…al genetic resources conservation by management, data banks and training

FAO ANIMAL PRODUCTION AND HEALTH PAPER

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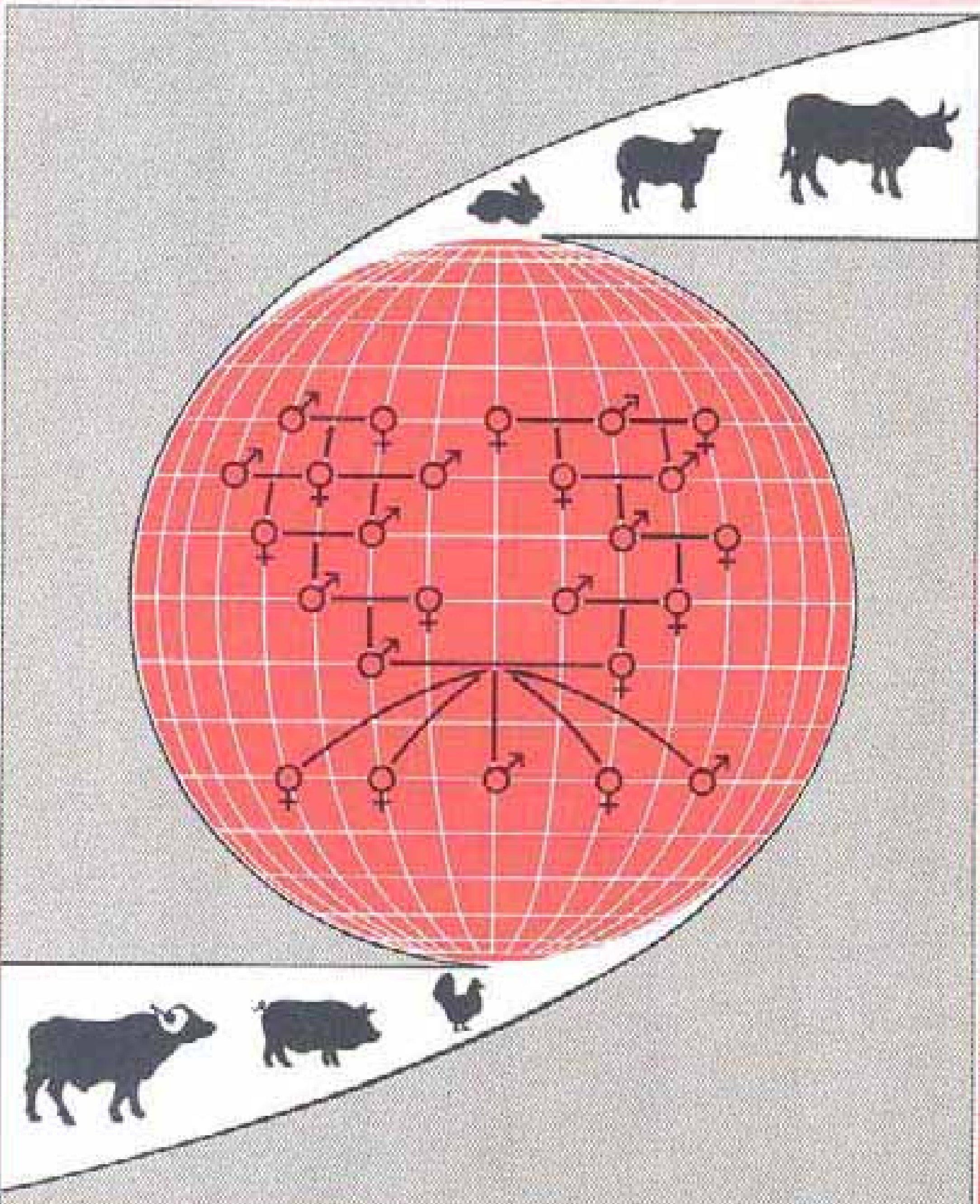

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

FAO ANIMAL PRODUCTION AND HEALTH PAPER 44/1

Animal genetic resources conservation by management, data banks and training

Proceedings of the Joint FAO/UNEP Expert Panel Meeting, October 1983 Part 1

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FOREWORD

Animal Genetic Resources are of immense importance to mankind, since they comprise the domestic livestock and birds which provide food, fibre and work, as well as contributing other products and benefits for human welfare throughout the world. The Conservation and Management of Animal Genetic Resources is therefore of concern to the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Environment Programme (UNEP). These two organizations have been working together in recent years to design and apply an appropriate strategy for application at national, regional and global levels which will both improve the immediate productivity of domestic animals and birds and also preserve the valuable, but currently unused breeds for posterity.

In 1983, FAO and UNEP created an Expert Panel of 36 eminent scientists to advise on Animal Genetic Resources Conservation and Management. The first meeting was held in Rome in October 1983, at which work in progress was evaluated, and recommendations made for the next few years. The meeting addressed 4 topics:

Conservation by management
Animal genetic resources data banks
Training methods in animal genetic resources
Cryogenic storage of germplasm and genetic engineering

The Proceedings of the meeting, with the full texts of the working papers presented and subsequently amended by the authors, are now published in two parts. This is Part 1 and contains the papers presented in the first three topic areas. Part 2 contains the papers in the section on Cryogenic storage of germplasm and genetic engineering. A short Report on the meeting containing summaries of the papers and the recommendations has already been published in English, French and Spanish. Parts 1 and 2 of the Proceedings and the Report are available from FAO Animal Production and Health Division, Rome, or from the official FAO sales agents.

