Z. dairy factories, and there is no milk collection for four to six weeks in mid winter. While all seasonal supply herds calve during the period June to October, individual herds vary greatly in timing and concentration of calving within this period (Simmonds, 1985).

A seasonal supply dairy farmer in New Zealand receives the same payment for each unit of milk-fat irrespective of whether it is produced in winter, spring, summer or autumn. Dairy companies pay on a complex formula involving milk solids and a volume deduction. On seasonal supply farms the cows should calve as early as possible in spring provided that they can be fed well from the day that they calve.

If calving is concentrated, but occurs before the spring growth of grass has begun, then the majority of the herd will be underfed in early lactation. It is essential, therefore, that all other aspects of management must be well organized in order to take full advantage of the potential benefits of a concentrated calving (Holmes and Wilson, 1987).

In most seasonal herds, a cow's lactation length is largely dictated by its calving date relative to the planned start of the concentrated calving date. This is because most cows remaining in the herd for another production season will be dried off within a week of each other from two to three months before the planned date of calving. The availability of fresh pasture during late lactation and the volume of conserved pasture as hay or silage are the major factors influencing a herd owner's decision to stop milking remaining cows in milk at that time (MacMillan, 1985).

1.3.2- Stocking Rate:

Daily intake of fresh herbage and dry matter of the grazing animal varies with the species and live weight of the animal (Hafez, 1946).

The grazing time required per unit intake of pasture was appreciably greater in the Jersey than Friesian, whereas the feed intake required per kg of fat-corrected milk produced was greater in the Friesian than Jersey. When the fat corrected milk production of the two breeds was the same, differences between them in grazing times were negligible. The Friesian animals, however, tended to have a somewhat greater rumination time (Brumby, 1959).

The single most important factor controlling efficiency of grazing is stocking rate (Bryant and Holmes, 1985). Stocking rate is conventionally measured in cows per ha; this implies that "cows" and "ha" are both unvarying items which is not the case (Holmes, 1984). Differences between size and breed of cows and also differences in productivity of lands will affect the stocking rate. Because of high dependency of New Zealand dairy farming on pasture, it is important to use pasture as efficiently as possible. This can only be achieved with stocking rate close to the optimum. Although stocking rate can influence pasture growth, this effect is variable and it probably depends on other factors, for example, the actual intensity of grazing at different times of the year (Holmes, 1984). The economic importance of stocking rates is centered on the raising of existing farm income and profitability by increasing the number of animals per unit of land and on the efficiency of pasture utilization.

Low stocking rate can cause a decrease in pasture growth because of the presence of increased amount of reproductive and older plant material which causes death and decay of the lower leaves and suppression of legume species. On the other hand, a very high stocking rate will also cause a decrease in pasture growth because of excessively intense grazing or over-grazing (Sung Ho, 1986). Stockdale and King (1980) found that at a stocking rate of 8.6 cows/ha pasture grew at 62 kgDM/ha daily in comparison with 73 kgDM/ha daily at a stocking rate of 4.4 cows/ha. In another experiment the mean daily intake of herbage DM was equivalent to 13.4 kg/cow at 3 cows/ha and 10.4 kg/cow at 4.9 cows/ha (Freer, 1960). These figures show that increasing stocking rate more than a specific level would cause a decrease in the amount of pasture eaten by each cow.

Stocking rates change between farms mainly because of variability in soil types, number of dry cattle carried or in the pasture conservation and fertilizer policy (Holmes, 1984).

1.4- Genetic Improvement:

A dairy cattle population can be genetically changed along any one or more of four separate pathways. Desirable genes are identified and then passed along one of these pathways to benefit the next generation. The four pathways are:

1. Male parents to male progeny.
2. Female parents to male progeny.
3. Male parents to female progeny.
4. Female parents to female progeny.

The idea in developing a plan for genetic improvement is to use all four pathways in the best possible combination. The best combination is going to be the one which provides the largest net income per cow under commercial dairying conditions (Wickham et.al., 1978). Searle (1961) and Evans (1969) found that the male to female and male to male pathways can make the greatest contribution to rates of genetic gain in New Zealand dairy cattle. The superior contribution of these male pathways rely on using AI to increase selection intensity relative to natural mating. This is being successfully achieved in New Zealand partly as a result of AI using fresh semen which can be further diluted than when semen is frozen. Also using the best females for contract matings to produce bull calves for the progeny test program utilises the female to male pathway to increase genetic gain. With advances in applying multiple ovulation and embryo transfer and using cloning and sexing embryos, the future may allow better use of the female to female pathway. However, a relatively long generation interval due to time required for progeny testing, reduces the amount of genetic progress per year and research is being done to overcome this problem.

An estimate of the genetic merit of New Zealand dairy cows is provided by the Breeding Index (BI). The Breeding Index represents the genetic merit relative to a base value of 100, the average genetic merit of dairy cows across the country in 1960 to 1964. Comparing the average BIs of New Zealand dairy cows by birth year shows a constant increase in BI.

Improvements in BI have been recorded in commercial herds which have consistently used the Premier Sire Service provided by the NZ Dairy Board in collaboration with Livestock Improvement Associations to produce all their heifer replacements (Macmillan, 1982). Premier Sire Service is a service designed to make maximum use of the Corporation's best bulls and to provide farmers the maximum gain at the least cost (Dairy Statistics, 1988-89). A comparison of BIs of bulls from 1975 through 1990, shows linear increase in BI (Wickham, 1989).

