THE BROAD GROUPS OF CATTLE IN AFRICA ARE DISCUSSED IN RELATION TO THE MAIN ECOCLOGICAL ZONES. IT IS INDICATED HOW THE LACK OF PUBLISHED INFORMATION ON LIVESTOCK BREEDING WORK IN THE CONTINENT HAS LED TO A PROJECT ASSEMBLING ALL AVAILABLE INFORMATION REPORTED IN NON-CONVENTIONAL FORM; TO THE COLLABORATIVE EVALUATION OF BREEDING RESEARCH OPERATIONS; AND TO DEVELOPMENT OF A MICROCOMPUTER BASED PERFORMANCE RECORDING SYSTEM SPECIFICALLY DESIGNED FOR USE IN LIVESTOCK RESEARCH AND DEVELOPMENT SITUATIONS IN AFRICA. BREEDING RESULTS DISCUSSED INDICATE THAT INDIGENOUS BREEDS ARE WELL ADAPTED TO LOCAL ENVIRONMENTS, AND THAT ANY INCREASE IN GENETIC POTENTIAL OF THESE BREEDS CAN BE EXPLOITED ONLY IF NUTRITIONAL, DISEASE AND CLIMATE STRESSES ARE REDUCED.

INTRODUCTION

Subsaharan Africa has a great need and also has considerable potential to increase both milk and meat production provided specific production constraints can be alleviated (Trail and Gregory, 1981a). In planning increased animal productivity in subsaharan environments, a principal requirement is for information allowing the usefulness of major animal types to be confidently predicted for different ecological zones, production systems, management levels, disease situations, nutritional resources, etc.

Researchers in the animal breeding field in Africa cannot afford to be complacent about their work, and assume that its importance is universally accepted. A recent comment on this subject appeared in the Economist in March 1985.

"Science alone is not going to change Africa. Scientists breeding super-plants are lucky. The magnificent yield increases which they have produced in rice and wheat will probably never be matched by genetic experiments with animals themselves. In the early 70's, it was clear that efforts to breed improved animals for the tropics had been, for the most part, a tremendous waste of money. The less spectacular improvements which can be made take a long time to show. An experimental rice crop may reach maturity in 90 days. An experimental calf has about five years to wait before it can produce offspring of its own."
This does not encourage donor agencies to provide funds for animal breeding research.

This paper surveys the broad groups of cattle in Africa and how they relate to the main ecological zones; and indicates what appear to be the possibilities for bringing about changes through application of animal breeding techniques.

Past cattle breeding research in Africa is then reviewed to see what can be learned from it. Why do reports state that it was for the most part a tremendous waste of money?

Setting up operations to collect information and carry out research in animal breeding is prohibitively expensive. Within Africa there are many countries and research stations with inadequate resources. The importance of inter-country research is therefore being increasingly emphasised. The work that the International Livestock Centre for Africa is doing with national research organisations to assemble available information on breeds and breeding is summarised.

Finally, are there examples of animal breeding work in Africa providing results that have actually convinced administrators and planners of their value and that actions should be taken on them? A few are indicated.

AFRICA'S CATTLE

Indigenous African cattle are multipurpose animals. Milk production is universally important, manure usually plays an important role in crop production, draught power and beef production are of localised importance, and all livestock play a key role as a cash reserve and as a source of income. Well-defined beef and dairy industries are not common although they exist to some degree around urban centres. Most stock are kept under extremely simple management conditions and receive little supplementary feed or health care. The ability to cope with environmental stress is the prime criterion for survival. Not surprisingly, Africa's livestock are slow growing, late maturing and are modest milk producers.

The indigenous breeds predominate and are classified in three very broad groups with further subdivisions possible: the humped Zebu; the small cervico-thoracic humped Sanga; and the humpless indigenous Bos taurus (e.g. Mason and Maule, 1960; Epstein, 1977). Existing indigenous cattle populations generally are well-adapted to survive and reproduce in their environment, because of qualities such as mothering and walking abilities, water economy, heat tolerance, disease tolerance, and ability to exist on low-quality feeds. Usually, however, they are late maturing, have poor growth rates and low milk yields, and produce small carcasses. Exotic cattle introduced into Africa also fall into three broad groups - Zebus such as the Sahiwal and Brahman types from Asia, European beef and dairy breeds, and Zebu exotic hybrids such as the Bonsmara and Santa Gertrudis.
THE AFRICAN ENVIRONMENT

There is a wide range of environments in Africa: cool temperate highlands, humid lowland tropics, rangelands and well-watered savannas, resulting in great diversity and localisation of breed types. Numbers of small ruminants and cattle are approximately equal, and their relative distribution is shown in Table 1.