The Proceedings provide an overview of the work currently in progress and visualized for the near future. Those wishing to keep in touch with the ongoing work are invited to send their name and address to FAO at the above address, for regular receipt of Animal Genetic Resources Information (AGRI), a newsletter published twice a year, and sent free of charge to all concerned with the conservation, management or utilization of domestic animals and birds.

WELCOME AND INTRODUCTORY REVIEW

ADDRESS OF WELCOME

by
Dr. R.B. Griffiths
Director, Animal Production and Health Division, FAO

I am pleased to welcome you here on behalf of the Director-General of FAO and the Executive Director of UNEP to the First Meeting of the Joint Expert Panel on Animal Genetic Resources Conservation and Management. It is encouraging to see such a distinguished group of scientists, representing, as you do, not only the many separate disciplines of genetics but also different regions of the world. It is noteworthy that although you are here in your personal capacities, and not representing your governments, you are drawn from developing countries in Africa, Asia, Latin America and the Caribbean, as well as from the Middle East; and also from developed countries in Europe, North America and Asia. Such widespread and diverse backgrounds, qualifications and experiences among its members augurs well for the work of the Expert Panel.

Although FAO has been active in animal breeding since its inception, the joint approach since 1974 with UNEP has added a new dimension to the conservation and management of animal genetic resources. A number of joint activities have been undertaken, including such projects as the survey of indigenous sheep breeds in the Middle East, the study of the use and potential of trypanotolerant livestock in Africa, in association with ILCA, and expert consultations on the breeding of Mediterranean cattle and sheep, on the breeding of dairy cattle in the humid tropics, and on the evaluation and conservation of animal genetic resources in Latin America.

The Joint Consultation of FAO and UNEP on Animal Genetic Resources in 1980 provided the first world focus on the objectives, possibilities, limitations, problems and hopes for this important subject. At that Consultation, in which some of you took part, we arrived at a coherent and rational global plan for action for the next few years. Funding for the implementation of the proposals outlined at that time has since been provided by FAO and by UNEP; and the plans have been endorsed by the governing bodies of FAO. Solid foundations are being laid, and although progress may seem to be slow, it is important to know not only where to go, but also how to get there. For this reason, pilot trials and methodological studies have featured prominently in the recent work of FAO and UNEP. This work is directed operationally by the Animal Production Service of FAO. One of the tasks we shall ask you to address during this week is an appraisal of the work which is now in progress. Additionally, we shall be looking to you for new ideas on some of the problems which have been encountered to date.

The subject is a fascinating one, partly because of the unusual combination of objectives. First, we seek not only to harness the animal genetic resources of developing countries in improved management programmes to enhance the production of food, fibre and animal power, but secondly we aim to conserve, in the preservation sense, those genetic resources that are in danger of being lost. The first is capable of yielding immediate results, whereas the second is a means of maintaining the flexibility necessary to respond to future unforeseen changes in animal production and market requirements. Cryogenic storage of fertilized ova and semen constitute appropriate means for the conservation of animal resources, but the mechanics of achieving them in the developing world are yet to be worked through.

Overhanging in this field of interest is the rapid, and to some, terrifying speed *of* research and development in genetic engineering, which regularly breaks new barriers and opens new scenarios of opportunity. It seems likely that we shall find these affecting both our attempts to increase animal productivity and our options for storing genotypes or even gene segments at risk of extinction. We are maintaining close links with the proposals for the establishment of an International Centre for Genetic Engineering and Technology and we expect to play a lead role in work on animal genetics if and when the Centre materializes.

All of this underscores the need for a wide base of continuing consultation and up-to-date scientific knowledge, combined with concern and commitment to the needs of the developing world. This is another of your roles on this Panel.

The subject of communication is of first rank in every area of human activity and includes as prerequisites the storage of knowledge and the provision of ready access to data needed for competent decision making. In 1980, recommendations were made therefore to create data banks on animal genetic resources and also for a Newsletter. I am glad to tell you that both have been started. We shall be inviting your involvement in facilitating their growth to maturity and their use. Only then will they contribute to the prudent conservation and management of animal genetic resources throughout the world.

We have noted a growing and very encouraging interest throughout the world during the 3 years that have followed the Expert Consultation on Animal Genetic Resource Conservation and Management held in 1980. Several groups of scientists, gathering principally for other purposes, have turned their attention to the matter, and have passed resolutions calling for increased activity at the international level by responsible bodies including FAO, UNEP and CGIAR. We regard the creation of this Joint Expert Panel between FAO and UNEP as a realistic step towards the establishment of an international programme in this field.

We are pleased today that among you are those who, while here in a personal capacity, are nevertheless associated with the work of other organizations in Animal Genetic Resources Conservation and Management. These include the Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO), The Interafrican Bureau for Animal Resources (IBAR), the Latin American Society for Animal Production (ALPA), the International Livestock Centre for Africa (ILCA) and the Commonwealth Bureau of Animal Breeding and Genetics (CAB). Our working relationships with each of these organizations have been established for many years, and we are pleased that during the last year we have been able to strengthen them further in the pilot trials now under way for data bank establishment.

