Case Study about the N'Dama breeding programme at the International Trypanotolerance Centre (ITC) in The Gambia

L. Dempfle[1] & J. Jaitner[2]

[1]Institut für Tierwissenschaften, TU-München, Freising, Germany
[2]International Trypanotolerance Centre (ITC), Banjul, The Gambia

Introduction

Very large areas of the sub-humid zone of West Africa are in need of indigenous breeds in order to exploit the available natural pastures, bushlands and crop residues. However, there is an urgent need to increase production because:

- there is a rapid increase in human population (in some countries population has doubled in less than 20 years);
- there is dramatic urbanisation (some large human agglomeration centres have doubled in less than a decade);
- some countries import large amounts of dairy products (mainly liquid and powdered milk) showing that even today the demand cannot be satisfied by local production.

As it is obvious, production can be increased by both increasing animal numbers and by increasing productivity of each animal. However, in some countries (e.g. The Gambia) the number of cattle has hardly increased during the last 15 years, strongly indicating that the carrying capacity of the land is largely utilised. Serious starvation at the end of the dry season is supporting this conclusion. Also the extension of crop production due to human population increase is reducing the availability of the natural grazing areas, but at the same time it allows increasing the intensity by using by-products of crop production as high quality feed (e.g. groundnut hay). Thus, these factors are very much in favour of increasing productivity per head. Genetic improvement is among other components to achieve this goal. For the prevailing low input system, indigenous breeds are absolutely necessary due to the periodically extreme scarcity of feed and the presence of serious diseases like Trypanosomiasis and Tick-borne diseases (Cowdriosis, Dermatophilosis and others). Fortunately with the

N'Dama breed there is one numerous breed available in West Africa which comprises several million heads. Any effective breeding and multiplication scheme could thus have a large impact.

The International Trypanotolerance Centre (ITC) in The Gambia was from its inception, devoted to enhancing the usefulness of genetically trypanotolerant animals.

In recent years ITC has implemented four genetic programmes for improving the efficiency of livestock production. These programmes are:

- pure-breeding N'Dama programme in cattle;
- pure-breeding Djallonké programme in sheep;
- pure-breeding West African Dwarf programme in goats; and
- a continuous F_1 cross-breeding programme for exotic dairy breed x N'Dama for peri-urban milk production.

Only the implementation and running of the N'Dama breeding programme will be described here.

N'Dama pure-breeding programme at ITC

From approximately ten million trypanotolerant cattle, more than half of them belong to the N'Dama breed (Hoste *et al*., 1988). These are distributed as:

Country	Numbers
The Gambia	290 000
Senegal (Casamance)	640 000
Guinea Bissau	300 000
Guinea	2 190 000
Sierra Leone	330 000
Liberia	10 000
Mali	410 000
Côte D'Ivoire	140 000
Ghana	30 000

In addition there are smaller populations in Zaire, Gabon, etc. Practically all of these N'Dama cattle are kept in low input systems.

After its inception ITC built up a large institutional herd of about 1 200 N'Dama cattle. In 1994 with support from BMZ/GTZ, a breeding scheme was initiated. It was decided to transform this institutional herd into an open nucleus herd. The intention was and is to have close collaboration with similar nucleus breeding schemes in Senegal and Guinea and jointly contribute to the genetic improvement of the N'Dama breed focussing on these three countries. The cattle of ITC were originally

distributed in many herds all over the country and the transformation of that cattle stock to a nucleus breeding unit in two sites took quite a time especially until all the necessary recording of pedigrees and performance testing was organized. Thus the start of the breeding work can be taken as commencing in mid 1995 and we were starting essentially from scratch (few performance data and even fewer reliable pedigree data are available).

Breeding goals

In 1989 there was an FAO mission to look into the possibility of genetically improving the N'Dama breed. In that mission report it was clearly stated that several traits were of importance: disease resistance / tolerance (the main trait justifying the breed), milk production, meat production and ability for traction. After reviewing the literature and becoming more familiar with the local system, it was decided to organize the breeding scheme in such a way that milk and meat production would be improved without loosing adaptability (e.g. trypanotolerance). Looking at the critical time path it was decided that it is much more urgent to implement the proper performance testing and recording than to first spend a lot of time to decide whether the emphasis for milk compared to meat should be a little bit higher or lower. In addition quite a lot of parameters (economic and biological ones) were not known very precisely making any precise derivation of economic weights somewhat illusory. This pragmatic approach was in our opinion justified in order to gain time but it was also criticised.

Once the reorganization was accomplished and quite an efficient performance testing and data recording and processing scheme was in place and functioning, the question of breeding goals was revisited.

When trying to improve cattle population, one has to take into account the intention of the official policy of the countries. Most countries have some livestock development plans and these definitely have to be taken into account as the main objectives must agree to ensure the smooth operation.

A Consultative Workshop was organized in ITC in 1996 and was very helpful for qualitatively defining the breeding goals. The directors of the livestock / veterinary services and research organizations dealing with livestock of Senegal, The Gambia, Guinea Bissau, Guinea and Sierra Leone, issued the following statement with regard to:

Cattle in the low-input system

'The N'Dama will remain the cattle breed of choice for the low-input system from The Gambia southwards. Throughout the region the breed is regarded as triple-purpose (for milk, meat and traction) and emphasis for improvement will be for milk and meat without the loss of disease resistance and other adaptive traits'.