Table 1: Distribution of human and livestock populations (millions) in sub-Saharan Africa.

<table>
<thead>
<tr>
<th>Zone</th>
<th>Land area (km² x 10⁶)</th>
<th>Humans</th>
<th>Cattle</th>
<th>Sheep</th>
<th>Goats</th>
<th>Livestock units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arid</td>
<td>8.3</td>
<td>24.8</td>
<td>31.6</td>
<td>37.1</td>
<td>48.3</td>
<td>41.7</td>
</tr>
<tr>
<td>Semi-arid</td>
<td>4.0</td>
<td>65.7</td>
<td>45.4</td>
<td>23.1</td>
<td>33.2</td>
<td>37.4</td>
</tr>
<tr>
<td>Subhumid</td>
<td>4.8</td>
<td>59.4</td>
<td>32.7</td>
<td>14.2</td>
<td>20.3</td>
<td>26.4</td>
</tr>
<tr>
<td>Humid</td>
<td>4.1</td>
<td>50.3</td>
<td>8.8</td>
<td>8.2</td>
<td>11.6</td>
<td>8.1</td>
</tr>
<tr>
<td>Highlands</td>
<td>1.0</td>
<td>38.0</td>
<td>29.0</td>
<td>24.4</td>
<td>11.9</td>
<td>23.6</td>
</tr>
</tbody>
</table>

Source: Jahnke (1982)

Livestock unit = 250 kg liveweight

Most livestock in Africa are kept by smallholders, whether on mixed crop-livestock farms or in pastoralists' herds. Commercial ranches are less important except in a few southern countries. Opportunities for within-herd or flock selection are greatly reduced by the prevailing ownership patterns (Table 2).

Table 2: Livestock distribution by farming system

<table>
<thead>
<tr>
<th>Livestock units (x10⁶)</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranching</td>
<td>8</td>
</tr>
<tr>
<td>Pure pastoralism</td>
<td>29</td>
</tr>
<tr>
<td>Pure mixed farming</td>
<td>32</td>
</tr>
<tr>
<td>Agropastoral¹</td>
<td>74</td>
</tr>
</tbody>
</table>

Source: ILCA (unpublished data).

¹This is a residual classification and reflects the large number of animals that use communal lands for part of the year and farm land for the remainder.

In general, in the very arid zone it is apparent that, in practice, little can be achieved through the introduction of new genotypes or by selection within indigenous populations.
In the temperate highland zone it appears that the importation and use of other indigenous, crossbred, and exotic cattle types are completely feasible based on their evaluation elsewhere. However, factors such as the production system, level of management and feeding practices need to be considered.

In the humid tsetse-infested zone, the exploitation of trypanotolerant breeds of cattle offers one of the most important approaches to overcoming the problem of animal African trypanosomiasis.

In the arid-to-semi-arid and semi-arid-to-humid zones, the climatic, nutritive, and disease-parasite environment generally favours the cattle with varying percentages contributed by Bos indicus breeds because of their general adaptability. The most feasible approach here is to achieve the level of improvement in the natural environment that is favoured by economic factors and to use crossbreeding systems or composite breeds that exploit the cattle having most nearly the "ideal" optimum additive genetic composition contributed by both Bos taurus and Bos indicus breeds.

PAST CATTLE BREEDING RESEARCH IN AFRICA

Mention is made on many occasions of the lack of funds available for animal breeding research in Africa. When one talks to the planners and economists concerned with the release of such funds, their attitude is that there is very little information available to them that convinces them of the possibilities of increasing productivity as a result of breeding research work. Is this really the case?

A bibliography (Trail, 1981) covering performance aspects of indigenous, exotic, and crossbred cattle in Africa south of the Sahara, lists approximately 500 references. These studies contain objective original data on some aspect(s) of reproductive performance, growth, viability, or milk production covering the 30 years from 1949 to 1978.

