Monitoring of Sahiwal and Friesian cattle genetic improvement programmes in Kenya

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Introduction

Livestock genetic improvement programmes aim at identifying superior animals for specific traits and allowing only these animals to be parents of the next generation. The use of genetically superior animals is expected to result in improvements in the efficiency of production, which in turn ensures that livestock products are more cheaply available to the human population. It is important to monitor breeding programmes in order to check if targeted improvements are realised for the desired traits and to quantify the impact of the programmes on genetic variation and diversity. Working examples of livestock improvement programmes in sub-Saharan Africa are, however, limited. The aim of this paper is to show the importance of monitoring genetic improvement programmes using the examples of an improvement programme for the Sahiwal breed in Kenya and a progeny testing scheme for Friesian cattle in Kenya. The paper is based on reports by Rege et al. (1992) and Rege and Wakhungu (1992) for the Sahiwal project and Rege (1991a and 1991b) for the progeny testing scheme for Friesian cattle.

Description of the programmes

The Kenya National Sahiwal Stud

The Kenya National Sahiwal Stud was started in 1962 to develop the breed for use as a dual-purpose animal (beef and milk) suitable for the semi-arid environments of Kenya and to develop appropriate management systems for the breed. A breeding plan for a closed herd was drawn up in 1965 and implemented in 1968. The herd consisted of 400–500 cows plus followers, a total of 1300 head, managed in a fairly extensive system. Records analysed to monitor the programme included cow, service sire and calf identifications; dates of birth or calving, service and conception, and weaning; birth weight; age at 125 kg; lactation milk yield and days in milk. Drying-off management was inconsistent as in some years, animals capable of sustaining lactation lengths greater than 305 days were dried off at 305 days. In other years, however, all animals were allowed to dry off naturally. Female selection consisted of eliminating 50% of heifers on the basis of first lactation milk yield and a further 50% at the end of the second lactation. Screening for reproductive performance was done but contributed little to selection intensity. The heifer herd was used for progeny testing of bulls. Ten test bulls were pre-selected from a total of 75 bull calves at two years of age on an index which included first lactation milk yield of their dams and their paternal half sisters; and own live weight at the end of a two-year performance testing period on pasture. At the end of the progeny testing period, two out of ten bulls were selected each year.

The progeny testing scheme for the Friesian breed

Commercial dairy production in Kenya started with the upgrading of zebu cattle in the Central Highlands mainly using imported semen, but also to a small extent, bulls from exotic dairy breeds that included the Friesian breed. Initially, the growth of the dairy population depended on imports of exotic dairy breeds, especially semen, from temperate countries. As the dairy population grew and the demand for semen concurrently increased, it was realised that relying on imports might not be sustainable. Moreover, there was a question of possible genotype by environment interaction especially between the diverse climates and production systems in exporting countries versus those in Kenya. Thus, in 1969, a progeny testing scheme for young bulls was initiated. The test bulls were produced by inseminating superior local dams with semen from either foreign or locally proven bulls. Performance records for progeny of test bulls and the dairy population as a whole were collected through the milk recording scheme, which was established in 1940. Records collected through the scheme included dam, sire and calf identification, birth date, calving date and parity, calving interval, and milk yield and butterfat content. The records summarised here were for a 21-year period of between 1967 and 1987.

Monitoring of breeding programmes

Sahiwal National Stud Herd

Genetic and phenotypic changes in the Sahiwal population were estimated using information collected during the period 1964–88 and reported by Rege and Wakhungu (1992). The traits studied were 305-day milk yield, calving interval, birth weight and age at 55 kg live weight. Trends in other traits were not estimated due to inadequate data. The annual genetic changes in birth weight and age at 55 kg were not significantly different from zero. The rate of genetic change for milk yield represented a genetic progress of 0.3% per year of the base period (i.e. 1964) average, which was lower than the expected rate of 2.5%. The low rates of genetic progress were explained by lower than planned selection intensities for the bulls. Sahiwal bulls have poor semen production —thus necessitating retention of genetically poor sires for long periods. The mean annual milk yield, however, showed a decline of about 13 kg per year; this was primarily a result of environmental (mainly nutritional) decline. Phenotypic trends for age at first service, conception and calving, number of services per conception and insemination period also showed a general decline in performance which was attributed to poor feeding and breeding management.

