Economic Evaluation Of Breeding Strategies For Improvement Of Dairy Cattle In Kenya

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Introduction

In Kenya, the dairy industry still heavily relies on imported semen (Ojango and Pollot 2002). Importation has been done without taking into account the effect of genotype-environment interaction (GE) between the importing and exporting populations. This is because improvement methods like progeny testing commonly used in developed countries are rarely practiced due to the costs involved. Nitter (1998) noted that unlike breeding programs in developed countries where the paramount interest is to maximize genetic gains, the cost effectiveness of the breeding programs in developing countries where modern dairy cattle breeding strategies are not yet fully developed should be considered. The cost effectiveness of breeding programs and strategies for different livestock species have been studied both in developed and developing countries (Holmann et al. 1990; Mpofu et al. 1993) but such studies are lacking in Kenya. The objective of this study was therefore to determine the economic merits of breeding strategies evaluated by Okeno et al. (2010) using cost-benefit analysis.

Materials and methods

Benefits and costs of genetic improvement: 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. In PLB and PIB the young bulls were slaughtered after semen collection and are stored until their daughters' records are available to select semen from best bulls for future mating. The benefits of genetic improvement in terms of predicted economic response (ER) for the four breeding strategies used in this study were estimated as, 33.85, 35.92, 45.72 and 42.30 US$/year for CPT, PLB, CSI and PIB respectively (Okeno et al. 2010). In determining the economic merits, these estimates were halved since the predicted genetic gains are usually higher than genetic response achieved in practice (Mpofu et al. 1993). The costs of genetic improvement were classified as production, investment and operational costs.

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Production costs included those incurred for feeding and veterinary services (Kahi and Nitter 2004). Investment and operational costs were obtained from the Central Artificial Insemination Station (CAIS 2005). This station is mandated to acquire bulls or bull calves and produce good quality semen for use in Kenya. The investment costs in local selection programs (CPT and PLB) included only costs for replacing investment items since the bull station already exists in Kenya. The operational costs are recurrent expenses incurred in running the strategy and it was assumed that 30 bulls were raised in the breeding station. The operational costs included bull maintenance costs per year, semen collection, storage and distribution. Other costs included those incurred during progeny testing, waiting period, data recording and processing. It was further assumed that semen from CPT was used to inseminate all cows while in PLB this semen was used only on 5% of the cow population (bull dams) with the remaining 95% being inseminated by semen from PIB (Okeno et al. 2010). For strategies involving importation of semen (CSI and PIB), the investment costs of CSI are low and include costs of facilities for semen storage and distribution. The operational costs are high, and in addition to the costs of storage and distribution, they also included costs of semen importation. The investment costs of PIB were similar to those for CPT but also included the costs for semen imports that are used on 5% of the cow population. The number of straws required was determined by the total cow population bred by AI and the number of services per conception. In this study, a total cow population of 2,500 was assumed and was bred by AI and conceived after two services. One percent more straws were required to allow for losses that may occur during storage and distribution (CAIS 2005). The average annual costs were estimated as US$ 204,050.00, 192,402.71, 515,178.57 and 208,840.71 for CPT, PLB, CSI and PIB, respectively.

Method of evaluation. Cost-benefit analysis was used to assess the economic merit of the four breeding strategies. Economic analysis using net present value (NPV) as the evaluation criterion was used in this study. Net present value has been used in earlier studies to ascertain the economic viability of breeding programs and strategies (Dekkers and Shook 1990; Mpofu et al. 1993). The project is considered economically viable when the NPV is positive. The NPV for each breeding strategy was estimated as;

$$NPV = \sum_{t=0}^{T} \left(\frac{\left(N \sum_{i=1}^{1} \mathrm{ER}_{1} \right)_{t} - c_{t}}{(1 + r)^{t}} \right)$$

where T is the evaluation period (25 years), N the total cow population bred by AI, ER the economic response c_t the costs of genetic improvement and r the discount rate (5%). This discount rate falls within the range of discount rates recommended when evaluating animal breeding programs (Bird and Mitchel 1980). Sensitivity analysis was done on changes in discounting rates, genetic correlation, initial genetic difference between Kenya and the USA and exchange rates.