An analysis of this bibliography indicates that only about 20% of the references contain information on three or more performance characteristics sufficient to allow characterization of breed types through a productivity index. For example, one simple productivity index used is "weight of calf plus liveweight equivalent of milk produced per unit weight of cow maintained per year" (this index is extended to cover more traits if information is available). In addition, only 20% of the references contain comparative information on two or more breed types. When analysis is made of these two necessary attributes combined, only 5% of the reports are shown to have sufficient data to allow comparisons on the basis of a productivity index. These observations illustrate that there is little published information that can be used to assess breed performance in Africa.
Much of the work on livestock production that has been carried out in Africa has not been published as journal articles or books with a wide circulation and remains unknown in the scientific literature. In an effort to overcome this problem, ILCA, with assistance from the International Development Research Centre (IDRC), is collecting unpublished literature on animal production and health from experiment stations, government departments, educational institutions and libraries in Africa. The aim is to make this 'grey literature' more widely available to livestock researchers, planners, and educators. Each institution participating in the project is provided with a complete set of microfiches of the documents collected in their country, a microfiche reader, and copies of the bibliographies of documents collected in other participating countries. So far the project has covered Botswana, Ethiopia, Ghana, Kenya, Malawi, Nigeria, Sudan, Tanzania, Zambia and Zimbabwe in anglophone Africa, and Benin, Burundi, Burkina Faso, Cameroon, Ivory Coast, Mali, Mauritania, Niger, Senegal, Rwanda, Togo and Zaire in francophone Africa.

The documents collected have been catalogued, indexed, abstracted and entered onto ILCA's computerised database. Specific literature searches can be conducted on request. The results of such a search are sent to the requester who can select the documents that are of prime interest and obtain photocopies or microfiches from ILCA's Documentation Centre; this service is provided free of charge to African users.

COLLABORATIVE BREEDING RESEARCH PROGRAMMES

Based on the data revealed by the Centre's information services, ILCA has been undertaking the analysis of national research data relevant to animal breeding studies, in cooperation with national organisations. One aim is to build up production information on the important livestock groups in Africa so that decisions about specific breeds, and the assessment of production traits within particular production systems and ecological zones can be made more easily. Major joint studies have been carried out and published with researchers in Ethiopia, Mali, Kenya, Rwanda, Senegal, Sierra Leone, Tanzania and Zimbabwe. This work characterises the performance of many breeds of African livestock under different environmental and management conditions, and has been widely reported (e.g. Trail and Gregory, 1981b; Gregory et al, 1985b).

Inadequate nutrition and the disease situation generally favour the use of the Bos indicus breeds of cattle in Africa. Increasingly, however, improvements in the meat and milk production of Africa's livestock are being sought through crossbreeding with imported breeds. Relatively modest increases in output can lead to large gains in the efficiency of use of feed resources, and this underlies the persistent attempts to
upgrade the *B. indicus* breeds by using imported *B. taurus* breeds with higher additive genetic performance for meat and milk production. The theoretical aspects of using heterosis, crossbreeding and composite breeds in the African tropics have been presented along with a series of reports on crossbreed performance (e.g. Gregory et al, 1982, 1984, 1985a; Trail et al, 1984, 1985a).

Where breeds of differing degrees of adaptation to stress are managed together in the various environments in Africa, significant interactions among genotypes and environments are usually found. The most practical way to build a database of these differing breed responses is to utilise the observations made in ongoing studies. Generally, two levels of information can be obtained: direct, such as the interaction observed between different levels of Boran and East African Zebu cross cattle under different pasture improvement and tsetse-clearance situations in Tanzania (Trail et al, 1985b) and indirect, when genotype x year effects can be identified with the associated seasonal and yearly climatic differences, an example being reported in work with different Sahiwal x Ayrshire crossbreds in Kenya (Gregory and Trail, 1981).

A MICROCOMPUTER BASED PERFORMANCE RECORDING SYSTEM

The collaborative efforts that have enabled the establishment of a microfiche collection of unpublished research reports, and the analyses of data from collaborative breeding research programmes, have also highlighted the need to provide a simple microcomputer based system for recording livestock performance in Africa. Such a system needs to:

- handle all important performance traits: reproduction, viability, growth, milk, wool, traction and their amalgamation into suitable indices of productivity, for a range of animal species: cattle, sheep, goats, camels, horses, donkeys;
- provide standardized database files for regional comparisons and national decision making;
- provide facilities for recording climate, nutrition and management information to allow biological interpretation of statistical outputs;
- allow all information on an individual animal to be immediately accessible; and
- allow the analyses on an individual farm to run to the point where all logical herd-level decisions can be made without having access to large computer facilities.