The Sahiwal herd was maintained as a closed herd for the period 1968 to 1988, raising fears of high levels of inbreeding, which could influence performance levels for some traits. Annual trends in the proportion of inbred cows, average inbreeding coefficient of cows entering production (i.e. first calvers) and of all cows were estimated. There was an increase in the proportion of inbred cows from zero in 1967 to 6.3% in 1975 and a decline thereafter to 0.6% in 1988. The annual rate of increase of inbred cows was small, 0.043%. The emergence of inbred animals in the earlier years of the programme was attributed to the fact that some of the foundation stock animals were related and the size of the foundation stock was small, 60 bulls and 13 females. The yearly mean inbreeding coefficient of cows showed an erratic pattern. However, cows freshening (calving for the first time) between 1973 and 1981 tended to be more inbred. The overall mean inbreeding coefficient of cows freshening in the herd was 0.08%. The general level of inbreeding declined after 1970s because mating of related animals was deliberately avoided following reports of declining performance in 1978. The mean inbreeding coefficient of all cows in the herd was generally similar to that of cows entering production, but inbreeding levels were higher. This was due to the cumulative effect of retaining inbred cows in the herd after their first calving, as culling was mainly on the basis of poor milk production and reproduction. Overall, these results indicated that inbreeding had no significant effect on performance.

The general conclusions from this study were that there was a very low rate of genetic progress, which could be improved by increasing selection pressure on the males. Inbreeding levels were very low and had no effect on production. Environmental factors had a big influence on performance —emphasising the need to improve management levels in the herd.

Friesian cattle

Estimated transmitting abilities of bulls were used to calculate genetic change in sires over time. All traits studied showed positive desirable trends in the initial period. Calving interval declined from 1968 to 1976, then slowly improved from 1977 to 1979, and then it increasingly improved up till 1982, after which it increased (deteriorated). Milk yield, both in all cows and first lactation cows, showed substantial positive gains from 1968 to 1976, but started to decline from 1977 to 1987. Age at first calving showed improvement up to 1982, but started to decline thereafter. The negative trends in later years can partly be attributed to relaxed selection pressure due to high demands for semen from within Kenya and from neighbouring countries. Furthermore, these trends can be attributed to long testing periods which in turn were due to the declining number of recorded herds and herds participating in the progeny testing scheme and inefficient management of the scheme. In addition, selection of bulls was not only on performance as additional selection criteria were introduced by the breed society.

Annual averages and estimated breeding values for the cows were used to estimate phenotypic and genetic trends, respectively, in the cow population. There was positive but non-significant genetic progress in milk yield for all cows. For first lactation cows, the rate of progress was negative but non-significant. This negative trend could indicate that the genetic quality of cows entering the herd was declining. This would imply that sire selection, which is supposed to inject new superior genes into the population, was actually having a negative effect. The positive trend response for all cows indicates that the genetic merit of new cows entering the herd and that of cows selected to remain in the herd was improving. Since sire selection yielded a negative response, an overall positive trend indicates that culling at farm level had a bigger impact than more systematic bull selection at national level. Annual genetic trend in age at first calving was high and significant, indicating the importance farmers put on this trait.

Phenotypic trends were in the same direction as genetic trends, but erratic for milk yield and in the opposite direction for age at first calving and calving interval. However, the trends for all traits were not significantly different from zero.

Lessons learnt

1. Expected progress was not realised. One of the reasons for slow progress was the inability to adhere to set programme goals or targets. For example, bulls were not selected as intensely as was intended due to poor fertility in the Sahiwal programme and due to high demand for exotic bulls in the Friesian programme.
2. The required management levels were not attained resulting in the environment having a larger influence on performance than do genetic factors.
3. Monitoring of rates of progress and factors affecting it is important as management and breeding decisions can be changed if, necessary. When inbreeding was thought to

influence performance in the Sahiwal herd, care was taken to avoid the mating of close relatives (from 1978 onwards). This resulted in overall low levels of inbreeding for the period of study and thus negative effects of inbreeding on production were avoided.

