GENETIC EVALUATION OF BREEDING STRATEGIES FOR IMPROVEMENT OF DAIRY CATTLE IN KENYA

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INTODUCTION

Like other developing countries, breeding of dairy cattle in Kenya involves the utilization of breeding strategies using both local and imported genetic materials (Bebe *et al.,* 2002). The rate of genetic progress for strategies based on imports depends on the migration rate, the initial difference in genetic mean and magnitude of genotype-environment interaction between the importing and exporting populations (Mpofu *et al.,* 1993). Previous studies indicate that in tropical countries, performance of high yielding temperate breeds has often been negatively affected and the re-ranking of genotypes may be influenced by genotype-environment interactions (Smith, 1988). In Kenya, such studies are lacking, the widespread use of imported germplasm notwithstanding. There is therefore need to compare breeding strategies utilizing local selection programmes and those based on imported semen for improvement of dairy cattle in Kenya. The objective of this study was to genetically compare breeding strategies for genetic improvement for milk yield of dairy cattle in Kenya using deterministic simulation approach.

MATERIALS AND METHODS

Characteristics of the simulated breeding strategies. Four breeding strategies with a single breeding unit (nucleus) were considered. Local strategies included closed progeny testing scheme (CPT) and young bull system progeny of local proven bulls (PLB). The strategies based on imported genetic material include continuous semen importation (CSI) and young bull system progeny of foreign bulls (PIB). In CPT, it was assumed that a progeny testing scheme was initiated within the local population and all cows under milk recording were sired by bulls selected locally. In CSI, the assumption was that there is no local selection and therefore improvement is through imported semen and all imports were from the USA. The young bulls were slaughtered after semen collection and are stored until there daughters' records are available to select semen from best bulls for future mating.

Method of evaluation. Deterministic simulation using gene flow procedures was used to estimate the population genetic mean and cumulative discounted expressions (CDEs) for the trait in the breeding goal. The CDE of a trait were calculated using the computer program Gflow (Brascamp, 1978). The CDEs can be calculated based on the year or generation approach. In this study, the year approach was used since the generation approach usually over estimates CDEs (Hill, 1974). The single breeding unit was assumed to have six male and five female age-classes and was evaluated within a projected period of 25 years. The biological and economic parameters used in this study were based on estimates from Kenya (Kahi *et al.,* 2004) and the USA (Holstein USA, 2005) and are presented in Table 1. The economic values for breeding goal traits in the USA were assigned based on values estimated for Kenya (Kahi and Nitter, 2004) using the approach used by Vargas and van Arendonk (2004).

Table 1. Means, phenotypic standard deviations (σ_p), economic values (v), heritability (h^2) (along diagonal), genetic correlations (below diagonal) and phenotypic correlations (above diagonal) of traits in the breeding goal in Kenya and the USA

			v (US$/unit)		h^2 and correlations			
Traits[A]	Mean	σ_p	Kenya	USA	MY	FY	PY	AFC
MY (kg)	5056.0	1110.0	0.27	0.00	**0.30**	0.75	0.70	-0.20
FY (kg)	227.3	41.3	1.32	0.45	0.75	**0.34**	0.85	0.05
PY (kg)	289.2	39.5	0.00	1.14	0.70	0.85	**0.31**	0.05
AFC (d)	837.0	448.8	-0.05	0.00	0.54	-0.10	0.05	**0.38**

[A] MY,milk yield; FY, fat yield; PY, protein yield; AFC, age at first calving.

Usually breeding strategies with different breeding goals cannot be directly comparable; one may not distinguish between the impact of strategy and that of the different traits in the breeding goal. The impact of the differences in the traits in the breeding goals was assessed by estimating the correlations among breeding goals and selection index of sires in the two countries. These correlations were estimated as suggested by Gibson and van Arendonk (1998) and were high (<0.97) indicating that any differences in breeding strategies cannot be attributed to the difference in breeding goals between Kenya and the USA.

