EVALUATION OF ALTERNATIVE BREEDING SCHEMES FOR MILK PRODUCTION IN KENYA

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INTRODUCTION

In Kenya, there are no effective genetic improvement programmes for dairy cattle, owing to various constraints, *e. g*. small herd size, lack of systematic identification, inadequate animal performance and pedigree recording, organisational shortcomings etc. Nucleus breeding programme can be a good strategy for genetic improvement in developing countries, which lack the money, expertise and structure required for operating an efficient improvement programme based on AI and milk recording in the whole population (Smith, 1988). It has been shown that a young bull system (YBS) has lower costs and gives more profit than the conventional old bull system and that it has an advantage when the time horizon considered is short, the resources are limited and interest rates are high (Owen, 1975; Mpofu *et al*., 1998; Nitter, 1998). The latter two are the common problems that characterise most of the non-industrialized countries. This paper therefore examines using deterministic simulation, a two-tier open nucleus-breeding scheme using the YBS with a view of evaluating the efficiency of various breeding schemes.

MATERIAL AND METHODS

Breeding objective. The breeding objective (*i. e*., the choice of traits to be genetically improved because they influence the producers income) assumed was dual purpose and represented an envisaged future objective for the Kenyan dairy cattle. It was assumed that payment of milk was based on the fat content rather than on milk volume, as is currently the case. The traits included: milk yield (MY, kg), fat yield (FY, kg), lactation length (LL, kg), preweaning daily gain (DG, g/day), age at first calving (AFC, days), calving interval (CI, days), postweaning daily gain (PDG, g/day), herdlife (HL, days), preweaning survival rate (SR, %) and postweaning survival rate (PSR, %). The economic values were un-discounted and calculated as the partial derivative of the profit with respect to the trait considered, keeping all other traits constant at the mean value (Kahi *et al.,* 2002a and b).

Selection groups. A two-tier open nucleus breeding scheme and YBS were assumed with intensive recording and 100% artificial insemination (AI) in the nucleus and 35% AI in the commercial population, which was the smallholder farm. The nucleus is the tier that generates genetic gain and where sire selection is the main activity. Selection of old bulls occurs to produce both bulls and cows used in the nucleus (old bulls to breed sires and old bulls to breed dams) while young bulls are the sires of dams (young bulls to breed dams). A small collection of semen is stored per young bull until the first batch of daughters has been tested. Selection of dams also occurs to improve both bulls (dams to breed bulls) and cows (dams to breed cows). In the nucleus, the last selection group is complemented by dams from the commercial sector, which are selected subjectively in their first lactation. This is a separate group to produce cows in the nucleus. The bull dams are inseminated with stored semen from the best bulls (*i. e*. old bulls). Only young bulls are used in the commercial sector to produce cows and to sire bull calves that are kept for use to mate a proportion of the cows in this sector. These calves become sires that are used in this sector to produce cows but their sons are not used for breeding. The dams in the commercial sector are used to produce both bulls and cows in this sector.

It was assumed that there is intense recording of performance in the nucleus but none in the commercial population. Therefore selection of cows is restricted to the nucleus but the best cows in the commercial sector that join the nucleus after their first lactation are selected subjectively. This is based on milk yield on a particular test day. The potential for movement of cows from an individual smallholder farm to the nucleus herd may be limited. Consequently, it was assumed that the commercial population comprises of 100 participating village herds each with several individual smallholder farms and therefore a considerable number of cows from which replacements can be selected.

Genetic and phenotypic parameters. Genetic and phenotypic parameters for the selection criteria and the traits in the aggregate genotype are required in order to calculate the composition and the accuracy of selection indices. These were developed from a search of the literature and are reported elsewhere (Kahi *et al.,* 2002b).

Computer programme, population structure and biological, technical and economic parameters. Based on the biological, technical and economic parameters, ZPLAN calculates selection indices for breeding animals and applies order statistics to obtain adjusted selection intensities for populations with finite sizes (Karras *et al.,* 1997). Reduction of the genetic variance due to selection and inbreeding is ignored. Different biological and technical parameters were used for the nucleus and the commercial population. Variable and overhead costs occur exclusively in the nucleus. The fixed costs were those incurred in one round of selection and are the overhead costs of running the nucleus of 2500 cows. The average time when fixed costs occur is assumed to be the mean generation interval, which was assumed to be 3.2 years. The biological, technical and economic parameters were based on Kahi (2000). Both variable and fixed costs only affect the profit but not the genetic response. The return was discounted at a rate of 5 % and costs at a lower rate of 3 %. An investment period of 25 years was considered. A total population of 50,000 cows was considered and the size of the nucleus with performance and pedigree recording was 5% (2500 cows) of this population. Seventy percent of bulls for the commercial sector come from the nucleus. In commercial sector, the bull to cow ratio was 1:500 and 1:50 for AI and natural mating, respectively. Twenty percent of the dams in the nucleus come from the commercial population. An important parameter for the population structure was the proportion of bull dams, which was assumed to be 5% of the nucleus. The annual monetary genetic gain and profit per cow in the population were used as evaluation criteria.