This statement nicely summarises the goals in a qualitative manner. However, from here it is still a long way to obtain an operationally defined breeding goal. In addition, there is another problem, the products of a breeding scheme are to be used by the herd owners and not by the politicians or researchers.

In cooperation with another project at ITC, a large Participatory Rural Appraisal Study (Bennison *et al*., 1997) was carried out trying to find out the motives of cattle owners. The study was carried out (including also sheep and goats) in 45 villages. Matrix ranking was used and there were 130 completed matrices in the end. Again milk, meat, traction and manure figured prominently.

Finally, a biological-economic model was developed utilising all the known biological and economical relationships. This model (Dempfle and Jaitner, 1998) has some similarity with a model developed earlier for the New Zealand Dairy Industry (Dempfle, 1986). With this model the question was answered (by marginal profit) in what direction we have genetically to move the population in order to maximise profitability. The derivation, was carried out under the realistic assumption that the amount of Metabolisable Energy is limited and fixed (maximum carrying capacity reached). In this derivation disease resistance is indirectly taken into account in such a way that animals are raised from one to three years in an extremely high challenge area. Only animals which perform well under this environment having high daily gain will have a chance. It was not considered necessary to take traction into account. This model for deriving economic weights for use in the overall index is still being refined (Dempfle and Jaitner, 1999). The best present objective function is:

- H = 0.22.
- Breeding value in daily gain in g + 0.52.
- Breeding value in milk in kg.

The absolute values of the weighing factors are irrelevant, since as long as the ratio of the two weighing factors (0.22:0.52) stay the same, the same animals are selected.

Breeding plan

Dealing with a dual (triple) purpose breed (milk and meat) it was natural to think of a progeny-testing scheme having at any time test bulls, waiting bulls and old proven bulls. However, when we had to prepare for the laying off of the bulls after they had completed the first round of mating, we did two things: we looked for a cheap way of storing semen and we employed all our data to optimise our breeding scheme. That was done in two stages: first optimising within a testing scheme and then comparing the optima of the various schemes. We considered: progeny testing scheme, half-sib scheme and young sire scheme. Somewhat to our surprise the half sib scheme and the young sire scheme came out to be about equally effective and both being ahead of the progeny testing scheme (Jaitner and

Dempfle, 1998). Independently, Syrstad and Ruane (1998) came to very similar conclusions. Since a young sire scheme is by far the simplest to run, that scheme was of course chosen. Fortunately in the present plan there is no need to either store semen or to have any waiting bulls. The problems and costs of using deep frozen semen should not be underestimated.

The plan followed might be best appreciated by studying Figure 1. In the programme the traits of interest are: daily weight gain from zero to ten months (suckling period) and daily weight gain from 15 months to three years in an extreme high challenge area and as a minimum the 0-100 day milk yield (milk off-take) of the first lactation. These traits are determined by monthly weighing of all animals and weekly measuring of milk off-take. Milk off-take is the additional milk not consumed by the calf.

The active breeding stock at any time is about six breeding bulls and 400 adult females, in total there are about 1 000 to 1 100 animals. The animals are located at ITC's stations Keneba and Bansang. In Keneba there are the breeding females (with their suckling calves) and the breeding bulls. After weaning (at an age of ten to twelve months) the young animals are moved to Bansang. The breeding scheme is designed as a young sire programme: all animals are raised after weaning up to three years under a very high tsetse challenge. After finishing the performance test with respect to daily weight gain the selection takes place. The best males are chosen to replace the breeding males, whereas most of the females are allowed to breed in order to be performance tested with respect to milk yield. About 75 percent of those are chosen to replace females of the active breeding stock. For the estimation of breeding values the BLUP procedure is used utilising all known relationships.

The scheme is operated as an open nucleus. Thus the scheme is complemented by a large screening operation where during and after the main calving season milk recording at the village level is carried out (July to December). The goal of this screening is to identify outstanding village cows with respect to milk yield. After weaning, male offspring of such cows are bought and become part of the nucleus. Usually between 500 to 1 000 cows are screened each year in a thorough manner. The efficiency and especially the cost efficiency of the screening will have to be assessed in the near future. In the future the concept of open nucleus also implies the exchange of breeding material with other nucleus breeding schemes in the region.