Finally, may I convey good wishes to you for success in the meeting, not only from myself but also from Dr. D.F.R. Bommer, the Assistant Director-General (Agriculture) of FAO, who would be here welcoming you today but for his unavoidable absence for meetings in the USA. We thank you for coming. We look forward with great interest to your recommendations on this important subject of Animal Genetic Resources Conservation and Management.

REVIEW OF THE FAO/UNEP PROGRAMME ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

John Hodges1

In 1980 FAO and UNEP held a Technical Consultation on Animal Genetic Resources Conservation and Management, which resulted in a number of specific recommendations. The Consultation was global in concept, and was the culmination of earlier work done by FAO and later in cooperation with UNEP, at local, national or regional levels. The Consultation brought together representatives of member countries, scientists and administrators. The recommendations are given in Appendix A to this paper.

Since then, FAO and UNEP have drawn up a cooperative programme of work which is operated by FAO, with funding from the FAO/UNEP project entitled Conservation of Animal Genetic Resources - Phase II and from FAO's Regular Programme. I will deal in turn with the items, giving an outline of the stage reached. Most of the items are also on the agenda for this meeting, and opportunities for detailed discussion of them will therefore arise later.

1. THE JOINT FAO/UNEP EXPERT PANEL ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

The Terms of Reference are given in Appendix B. The Panel was constituted earlier this year with 36 members being appointed (Appendix C) out of a possible maximum of 40. Members were nominated and agreed by both organizations. Members will serve for four years in a personal capacity and not as representatives of their governments. Consultation will be by meetings such as this, by correspondence with groups or with individuals, depending upon the subject matter. On this occasion 19 of the Panel Members have been invited to attend; in addition 5 invited speakers with special expertise are also invited. Future meetings will be held when needed and will be alternately funded by FAO and UNEP. FAO is funding this meeting from its Regular Programme budget.

The organization of the meeting is in sections each with a rapporteur who has kindly agreed to prepare written summaries of the major points presented and discussed, and also to bring to the meeting on the last afternoon the recommendation of their sections. In preparing these, they will be supported and guided, not only by the general discussion, but also by the speakers in the sections concerned, who with them will form a small consultative group to formulate the recommendations. Following the meeting, a report with the summaries of the meeting and the recommendations will be produced; later, proceedings will be published carrying the papers. Authors will, of course, have the opportunity of revising their working papers before publication, and should return their amended papers to me by 31 December for inclusion in the proceedings.

I should add that the proceedings will be published in two parts. Part 1 will carry all papers except those in the section on Cryogenic Storage of Germplasm and Molecular Engineering, which will be in Part 2, and published separately. The authors for this section, at the request of FAO, have produced longer papers and the publication on this topic is intended to contain comprehensive reviews of the subject matter.

2. DATA BANKS

This topic was the subject of a recommendation in 1980. During the last six months pilot trials for one year each have been established in Africa, Asia and Latin America. Their main purpose is to identify appropriate methodologies for the preparation of data for the bank, working with a variety of species in different parts of the world. A more detailed review of the work in progress on this subject will be given later in the meeting.

3. CONSERVATION PROJECTS

Some breeds with economic potential, which are often scattered in several countries, or which are in danger of total loss through having very small population size, are the subject of pilot lonservation projects. These are at various stages of progress, and include some of the few dairy breeds suited to the tropics, such as the Sahiwal, Kenana and Butana breeds; also trypanotolerant cattle breeds and sheep breeds in West Africa. Others are being explored in association with the development of data banks. More details of these will be given in the section on this subject later in the meeting.

4. GENE BANKS

The concept of conservation by gene banks is complex. One can think of live animals, being preserved *in situ,* or in some semi-artificial situation; alternatively one may think of cryogenic storage of perm or fertilized ova or other tissues or gene segments. The economic problems are difficult with both live animals and with haploid or diploid cells. Who is to pay? There are also questions of how many to preserve, for how long, and where. These questions are not easy to solve even in the developed countries where cryogenic technology had its origin, but they become especially difficult when applied to the developing countries. At present the plan is to seek the advice and recommendations of this Expert Panel and of other scientists in the field, and as already mentioned to publish their work in a special volume. Then, a feasibility study is planned to study some of the practical problems of costs, health control, movement of semen across national boundaries, safety, etc.

5. TRAINING COURSES

The first training course for animal scientists from developing countries in Animal Genetic Resources Conservation and Management was organized by FAO/UNEP in September 1983. It was held in English and was mounted by the Hungarian University of Veterinary Science in Budapest. This Institution was chosen because of the advanced stage of planning and live animal conservation initiated in Hungary and because of the body of lecturers available in the country. They were supplemented by lecturers from other countries. Eighteen animal scientists from fifteen countries were present. You will hear more later in the meeting. The intention is to arrange further courses, as the demand exists, from other developing countries and as the technology and experience in the subject matter advances. Other courses may be held in French and Spanish as needed.

6. NEWSLETTER

As requested by the 1980 Consultation, FAO and UNEP have started a newsletter for all concerned with the subject of animal genetic resources conservation and management. It will be published twice yearly. The first issue was in the summer of 1983 and the second will be early in 1984. An initial mailing list of 1000 was created. The newsletter, known as Animal Genetic Resources Information (AGRI) will have 40/50 pages, and will carry articles of up to 3000 words with illustrations, news items, book reviews, descriptions of methodologies, details of breeds in need of conservation and plans for undertaking this work. It will also report on the activities of FAO and UNEP. It is also hoped that there will be a correspondence section which we encourage members of the Expert Panel to initiate and use. We also invite you to nominate others who ought to be on the mailing list.