Breeding schemes, selection criteria and index information. Breeding schemes were defined which differed in the records available for use as selection criteria as well as in the costs and investments parameters. Breeding schemes, which require increased levels of performance recording and genetic evaluation have increased costs, which are directly attributed to the scheme. Table 1 shows the available selection criteria for each scheme. Selection was on an index that was based on the available criteria (Kahi *et al.,* 2002b).

Table 1. The available selection criteria for each breeding scheme

Breeding scheme	Traits recorded[A]								
	AFC	CI	SR	PSR	LL	MY	DG	PDG	FY
1	X	X	X	X	X				
2	X	X	X	X	X	X			
3	X	X	X	X	X		X	X	
4	X	X	X	X	X	X	X	X	
5	X	X	X	X	X	X	X	X	X

[A]AFC = Age at first calving; CI = Calving interval; SR = Preweaning survival rate; PSR = Postweaning survival rate (to 18 months); LL = Lactation length; MY = Milk yield; DG = Preweaning daily gain; PDG = Postweaning daily gain; FY = Fat yield.

RESULTS AND DISCUSSION

The annual monetary genetic response, returns, costs and profit of alternative breeding schemes are shown in Table 2. The annual monetary genetic response was highest in scheme 5 representing the highest level of investments. A comparison of the annual monetary genetic response of scheme 4 and 5 showed very little difference indicating that there is little benefit including fat content as a selection criterion. The difference in profit per cow between scheme 4 and 5 was also small (approximately 4%).

Table 2. Annual monetary genetic response, returns and profit per cow of alternative breeding schemes

Breeding scheme	Annual monetary genetic response (US $)	Total return per cow (US $)	Profit per cow (US $)
1	4.71	25.55	18.28
2	5.76	31.78	23.95
3	5.40	28.85	21.48
4	6.41	34.56	26.64
5	6.45	34.80	25.63

Scheme 5, which ranked highly for annual monetary genetic response and total return per cow, did not rank the same in profit per cow. This was probably due to the high costs incurred for milk sampling, laboratory determination of fat content and recording FY.

Usually in establishing a breeding and recording scheme, the major question is that of return on investment. Therefore there must be a compromise between achieving a certain degree of genetic gain and maximizing of profits. Profit per cow in the population was lowest in scheme 1. Results demonstrated that breeding schemes, which require increased levels of performance recording and genetic evaluation have increased costs. Selection should be based on all the traits represented in the aggregate genotype but with no measurement of fat content. Recording of FY in scheme 5 resulted in profits that were lower than those obtained in scheme 4, which assumed that there was no recording of FY. Therefore, under the prevailing conditions, a breeding scheme that requires records on FY seems not to be justified from an economic point of view especially in situations where these records are to be obtained from all cows in the nucleus, which was assumed in this study. To reduce the overall costs of recording FY in the nucleus, simplified recording methods can be adopted, for example by reducing the number of cows tested and samples taken from each cow per lactation period. Alternatively, a reduction in recording costs of fat content is also possible by testing for fat on pre-determined test days. Use of test-day records instead of cumulative lactation totals for genetic evaluation of potential parents results in improved genetic information and accurate estimated breeding values (Schaeffer *et al.,* 2000). While the possibility of payment based on fat content rather than on milk volume and hence of widespread use of fat recording in Kenya seems unrealistic for the next several years, this suggestion could serve as a guideline for future breeding activities.

CONCLUSIONS

The information from this study is a prerequisite for successful establishment of breeding programmes for dairy production. There is evidence that under the current production and marketing conditions, a well-organised nucleus utilizing the smallholder as the commercial population could sustain itself. However, before any breeding programme is established on a large scale, pilot selection schemes should be developed first and shown to work. During all the establishment stages, the needs and interests of the producers as well as the ecological conditions should seriously be taken into consideration. There is therefore the need for further studies on how this can be realized and improved genetics delivered to cattle owners, especially smallholder producers.

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