Knowledge gaps

1. In traditional livestock production systems the sire of an animal is not usually known as mating is not controlled. However, the dam is always known with certainty. Most animal evaluation computer software use the sire model, and more recently, the animal model. It may be important to evaluate the use of a dam model for such production systems.
2. The design of appropriate recording schemes for the smallholder sector is required – the type of information that should be collected and how the scheme should be operated.
3. The breeding schemes described above are a closed nucleus scheme and a field-testing scheme. Nucleus schemes are said to be less expensive to run when compared with field-testing schemes and are likely to give higher rates of genetic progress as the selection goals can be adhered to, expertise is concentrated in one herd etc. Therefore, they have been highly recommended for developing countries, especially where field recording is not available. The existence of data for the two schemes gives an opportunity to evaluate the schemes using both genetic and economic parameters.
4. The bulls tested in the purebred milk recorded population are either foreign bulls or sons of foreign bulls. They are later used for crossbreeding in the smallholder sector. This sector, in most sub-Saharan countries, is growing and is larger than the commercial sector. However, testing of bulls in this sector is limited by lack of recording services in the sector and/or the unwillingness of smallholder farmers to participate in complex recording schemes, which are over and above their needs.
    a. Selection goals for the smallholder sector may be different from those of the commercial sector, as production conditions are different. There is a need to document selection goals for this sector and to investigate how they can be incorporated in the selection of bulls tested in the commercial sector?
    b. There is a need to investigate the importance of genotype by environment interaction at two levels:
        i. Should bulls that have been selected in a foreign country be used in an importing country's commercial sector?
        ii. Should bulls selected for the commercial sector be used in the smallholder sector within the same country?

Discussion questions

1. The most limiting factor in breed improvement programmes for Africa is that there are very few recording schemes. In some cases, when such schemes exist, there is rudimentary or no analysis of data generated by the schemes due to lack of capacity (human capacity, computer hardware and software etc.).
    a. What are the major constraints to setting up livestock recording programmes in your country?
    b. If the programmes exist:

i. Is membership low or high, what influences the size of membership?

ii. How is the data generated from these schemes used – as a management tool by farmers, for research, for estimation of breeding values and selection, by policy makers in estimating food production figures?

2. For a country with no livestock recording services, would you recommend a closed or an open nucleus breeding scheme, and why?

3. The breeding industry in some sub-Saharan African countries includes animal registration and animal recording services, progeny testing schemes, data processing and analysis services, artificial insemination services (to disseminate improved livestock), research organisations, breed societies and farmer organisations to promote breeds etc.

   a. Are all these organisations a necessity? Do all or some exist in your country?

   b. Are the existing services publicly or privately owned? Which ones do you think should be privately owned and why?

   c. Which of the services do you think could be taken over by universities?

References and related literature

Bondoc O.L., Smith C. and Gibson J.P. 1989. A review of breeding strategies for genetic improvement of dairy cattle in developing countries. *Animal Breeding Abstracts* 57:819–829.

Rege J.E.O. 1991a. Genetic analysis of reproductive and productive performance of Friesian cattle in Kenya. I. Genetic and phenotypic parameters. *Journal of Animal Breeding and Genetics* 108:412–423.

Rege J.E.O. 1991b. Genetic analysis of reproductive and productive performance of Friesian cattle in Kenya. I. Genetic and phenotypic trends. *Journal of Animal Breeding and Genetics* 108:424–433.

Rege J.E.O. and Wakhungu J.W. 1992. An evaluation of a long-term breeding programme in a closed Sahiwal herd in Kenya. I. Genetic and phenotypic trends and levels of inbreeding. *Journal of Animal Breeding and Genetics* 109:374–384.

Rege J.E.O., Lomole M.A. and Wakhungu J.W. 1992. An evaluation of a long-term breeding programme in a closed Sahiwal herd in Kenya. I. Effects of non-genetic factors on performance and genetic parameter estimates. *Journal of Animal Breeding and Genetics* 109:364–373.

Trail J.C.M. and Gregory K.E. 1981. *Sahiwal cattle: An evaluation of their potential contribution to milk and beef production in Africa*. ILCA (International Livestock Centre for Africa) Monograph 3. ILCA (International Livestock Centre for Africa), Addis Ababa, Ethiopia. 128 pp.

Yappi-Gnaore C.V., Oya A., Rege J.E.O. and Dagnogo B. 1997a. Analysis of an open nucleus breeding programmes for Djallonke sheep in the Ivory Coast. 1. Examination of non-genetic factors. *Animal Science* 64:291–300.

Yappi-Gnaore C.V., Rege J.E.O., Oya A. and Alemayehu N. 1997b. Analysis of an open nucleus breeding programmes for Djallonke sheep in the Ivory Coast. 2. Response to selection on body weights. *Animal Science* 64:301–307.