7. INVENTORIES

The 1980 Consultation drew attention to the lack of information in the West about the extensive livestock resources of the USSR and of China. Initiatives by FAO/UNEP have resulted in a positive response from the USSR in the last month, indicating their willingness to cooperate in creating an inventory of their breeds. This work will be carried out by scientists of the USSR with all the support on techniques and experience that can be offered by FAO and UNEP. The Inventory will be published in Russian and in English. It is also planned to link this inventory with the creation of data banks. We are less advanced in our contact with China, but are glad to be able to announce the intention of FAO to publish, in English, Professor Cheng's book on Chinese Livestock Breeds, already published in Chinese by Chinese Academic Publications. We are fortunate in having the services of Dr. Helen Newton-Turner as editor to prepare the manuscript in readiness for the English publication. Hopefully, this initial work will be extended by further cooperation with out animal geneticist colleagues in China.

These are the principal activities currently underway as a result of the 1980 Consultation. In conclusion, I would like to add that in most of the components of this extensive programme, we are able to cooperate with national and regional organizations as well as with national governments. For example, in Asia, with The Society for the Advancement of Breeding research in Asia and Oceania

(SABRAO); in Africa with the Interafrican Bureau for Anima Resources of the Organization of African Unity (IBAR of OAU) and the International Livestock Centre for Africa (ILCA); in Latin America the Latin American Association of Animal Production (ALPA).

APPENDIX A

I. RECOMMENDATIONS OF THE FAO/UNEP TECHNICAL CONSULTATION ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT, ROME 1980

A. Recommendations to FAO/UNEP

1. It is recommended that FAO establish an appropriate coordinating mechanism for the conservation and management of the world's farm animal[1] genetic resources at national, regional and international levels, with the following terms of reference:

i. To give support and advice to existing activities concerned with breeding programmes, management and conservation of the world's farm animal resources and to find means of providing a framework for cooperation.
ii. To stimulate the establishment of activities with respect to the conservation of farm animal genetic resources in countries where no such activities exist, but are required.
iii. To stimulate the establishment of regional activities and laboratories devoted to the documentation, evaluation and conservation of regional livestock resources, including the rationalization of breeding programme development and conservation programmes in each of the countries of each region.
iv. To stimulate the development of training programmes at regional level for the techniques appropriate to the conservation and management of farm animal genetic resources.
v. To promote research on the mechanisms of adaptation and disease resistance and tolerance in the genetic stocks in developing countries.
vi. To facilitate study of health barriers to the international exchange of genetic materials.

2. FAO/UNEP are requested to arrange for the preparation and distribution of an international newsletter on the conservation and management of farm animal genetic resources. The newsletter should provide information about training programmes, techniques, activities and developments; should contain a correspondence section; and should be a means of stimulating cooperation on a worldwide basis.

3. It was agreed that the FAO/UNEP project had brought out a great deal of interesting information on livestock populations and their conservation. However, it was noted that the information was very incomplete and that in particular, the project did not include two of the major livestock countries of the world, namely China and the USSR, and barely touched on a third, namely the USA. The Consultation therefore recommended that FAO and UNEP, in collaboration with the countries concerned, should try to complete this study.

4. FAO/UNEP should examine the feasibility of establishing one or more centres for the conservation and long-term storage of genetic material - a gene bank. Each gene bank should be designed, health considerations permitting, to serve a region and should be capable of long-term storage of semen, oocytes and embryos {and other types of genetic material where appropriate) of all farm species with which storage is possible. FAO/UNEP should include in the feasibility study the training needs for the establishment, maintenance and use of regional gene banks; the nature (location, size, etc.) and control (health and safety) of stored genetic material; and the circumstances relating to the choice of initial material for storage and the release and replacement of stored material.

B. Recommendations to FAO/UNEP and Member Governments

5. It is recommended that FAO/UNEP assist in the development of a data bank for livestock resources in member countries, and in the coordination of these at regional levels. In this context, it is recommended that FAO/UNEP should investigate:

i. the development of standardized definitions, nomenclature and data collection and collation systems;
ii. the provision of assistance to existing regional organizations, and the development of, and subsequent assistance to, necessary new regional organizations in maintaining documentation systems;
iii. the development of a two-stage data bank system
    a. initially emphasizing enumeration of breed populations, popula tion structure and minimum information on productive and adaptive characters;
iv. to be followed in each country as part of breeding programme development by more extensive documentation of performance and adaptive traits and the environmental conditions under which performance, etc. was measured.

6. In view of the importance of adapted breeds for agricultural development in general and for the promotion of the livestock indutries in particular, it is recommended that FAO should encourage Member Governments and/or participating organizations to include in the agricultural development programmes a component for the development and conservation of local breeds. Such breed development and conservation should take account of economic and genetic considerations appropriate to local conditions.

7. The implementation of breeding programmes at the national level would be greatly facilitated by the introduction of routine recording, evaluation and selection procedures. FAO should assist in the establishment of a limited number of pilot schemes for selection in local populations which pioneer methods of livestock improvement that make most efficient use of limited resources and infrastructure.

8. Several important breeds in the developing world are spread over a number of countries covering one or more regions. FAO should assist the governments concerned to cooperate in the implementation of a common programme for the genetic improvement and conservation of each such breed.