Genetic merit of New Zealand dairy cows compete with the animals of the same breed from other parts of the world. Although production performance of dairy cows in New Zealand is not as high as cows of some other countries; running them under similar nutritional environment to overseas dairy cattle allows a comparison of the genetic merit of N.Z. and foreign dairy cows. Results of a comprehensive comparison of different 'strains' of cattle from different countries obtained from FAO-Polish trial with 'black and white' cattle stated in Jasiorowski et. al. (1983) shows the position of Holstein-Friesian of New Zealand in the world. Records of progeny from young sires from N.Z. were lighter than average of all countries but produced more milk than average. Their fat percentage was highest and equal to those from Netherlands. Protein percentage of milk of daughters of bulls from New Zealand was second, with a very small difference, after bulls from USA. Their total butter fat and protein yield per lactation and per 100 kg of live weight was the highest among all other strains.

1.4.1- Data Collection:

Several organizations and individuals are involved in breeding dairy cattle in New Zealand including private breeding companies and private herd owners. The six Livestock Improvement Associations in addition to their artificial insemination services, provide the official herd recording services for dairy farmers and data collected by the herd testing service from sire proving herds are used in the progeny testing of bulls (Holmes and Wilson, 1987). The information from herd testing can also be used by the owner of the cows to assist in the management of their herds and in the selection of cows for the breeding of replacement heifers.

1.4.2- Herd Testing:

Herd testing in New Zealand began as early as 1909 and its use was fostered by the then Department of Agriculture. The practice grew and group herd testing was established through the country by the mid 1920s. In principle this system of testing was operated by and for commercial herd owners. Additional systems of testing, certificate of record, and official herd test were administered for pedigree herds by the Department of Agriculture. In 1939 different herd testing associations were amalgamated into six regional associations (NZDB, 1987-88).

Samples of milk from individual cows are collected regularly by sampling officers or by the farmer (self-sampling) and processed through central laboratories providing information on milk yield, protein, milk-fat, and somatic cell counts. Sampling interval can be 4, 6 or 8 weeks or 2 or 3 times per year. Over 1 million cows, or 50% of the national herd, are tested. This testing forms the basis of production recording, progeny testing and some herd management decisions (Coop, 1987).

Presently record services are provided by Livestock Improvement Corporation which enables farmers to establish and maintain complete herd records.

1.4.3- Sire Evaluation:

The objective of sire evaluation is to allow comparisons of the genetic merit of sires. Sire proofs are based on a comparison of the production of a bull's daughters with that of other cows (herdmates) of the same age and by the same breed of sire, being milked in the same herd at the same time. In addition, information on the bull's ancestry and the breeding value of the herdmates' sires is taken into account (NZDSSR, 1988-89). The result of sire evaluation is referred to as the Breeding Index

(BI) of sires. In New Zealand, BIs are calculated for fat yield (FAT BI), protein yield (PROTEIN BI), milk yield (MILK BI), and for a combination of these three BIs (PAYMENT BI). The reliability for each BI is also calculated.

The PAYMENT BI has been designed for the payment system "a+b-c" in N.Z. This system is applied because protein yield is valuable to the factory supply farmer along with fat yield, but large volume of milk will be penalized. This BI reflects the true value of the milk of proven sires' daughters to both farmer and the manufacturing sector (NZDAAR, 1988-89). Each BI compares a sire with the average progeny tested bull in the base year (1960).

The Sire Proving Scheme is a progeny testing program designed to provide a continuous supply of proven bulls of high genetic merit. Each year about 125 bulls are progeny tested from which five or six best bulls being kept and used in Premier Sires and Nominated Service (Dairy Statistics, 1988-89). Based on the information about the ancestors and through contract matings between the best bulls and cows in the country, the necessary young bulls for progeny testing are produced. Semen is collected from these young bulls when they are about 15 months of age and used on cows in "Sire Proving Scheme" herds. These are normal commercial herds where the owner has agreed to let his cows be mated to unproven bulls in return for certain financial considerations. The aim is to provide about 50 daughters from each young bull distributed at one daughter per herd. The cows for these matings are selected randomly to prevent any bias through mating of some bulls to genetically superior cows.

To calculate BI, the genetic value of the bull is first estimated from his ancestry. The average milk, fat and protein yields of the bull's daughters milking in the current season are compared with the average yields of herdmates. After computing BIs for fat, protein and milk, these BIs are combined to calculate PAYMENT BI.

In addition to production traits, dairy sires in N.Z. are ranked based on about seventeen traits other than production traits. These traits are considered because of their indirect contribution to the farmer's income. Using two year old progeny of sires their breeding value for each of these traits are calculated. Applying respective economic values for each score of each trait, the Economic Breeding Value of each trait other than production is calculated. Finally by summing Economic Breeding Value of the traits other than production and PAYMENT BI, The " total breeding index" of each sire will be calculated. The total breeding index ranks all sires within a breed according to their genetic and economic merit for production, management, efficiency and conformation (NZSER, 1988-89).

1.4.4- Artificial Insemination:

Early investigations and experiments concerning AI in New Zealand started about 1939. In 1943-44 the experimental work to inseminate 1000 cows was done of which 80 percent proved in-calf after a service of about 3 months (Dalton and Rumble, 1985).

According to the 1988-89 Cow Census made by New Zealand Dairy Board (Dairy Statistics, 1988-89) the number of cows which used AI summed to 1,652,409 and the number of yearlings which used AI was 57,942. Milk-fat production per cow for farms using AI was 143.9 kg while it was 130.3 kg for farms which didn't use AI. Milk-fat production per hectare was 358.6 kg and 279.5 kg for AI users and non-AI users respectively.

The Livestock Improvement Corporation offers two main artificial breeding services. "Premier Sires" in which most semen used is in liquid form (i.e. fresh) and allows greater utilization of bulls. Farmers have the option of inseminating cows themselves or having a AB technician do the inseminations. "Nominated Service" gives the farmers the opportunity of choosing individual bulls to be used. This service uses frozen semen. Many of the bulls in the Premier Sire Service are also available through the Nominated Service.