Results and discussion

The NPV for the four breeding strategies assuming different levels of genetic correlations and initial genetic differences between Kenya and the USA are presented in Table 1. As expected, the NPV ranking (Table 1) differed with genetic ranking (Okeno et al. 2010). Genetically, CSI and PIB ranked above CPT and PLB (Okeno et al. 2010). The NPV ranking, however, changed as generally the local selection programs were superior to strategies involving imports at all levels of genetic correlation and initial genetic differences between Kenya and the USA (Table 1). Although CSI had the highest NPV (Table 1), it ranked low because NPV was negative, indicating that the benefits cannot offset the costs. This could be explained by the high operational costs involved in importing semen annually. The PIB however, ranked above CPT at 2.00SD. The current findings concur with those reported by Mpofu et al. (1993) for the use of imported semen to improve dairy cattle in Zimbabwe.

Table 1: Net present values (US$)[α] for breeding strategies at different levels of genetic correlations and initial genetic difference between Kenya and the USA

	Level of genetic correlations				Initial genetic differences (SD)		
Strategies[ß]	0.30	0.58	0.90	1.00	1.25	1.50	2.00
CPT	0.18	0.18	0.18	0.18	0.18	0.18	0.18
PLB	1.13	1.13	1.13	1.13	1.13	1.13	1.13
CSI	-42.82	-42.78	-42.73	-42.70	-42.75	-42.73	-42.68
PIB	-2.35	-1.71	-1.00	-0.78	-0.67	-0.35	0.31

[α]Divided by 10^6.

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

Table 2 shows the NPV for breeding strategies at different discount and exchange rates. The NPV for all strategies were sensitive to changes in discount rate. Increase in discount rate led to a decrease in NPV for CPT, PLB and PIB but an increase in NPV for CSI. This is because CSI had higher operational than investment costs. The exchange rate had a negative impact on NPV of importing strategies. A depreciated shilling was associated with reduction in NPV for CSI and PIB.

Generally, when strategies utilizing local genetic materials were compared, PLB was superior to CPT (Table 1 and 2). This is because in CPT, proven bulls have a longer generation interval compared to young bulls. This is in agreement with previous studies which compared the profitability of old and young bull schemes (Mpofu et al. 1993; Nitter 1998). If the genetic correlation of 0.58, the actual level of GE between Kenya and exporting countries (Ojango and Pollot 2002), is to go by, then utilization of local selection programs especially PLB is recommended because it had the highest NPV (Table 1).

Table 2: Net present values (US$)[α] for breeding strategies at different discount and exchange rates

	Discount rates (%)			Exchange rates (US$:KSh)		
Strategies[ß]	0	5	10	1:50	1:70	1:90
CPT	1.54	0.18	-0.23	0.18	0.18	0.18
PLB	3.69	1.13	-0.01	1.13	1.13	1.13
CSI	-75.70	-42.75	-27.10	-30.00	-42.75	-54.10
PIB	1.37	-0.67	-1.38	-0.25	-0.67	-1.11

[α]Divided by 10^6.

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

The results of this study indicate that the use of import strategies are not economically viable under Kenyan production conditions while use of PIB strategy can only be profitable if young bulls used were sons of sires from countries whose dairy cattle population is >2.00SD above the Kenyan. Such semen may be expensive to smallholder dairy farmers who own 70% of the dairy cattle population in Kenya and live below the poverty line (Ojango and Pollot 2002).

Conclusion

This study has shown that the economic merit of breeding strategies, especially those involving importation of semen, is mainly dependent on the level of GE, initial genetic difference between importing and exporting populations and the exchange rates. The utilization of local semen, especially from young bulls (PLB), is more profitable because benefits from imported semen cannot offset the costs. If importation of semen has to continue, then PIB is an alternative strategy, but only semen from populations which are 2.00SD above the Kenyan dairy cattle population should be imported.

References

Bird, P.J.W.N. and Mitchell, G. (1980). *Anim. Breed. Abst.,* 48:499-505.

CAIS. (2005). *Tech. Report*, November, CAIS, Kabete, Nairobi, 23 pp.

Dekkers, J.C.M. and Shook, G.E. (1990). *J. Dairy Sci.,* 73:1902-1919.

Holmann, F., Blake, R.W., Milligan, R.A. *et al.* (1990). *J. Dairy Sci.,* 73:2179-2189.

Kahi, A.K. and Nitter, G. (2004). *Livest. Prod. Sci.,* 88:161-177.

Mpofu, N., Smith, C., van Vuuren, W. *et al.* (1993). *J. Dairy Sci.,* 76:1173-1181.

Nitter, G. (1998). In *Proc. 6th WCGALP,* Volume 23, Pages 435-438.

Ojango, J.M.K. and Pollot, G.E. (2002). *Livest. Prod. Sci.,* 74:1-12.

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