9. International research projects should be stimulated with a view to (a) the comparison under different environmental conditions, of breeds from different countries, and (b) the clarification of the genetic nature of any differences observed and their implications for breeding programmes. (These might be arranged via AI on the lines of the current dairy cattle strain comparisons in Poland and Bulgaria or suitable modifications of them. Or they might be performed using the technique of reference breeds (control breeds).) Groups of breeds for consideration include prolific sheep, tropical beef cattle and buffaloes.

10. There are several livestock species/breeds which are adapted to very specific environments and which play a major role in rural economies (e.g. the Andean Camelidae, Old World camels, the Himalayan Bovidae, livestock in tsetse-infes ted areas, etc.). In spite of their importance, too little is known about these species/breeds. It is recommended that international support be given to the governments concerned for studies on their biology, genetic profile, genetic improvement and conservation. Special attention should be paid in this context to endangered as well as genetically unique species/breeds that have particular traits to an exceptional degree and deserve priority treatment.

11. Some livestock breeds which played a significant role in the past in the rural economies of developed countries, and which were adapted to specific environments, are now in danger of disappearing (e.g. seaweed eating sheep, heavy draught horses, breeds of large donkeys). It is recommended that international encouragement be given to the governments concerned, for their conservation, and where not so far available, for their study.

12. The Consultation urged all governments to give full consideration to ways and means of conserving viable populations of wild animal species, including avian, which are the ancestors or close relatives of domestic species and recommended that FAO and UNEP expand their programmes in support of the establishment and improved management of national parks and reserves.

APPENDIX B

EXPERT PANEL ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

TERMS OF REFERENCE

1. Background and Justification

In the 1930s and 40s the scientific basis for the genetic selection of animals was worked out in institutions in Europe and the United States of America. The application of these findings to practical animal breeding improvement programmes has made possible an unprecedented rate of increase in the production of food and fibre per animal. A few high performance breeds have emerged which are gradually displacing the local breeds in temperate regions. As a result there is growing concern that the latter may disappear altogether unless special efforts are made to conserve them.

The developing countries are likewise increasingly concerned about their livestock resources, especially after the many large scale introductions of high-yielding breeds from the temperate zones which often cause a decline in the numbers of local livestock types. The latter have, through natural and man-selection, developed characteristics which make them well adapted to the often harsh environmental conditions under which livestock have to live and produce in these areas. This valuable genetic material needs to be maintained and improved as the basis for national livestock breeding programmes and policies.

The problems facing the world's animal genetic resources were identified by a high level FAO/UNEP Technical Consultation held in 1980 as being principally of three kinds. The first is a decrease in genetic variability within breeds; this is mainly a problem of the high-yielding breeds maintained in temperate zones and employed in intensive production systems. The second is the rapid disappearance of indigenous breeds and strains of domestic animals through the indiscriminate introduction of exotic breeds. The third concerns the special problem of hot, humid climates and other harsh environments common the developing countries. Only in restricted areas within these environments is it possible to improve animal health protection measures and feeding and management practices to levels that would allow high-yielding animals from the temperate zones to be used. In these circumstances the need is to design and implement appropriate selective breeding programmes based on existing populations of animals adapted to harsh environments.

The emerging awareness of the need for urgent action to conserve and develop the world's animal genetic resources has resulted in a number of limited and mostly uncoordinated efforts in this direction. Regional agricultural and/or animal husbandry organizations in Africa (IBAR of OAU), Europe (EAAP), Asia and the Pacific (SABRAO) and Latin America (ALPA) have set up committees on animal genetic resources and initiated studies on their .management. However, there is an obvious need for the coordination of these activities as well as for the continuous exchange of information on experiences, achievements and methodologies for the efficient management and conservation of animal genetic resources for future needs. The future potential use of a specific animal genetic resource may not necessarily be confined to the country or area where it is at present threatened. Instead, it may well prove its usefulness in some other part of the world. This fact underlines the need for a strong involvement of international bodies like FAO and UNEP.

In recent years techniques for the recovery of embryos of animals and their long term conservation at supra-low temperatures have been developed and the scientific research in this field is at present in a very intensive phase of development. In consequence, new knowledge is being continuously generated on animal genetic resources conservation in vitro, for both short and longer term periods. At present, of course, the development of the embryo transfer/storage techniques is geared mainly toward its immediate use for commercial purposes. But the potential for its use in connection with the conservation of animal genetic resources is great. This would require its continuous study at the global level. There is already information available that embryo banks are being established in some of the industrialized countries.

In the light of the above considerations, it would be desirable to establish an FAO/UNEP Panel of Experts on Animal Genetic Resources Conservation and Management. This would be consistent with the recommendations of the FAO/UNEP Technical Consultation (1980) that FAO and UNEP establish an appropriate coordinating mechanism for the conservation and management of the world's farm animal genetic resources at national, regional and international levels. The work of the Panel will be enhanced by support from UNEP through the FAO/UNEP Project on Conservation of Animal Genetic Resources - Phase II which was recently approved.