Such a system has now been developed (acronym 'IDEAS', ILCA Data Entry & Analysis System) and can be used under a licensed agreement with ILCA. It incorporates Ashton Tate's dBASE III command language and programs compiled using the
Microsoft Fortran 77 compiler. The package is supplied on diskettes and in addition to an Introduction and Guide, a Technical Reference Manual is produced. ILCA will assist in the technical installation of the package in African research and development situations where its use can be of benefit. ILCA will maintain close links with users; evaluate progress on a continuing basis; and be prepared to undertake improvements as required.

The package is centred around 10 databases

Herd details. This stores records of site details such as animal species, geographical location etc. for each herd entered.

Climate details. This stores meteorological data records relevant to the herd environment.

Basic animal details. This stores the breed, sex, parentage etc. of each animal within the herd.

Reproduction details. This maintains mating and parturition details of breeding parents, and the details of new born animals.

Weight details. This maintains the details of each weighing of each animal.

Milk details. This maintains the details of each milk measurement of each animal.

Wool details. This maintains details of each wool clip from each animal.

Traction details. This maintains details of each traction measurement on each animal.

Health details. This maintains the details of each diagnosis and/or treatment of each animal.

Nutrition details. This maintains the details of each food intake measurement recorded for each animal.

All possible data integrity checks are performed and there is always the opportunity to verify data entry before allowing the updating of relevant databases. Data can be corrected by use of a modify facility within the package and listings of databases for spot checking can be obtained at any stage. Appropriate files can be created from any database at any time. These can be transferred on diskette, or directly linked with standard packages such as SPSS/PC for immediate analyses as required. Thus there are very powerful reporting capabilities for all databases. A major design feature included in Ideas is its ability to undertake least squares analyses on the entered data. Thus information in the animal databases such as the milk production of females is analysed to measure the influence of effects such as age, breed, management group etc. The identification and measurement of such factors plays
an important role in allowing accurate herd management decisions to be made. In addition, facilities are incorporated that allow productivity indices to be built up from the more important performance traits, and analysed using least squares techniques.

RESEARCH RESULTS CONVINCING TO DEVELOPMENT PLANNERS

Africander, Tswana, and Tuli cattle in southern Africa.

As recently as 15 years ago, there was almost no information on the comparative productivity of the indigenous Sanga breeds of cattle in southern Africa. Of the three locally available Sanga breeds in Botswana in 1970, about 80% were indigenous Tswana, 15% were Africander (mainly originating from South Africa imports), and a small proportion were Tuli. The Tuli breed had been developed since 1946 from Tswana types in the southwest of Zimbabwe. In 1970, it was widely believed throughout southern Africa that the Tswana breed was an unimproved type – hardy but very slow growing with low milk yields. The Africander breed, in contrast, was believed to be a very superior indigenous breed and was used extensively for beef production, both as a pure breed and for crossing with other indigenous types. The use of Africander bulls on Tswana cows had been recommended for a number of years and encouraged through a government-operated bull subsidy scheme and by the provision of Africander semen at artificial insemination centres.

In 1970, when an animal production research unit was first established in Botswana, it was considered essential to compare these breeds under a standard of management that would be appropriate to the rapid development of the beef industry. Herds of Africander, Tswana, and Tuli cattle were assembled on a network of government ranches.

Three major traits contribute to beef cattle production in Botswana, reproductive performance, viability, and growth; when combined, these three traits provide a productivity index useful for breed comparison. Table 3 shows the productivity estimates of the three indigenous breeds expressed as "weight of 18-month-old calf/cow/year." These estimates involved several thousand animals in each breed group, over a 10-year period.

Table 3: Productivity of Tuli, Tswana and Africander cattle in southern Africa.