Economic response in US$ (ER) was defined as the sum of genetic response for all traits in the breeding goal, each weighted by its discounted economic value. The economic response in US$ per year in each selection pathway was estimated as:

$$ER_l = \frac{\sum_{i=1}^{j}\left(GR_j \text{ x } CDE_j \text{ x } v_j\right)}{L_l}$$

where GR_j is the genetic response for the *jth* trait, CDE_j the cumulative discounted expressions of trait *j,* v_j the economic value of trait *j* and L_l the generation interval of selection pathway *l*. The *GRj* was calculated using selection index methodology (Hazel, 1943) and was multiplied by the genetic correlation (r_g) between breeding goal traits in Kenya and USA to estimate the genetic response in traits for breeding strategies that involving semen importation. Inbreeding is important in breeding programs especially in CPT scheme but less important when imports are utilised. The reduction in genetic variance due to inbreeding was assumed to be negligible for the period considered and was ignored. The reduction in performance because of inbreeding was, however, considered and its rate calculated using Wright's formula (Falconer and Mackay, 1996). Rates of inbreeding found in this study were within 0.005-0.01, which is the annual acceptable rate of inbreeding in a breeding program (Bijma, 2000) and are therefore not reported.

RESLTS AND DISCUSSION

Table 2 shows economic responses for the four breeding strategies assuming five levels of genetic correlation and an initial genetic difference of one between the USA and Kenya. Generally, the CSI and PIB strategies were superior in economic response when the correlation between the two populations was strong (0.90 and 1.00) (Table 2). This ranking, however, changed at low correlations (0.30 and 0.58) indicating that genotype-environment interaction (G x E) has a negative impact on the genetic gains of strategies utilizing imported semen. The responses achieved in CPT and CSI were not significantly different at a genetic correlation of 0.70 indicating that imported semen is only genetically viable at correlation of ≥0.70. This genetic correlation is, however, slightly lower than 0.75 reported in earlier studies (Mpofu *et al*., 1993; Vargas and van Arendonk, 2004). Comparison between the CPT and PLB showed that the later was superior and this could be explained by short generation interval of the young bulls (Nitter, 1998).

Table 2. Economic response (US$) for breeding strategies assuming four levels of genetic correlation (r_g) and an initial genetic difference of one between Kenya and the USA

	Genetic correlation				
Strategy[A]	0.30	0.58	0.70	0.90	1.00
CPT	28.57	28.57	28.57	28.57	28.57
CSI	11.75	22.72	27.42	35.25	39.17
PLB	31.12	31.12	31.12	31.12	31.12
PIB	10.50	20.31	24.51	31.51	35.01

[A]CPT, closed progeny testing scheme; CSI, continuous semen importation; PLB, young bull system progeny of local bulls; PIB, young bull system progeny of imported bulls.

The effects of initial genetic differences between the two populations were also investigated assuming a genetic correlation of 0.58 between the two populations and results are presented in Table 3. Ojango and Pollot (2002) reported genetic correlations of 0.58 between the breeding values for MY of Holstein Friesian sires in Kenya and exporting countries. The genetic response for strategies involving imports improved with increased initial genetic differences. The CPT was superior to CSI when the genetic difference between the two populations was ≤1.25 SD while PLB was superior to PIB when the difference was ≤1.50 SD. In Kenya, young bulls progeny of imported bulls are also used for breeding and therefore if imports have to be used at this level of genetic correlation, then only semen from countries with dairy cattle populations that are ≥2.00 SD above the Kenya population should be imported. The results of this study are in agreement with those reported by Mpofu *et al.* (1993) for Zimbabwe dairy cattle population. When importing genetic materials, emphasis should be given to the effect of G x E. If genetic correlation of 0.58 is close to reality for Kenya, then the use of genetic material from local selection programs especially PLB strategy is a better alternative. It has already been noted that countries relying on imported genes for genetic improvement will have to switch at some point to local selection programs (Mpofu *et al*., 1993; Vargas and van Arendonk, 2004).

Table 3. Economic response (US$) for breeding strategies assuming four levels of initial genetic differences and a genetic correlation of 0.58 between Kenya and the USA

	Initial genetic differences			
Strategy[A]	1.00	1.25	1.50	2.00
CPT	28.57	28.57	28.57	28.57
CSI	22.72	28.40	34.08	45.44
PLB	31.12	31.12	31.12	31.12
PIB	20.31	25.39	30.47	40.62

[A]CPT, closed progeny testing scheme; CSI, continuous semen importation; PLB, young bull system progeny of local bulls; PIB, young bull system progeny of imported bulls.

CONCLUSION

This study has shown that the alternative breeding strategies compared if effectively utilized under conditions in Kenya will result in genetic improvement of dairy cattle. Effective utilization of imported semen is influenced by the level of G x E and the differences in genetic merit between Kenya and the USA. It also showed that with a genetic correlation of 0.58, semen should only be imported from countries with a dairy cattle population that is 2.00SD above Kenya population. An economic evaluation, however, is needed to ascertain the profitability of these strategies under the local production conditions.

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