II. Objectives and fields of activity

The objectives of the Panel would be to:

- Review periodically ongoing work on animal genetic resources conservation and management in the different parts of the world and delineate future work programmes on a priority basis.
- Identify the principal problems' hampering the exploitation and improvement of animal genetic resources at national and regional levels.
- Determine how these problems may be solved, what action programmes and projects may be developed in given situations, and how existing national and regional organizations may be strengthened for this purpose.
- Formulate ways and means of stimulating regional and global cooperation in programmes for promoting animal genetic resources development with special emphasis on mutual assistance among national and regional institutions.
- Advise the Director-General of FAO and the Executive Director of UNEP on critical issues relating to the conservation and management of animal genetic resources.

The Panel activities will cover the following fields:

i. Genetic resources conservation and management activities at global, regional and subregional levels.
ii. The design and implementation of selective breeding programmes for animal populations in harsh environments.
iii. The establishment and operation of data banks on animal genetic resources.
iv. The development and application of an in situ animal genetic resources conservation methodology.

v. Public relations and collection and dissemination of information programmes for animal genetic resources conservation in developing countries.
vi. The development and application of an in vitro conservation methodology on animal genetic material, including disease control aspects.
vii. The development and maintenance of inventories of animal genetic resources and of a global register of such resources.

III. Membership

The Panel will be a standing and authoritative body of experts, the total number not to exceed 40. The number of participants at specific meetings will depend on the topics dealt with, as well as on the budgetary allocations available.

Half of the members will be nominated by the Director-General of FAO and half by the Executive Director of UNEP. The nominations will be made through consultation between the two agencies to avoid overlapping and to make certain that subject coverage and geographic and linguistic distribution are adequately taken into account.

Responsibility for convening meetings of the Panel would rest with FAO after consultation with UNEP. Secretariat arrangements will be handled by FAO.

In view of the need to obtain the broadest possible involvement in the conservation of animal geneic resources, it is envisaged that other international agencies concerned, such as UNDP and the World Bank, will be encouraged to support the Panel.

IV. Expected duration of the Panel

The problems relating to animal genetic resources conservation and management will require increasing attention over a long period of time. The problems are often complex and are usually not amenable to uniform "one time" solutions. The long generation intervals of the larger species of domestic animals increase the time span required for arriving at viable solutions. Therefore, a long term FAO/UNEP responsibility for the coordination of animal genetic resources conservation has to be accepted. Initially, a six-year duration of the Panel is foreseen, as if an extension, taking into account experiences gained during the initial period.

V. Periodicity of sessions

It is proposed to have a minimum of one panel session every third year. The actual need for panel work is likely to be much higher. FAO and UNEP would, however, make efforts to hold panel meetings more frequently. The parties would also meet the need for expert advice, at least partially, by correspondence with the institutions and/or individuals involved in animal genetic resources conservation work, the world over.

APPENDIX C

MEMBERSHIP OF THE JOINT FAO/UNEP PANEL OF EXPERTS ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

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1 The term "farm animals" in this document includes all domesticated mammalian and avian species.

CONSERVATION BY MANAGEMENT

ESTIMATED COSTS OF GENETIC CONSERVATION IN FARM ANIMALS

Charles Smith1

SUMMARY

Current UK costs have been obtained or are estimated for the different farm species for collecting, freezing and storing semen (50 doses from each of 25 sires) and embryos (25 embryos from each of 25 donors) and for maintaining a live breeding stock (in numbers to limit inbreeding to 0.2 percent per year). Estimated collection costs for frozen embryos (possibly only for sheep and cattle) are high (£50 000 and £75 000 per stock conserved). The costs are still also appreciable for frozen semen for the different species (£9000 to £25 000). However the annual storage costs for frozen stocks are very small. The costs per year of maintaining a live breeding stock are lower (£3000 to £12 000), but they are cumulative over time. For periods over five years semen storage becomes the cheapest form of conservation. Benefits from conservation cannot be predicted, but it is shown that conservation would be justified, even with a very low probability of use, if there were some gain in the economic efficiency of production through use of the conserved stock in the future.

There is considerable interest and feeling about the need for conservation of rare breeds of livestock, both by laymen and officials and at local, national and international levels (e.g. Maijala *et at.* 1983). The genetics and conservation have been examined previously (e.g. Smith 1983; Simon 1983) and the merits of different systems discussed. The objective of this paper is to try and derive costs of conservation by different methods and so indicate the resources needed to conserve breeds in danger of being lost. An attempt is also made to quantify the justification for breed conservation.

1. METHODS

Each rare breed will present a different set of circumstances with regard to numbers, distribution, ownership, performance levels and health, and these will affect the cost and need for conservation. While appreciating this, the intention here is to obtain or estimate a set of approximate average costs of conservation for each species. Where possible, costs have been obtained from specialist colleagues in each area, as shown in the tables. For other cases, the costs have been estimated, but the assumptions made and the methods used are shown, so that alternative figures may be substituted.

While major genes can be stored either in purelines in mixed stocks, for most performance traits breeds need to be stored in purebred form. The three main methods of conservation are (i) as breeding stocks, (ii) as frozen semen and (iii) as frozen embryos. Purebreds can be obtained with frozen semen by continuously keeping a small group of breeding females (Brem *et al.* 1983) or discontinuously by keeping a small store of frozen embryos (Smith 1983). This avoids the need for grading-up to the frozen semen stock, and allows substitution, and selection during substitution (Smith 1983).