<table>
<thead>
<tr>
<th>Breed</th>
<th>Calving percentage</th>
<th>Calf mortality (%)</th>
<th>8-month weight (kg)</th>
<th>Wt of 18-mo old calf/cow/yr (kg)</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuli</td>
<td>85</td>
<td>7</td>
<td>287</td>
<td>227</td>
<td>106</td>
</tr>
<tr>
<td>Tswana</td>
<td>79</td>
<td>8</td>
<td>295</td>
<td>213</td>
<td>100</td>
</tr>
<tr>
<td>Africander</td>
<td>67</td>
<td>12</td>
<td>277</td>
<td>163</td>
<td>76</td>
</tr>
</tbody>
</table>

Table 3 indicates that the Tuli is the most productive breed because of exceptional reproductive performance and low mortality, although its weight at 18 months was lower than that of the Tswana. The Tswana outperformed the Africander and was obviously a highly productive breed in its own right. The Africander proved disappointing in all three production traits.

By the late 1970s, it had thus become apparent that there was no justification for the replacement of the Tswana by the Africander, and that inadequate knowledge of the production capabilities of the two breeds had resulted in the Africander being used too extensively. Appropriate steps were therefore taken to reverse the policy of making Africander genes readily available through bull subsidy and AI schemes.

If breed characterization information regarding the Africander and other Sanga breeds in southern Africa had been available earlier, it might have influenced decision making in several areas. In Botswana, more productive crossbreds might well have been utilized earlier, and Sanga types other than Africander might have been used in the development of breeds such as the Bonsmara in South Africa and Belmont Red in Australia, and productivity of these might well have been even higher.

N'Dama cattle in West and central Africa.

The exploitation of livestock possessing genetic resistance to disease is being given increasing consideration in livestock development programmes particularly where conventional disease control measures are too costly, too complex to implement or, as is also common, drugs and vaccines are not available. Such an approach is applicable to animal African trypanosomiasis, a disease that certain indigenous Bos taurus breeds of cattle are able to survive in tsetse fly endemic areas without the aid of treatment but to which other breeds rapidly succumb.

While trypanotolerant breeds are a well recognized component of livestock production in certain areas of Africa, they represent only about 5 per cent of the total cattle population in the 36 countries where tsetse occur (ILCA 1979). Failure to exploit these breeds can possibly be attributed to the belief that because of their small size they were not productive and that their trypanotolerance was a characteristic which had been acquired to the local trypanosome population. However, it has now been confirmed that trypanotolerance is an innate characteristic and may, therefore, be genetically exploited (reviewed by Murray and Trail, 1982; Murray et al, 1984). In a survey of the status of trypanotolerant livestock in 18 countries in West and central Africa (ILCA, 1979), indices of productivity were examined using all the basic production data that could be found for each region, each management system and for different levels of tsetse challenge (Table 4).
Table 4. Productivity of Zebu and N'Dama cattle in West and central Africa

<table>
<thead>
<tr>
<th>Breed</th>
<th>No. of herds</th>
<th>Management</th>
<th>Tsetse challenge</th>
<th>Productivity index (kg)(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zebu</td>
<td>20</td>
<td>Ranch</td>
<td>Zero-low</td>
<td>38.6</td>
</tr>
<tr>
<td>N'Dama</td>
<td>30</td>
<td>Ranch</td>
<td>Low</td>
<td>37.1</td>
</tr>
</tbody>
</table>

Source: International Livestock Centre for Africa (ILCA), 1979.

\(^a\)Total weight of 1-yr-old calf and liveweight equivalent of milk produced/100 kg of cow/year.

The results indicated that in areas of no or low tsetse challenge the productivity of N'Dama cattle relative to other indigenous breeds was much higher than previously assumed. Comparative data between breeds were not available in many areas because the level of trypanosomiasis risk was such that breeds other than trypanotolerant ones could not survive.

These results have encouraged major importations of N'Dama cattle from The Gambia and Senegal to Nigeria and Gabon in the last few years. In addition, major funding to set up an International Trypanotolerance Centre in The Gambia has been provided by the African Development Bank and the European Community.

CONCLUSIONS

There is a major lack of published information on results of animal breeding research work to guide development operations in Africa. Steps have therefore been taken by the International Livestock Centre for Africa to help overcome this by reviewing, microfiching and cataloguing extensive amounts of previously unpublished material; by providing facilities to handle the analyses of data in these unpublished studies; and by developing a microcomputer based performance recording system specifically designed for African research and development situations. The broad pattern emerging demonstrates the adaptation of specific indigenous breeds to localised environments and the need to modify environmental stresses of various types if breeds with higher genetic potential are to be introduced.

REFERENCES