Dissemination of genetic progress

We did not think that we would already have a product really worth disseminating (after four years breeding work in cattle starting from scratch, do not expect too much)! However, soon we will be able to have young bulls which are on average sufficiently better than any randomly picked bull. Thus preparation for multiplication has started and the first

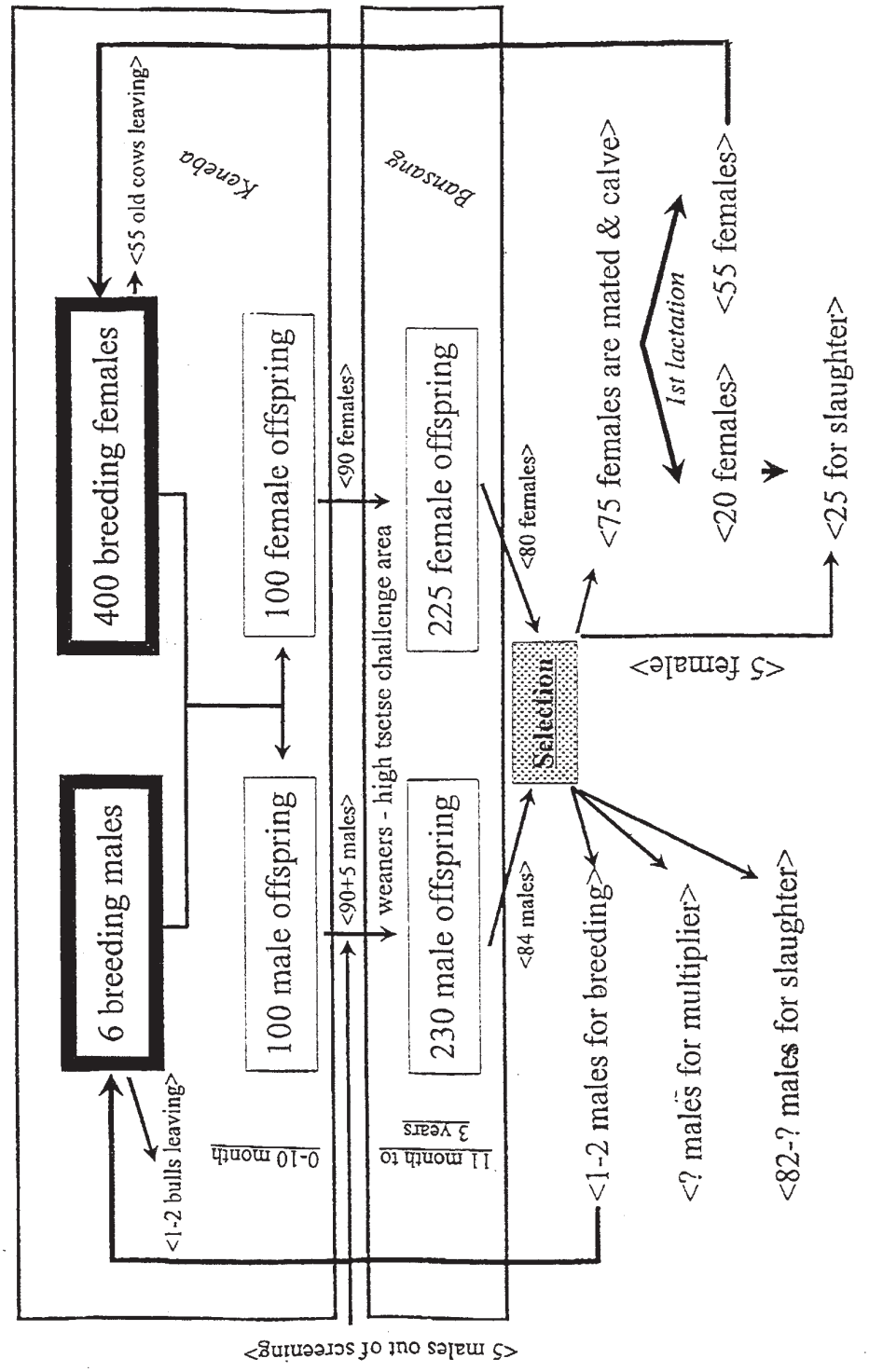

Figure 1. Cattle Nucleus Breeding Scheme (simplified).
Note: <...> annual movement; other numbers are stock numbers.

step was to learn more about the ownership structure (highly complex) and the management of the village herds. Also we will learn from our sheep and goat multiplication where, on a trial basis, presently we are building up multiplier herds (villages). In cattle it is envisioned to have a structure with

open nucleus -> multiplier -> producer

where any genetic progress is disseminated by males. It is to be remembered, however, that the final structure is not yet in place.

The breeding scheme is operated by ITC with funds from Germany (BMZ / GTZ) in cooperation with the Department of Livestock Service and building up links to organizations having similar breeding schemes in Guinea and Senegal. It was always tried to keep the scheme as simple and robust as possible (e.g. young sire programme) so that the running costs are low. A major factor in that respect is the training of dedicated local staff. It will only be sustainable if it is essentially run by local staff. The income generating ability of such a programme by selling breeding stock is judged as limited.

Additional remarks

As stated above, originally a progeny testing scheme was envisioned, but then due to the long generation interval of that scheme in general and especially the extremely long generation interval of the N'Dama, a young sire programme is more efficient and much more simple. Using the usual prediction equation (Rendel and Robertson, 1950) the genetic progress is calculated as more than one percent of the mean. It is hoped that by reducing the generation interval by means of management, that this figure can be increased. At present the testing period for daily gain is up to three years but the average age at first calving is five years. It should be tried to bring down this age at first calving. During the testing period (up to three years) the typical village management has to be applied but afterwards by supplementing, the heifers age at first calving should and could be brought down.

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