1.1 Cost of Maintaining a Live Breeding Stock

Extra costs are incurred in maintaining a live breeding stock in several ways. Among them are (i) costs in purchase and collection of a representative sample for conservation; (ii) operating costs in identifying, recording, special matings (and incubation and hatching for chickens), and in supervising and administering the conservation procedures; (iii) costs of keeping extra males for breeding; and (iv) lover economic performance of the conserved stock, compared with current commercial stock. However there may also be extra returns, for example in the sale or display of animals from the rare breeds.

Estimates of the costs of keeping extra males are derived for the different species in Table 1. It is assumed that males need to be kept for about four months beyond slaughter age, to allow them to reach sexual maturity and to complete a short and fertile service period and be sold. The main costs are feed costs but further costs, set at 35 percent of feed costs, are added. There will also be a loss in slaughter value for the male, and this is set at 20 percent of normal sale value.

Table 1 ESTIMATED COSTS OF MAINTAINING A BREEDING STOCK

	Cattle	Sheep	Pigs	Chickens
Costs per male				
Extra days maintained beyond slaughter age	120	120	120	120
Feed per day (kg)	8	2	3	0.25
Cost per kg (£)	0.11	0.11	0.16	0.19
Fixed costs/feed costs	0.35	0.35	0.35	0.35
Extra costs (£)	143	36	78	7.7
Sale value per male (£)	450	45	65	1
Extra cost from 20% loss in sale values (£)	90	9	13	0.2
Total cost per extra mal? (£)	233	45	91	7.9
Cost per female				
Number of progeny per year	0.8	1.5	16	20
Extra costs per female and her progeny from a 15% loss in sale value	54	10	156	7.5

Extra costs per female arise from the lower economic performance of the conserved stock. This will vary greatly among stocks to be conserved depending on their merit, and will tend to increase with time as current stocks are improved further. Here, as an average, a figure of 15 percent lower performance is used, but with 5 percent lower input costs. Since purebreds rather than crossbreds are kept, the value of heterosis is lost (set at 10 percent but again with 5 percent lower input costs). The net loss has thus been set at 15 percent of sale value of the progeny. For pigs with a large progeny sale value per female, it might cost less to dispose of surplus progeny at birth, but the loss per individual would need to be. larger than the 15 percent of sale value used here. The costs are derived with meat type stocks in mind. For dairy cattle and egg-laying chickens, where breed differences in merit may be larger, the costs might well be higher. Of course, the costs for the larger species of farm poultry would be larger than those shown for chickens.

The relative costs per extra male and per breeding female affect the ratio of males and females kept. The rate of inbreeding can be minimized by keeping the conserved stock like a pedigreed genetic control line, with one son per sire and one daughter per dam. The rate of inbreeding per year is then $\Delta F/\text{year} = 1/32L\ (3/mL + 1/fL)$ (Hill 1972), where m and f are the number of males and females entering the breeding herd per year and L is the generation interval ($L = L_m + L_f)/2$). It is cost-effective to keep each male for only a short period, but to keep females for as long as possible, as shown in Table 2. The total costs of keeping the conserved stocks are then $mC_m + fgC_f$, where C_m and C_f are the costs per male and per breeding female per year, and g is the number of years a female is retained. The values of m and f which minimize the overall cost for a given level of inbreeding can be derived, given C_m and C_f (Smith 1976).

Table 2 ESTIMATED COSTS TO MAINTAIN A BREEDING STOCK*

	Cattle		Sheep		Pigs		Chickens	
	Male	Female	Male	Female	Male	Female	Male	Female
Years of breeding use (g)	1	5	1	5	1	2.5	1	1
Average parental age (years)	2	4	1	3	1	2	1	1
Generation interval (L) (years)	3		2		1.5		1	
Cost per breeding animal per year (£)	233	54	45	10	91	156	8	8
Number* of breeding animals entering per year (including 15% spares)	10	5	22	12	44	18	72	72
Size of breeding unit	10	26	22	60	44	44	72	72
Cost for each sex (£)	2330	1400	990	600	4000	6860	580	580
Operating costs (£)	1000		1000		1000		1000	
Mating-hatching costs (£)	-		-		-		1000	
Total cost per year (£)	5000		3000		12000		3000	

* Inbreeding rate = 0.2 percent per year
Optimized ratio of males and females to minimize total cost

Some tolerable level of inbreeding must be set. In many breeds of livestock, levels of about 0.5 percent per generation are common (e.g. Dalton 1980; Smith *et al.* 1978). This corresponds to about 0.1 to 0.2 percent per year. A figure of 0.2 percent per year has been used here, so that the conserved stock should be similar to the commercial breeds in the rates and effects of inbreeding on performance and genetic variation. This would be appropriate if the stock were to be used in purebred form. However, if future use is seen in crossbreeding or formation of new synthetic breeds, then inbreeding is less important, and higher levels might be tolerated (say 0.5 to 1 percent per year) and smaller numbers of conserved stock (40 to 20 percent of the numbers used in Table 2) could be maintained. However, the numbers would then get rather low, as for cattle, and the risks from losses in breeding and in mortality would become important.

The numbers of breeding individuals to maintain an inbreeding rate of 0.2 percent per year are also given in Table 2. An allowance of 15 percent for spares is included. For pigs and chickens, the constraint that there must be at least one breeding female per male was required. Due to the different generation intervals there were quite large differences in the size of the stocks that need to be maintained in the different species.

Compared with commercial stocks, there will be extra costs also in identification, in recording, in controlled matings and in supervising and administering the conserved stocks. A sum of £1000 per stock per year has been added for the extra labour, and recording and supervisory time, assuming one person can look after several conserved stocks. For chickens there are further costs in individual mating cages, or in AI, and in incubating small batches of eggs (requiring special small incubating facilities) and a further £1000 per year has been set against this. Costs of purchase and transport of stocks are not included.

The estimated costs for maintaining stocks for the different species for males and for females and overall are given in Table 2. The largest costs are for pigs, due to the number of males needed, and the large value of output per sow. In practice, it may well be possible with good organization and willing cooperators to reduce these costs substantially or to have others meet them from their interest in conserving live stocks of rare breeds.

1.2 Cost of Frozen Semen

Estimates of the costs of collection and storage of frozen semen are given in Table 3. The genetic bottleneck due to freezing from N sires is equivalent to an inbreeding coefficient of 1/2N. With 25 sires (Smith 1983), the inbreeding incurred is thus 2 percent, corresponding to 10 years for the level (0.2 percent per year) set for maintaining a breeding stock. The sires (with spares) need to be held for health testing, training, collection and disposal periods. The collection (and evaluation) periods to collect a minimum of 50 doses of frozen semen are short for cattle and sheep but are still long for pigs (7 weeks) and poultry (17 weeks, or 9 weeks for strains capable of yielding in each ejaculate sufficient semen for two doses). The costs of collection and freezing per dose are low in cattle and sheep but are still high for pigs and chickens. In poultry the methods are still experimental, and include the cost of a programmable freezer which would most likely be replaced by a cheaper method of freezing with a commercial development. The total costs of freezing at least 50 doses of semen from 25 sires are appreciable for all species. The advantage is that storage costs are small, so that the stock can be stored for long periods at little further cost.

1.3 Cost of Frozen Embryos

It is not yet possible to freeze embryos collected from pigs and chickens. The requirement for frozen embryos, to parallel those for stocks and semen, is set at 25 embryos from each of 25 donors (Smith 1983), as shown in Table 4. The collection costs are very high, but as for frozen semen the annual storage costs are low.

Table 3 ESTIMATED COSTS OF CONSERVING A BREEDING STOCK BY FROZEN SEMEN

Item	Cattle	Sheep	Pigs	Chickens
Holding cost per sire per week (£)	30	4	15	0.3
Number of sires started	30	30	40	30
Number of sires collected	25	25	25	25
Holding period (weeks) Health tests, training, etc.	8	8	8	8
Fertility of frozen semen (%)	50	40	40	80
Doses of semen used per mating	1	2	2	1
Doses per collection	100	20	10	1 (2)*
Collections per week	1	4	1	3
Collection period (weeks)	1	2	10	17 (9)
Doses collected per sire	100	160	100	50
Number of fertile matings per sire	50	30	20	40
Number of viable progeny per sire	40	40	120	200
Collection cost per dose (£)	0.2	1.7	5.5	8.2(4.7)
Number of storage cylinder (£)	3	3	10	3
Cost per cylinder (£)	250	250	370	250
Total collection cost *(£)*	9200	8700	25200	11200(6800)
Annual storage cost (£)	200	200	400	200

Cattle : J. Isbister, Scottish Milk. Marketing Board
Sheep, Pigs : H.C.B. Reed, Meat and Livestock Commission
Chickens : P.E. Lake, Poultry Research Centre

*Figures in brackets are estimates, considering developments in freezing technique for practical application and using males capable of two doses per collection.

Table 4 ESTIMATED COSTS FOR COLLECTING, FREEZING AND STORING EMBRYOS
(25 EMBRYOS FROM EACH OF 25 DONORS)

	Cattle*	Sheep**	Pigs	Chickens
Cost per embryo (£)	120	80		
Cost for 625 embryos (£)	75 000	50 000	Not possible	Not possible
Storage cost per year (625 embryos) (£)	500	500		

*W.B. Christie, Premier Embryos, Northumberland

**R. Newcomb, Sudbury, Suffolk

Costs include: Holding time, feed, labour, overheads, laboratory tests, drugs, freezing, wastage, etc.

Table 5 ESTIMATED COSTS OF STOCK CONSERVATION FOR DIFFERENT SPECIES

	Cattle	Sheep	Pigs	Chickens
Maintaining a breeding stock (per year) (£)	5 000	3 000	12 000	3 000
Frozen semen from 25 sires (£)	9 000	9 000	25 000	11 000 (7 000)*
Frozen embryos (625 stored) (£)	75 000	50 000	Not possible	Not possible

* See Table 3

1.4 Relative Costs

Comparison of the estimated costs of conservation, by different methods is given in Table 5. These are meant to serve as guides to the costs likely to be incurred, and depend on current technologies, on many assumptions about individual costs and on the levels of inbreeding set by the different methods. Collection of frozen embryos is still comparatively expensive, and even collection of ample frozen semen incurs appreciable costs. However these costs are only incurred once, and storage costs are low. Maintaining a live breeding stock costs least to start with, but the costs are continually incurred and accumulate over time. For periods of over five years, semen storage becomes the cheapest form of conservation.

Costs of conservation in dairy cattle are given by Brem et *al.* (1983). These are somewhat lower than the costs estimated here; 70 percent for a breeding stock and for frozen semen, and 80 percent for frozen embryos. These differences remind us that many of the assumptions and costs assigned are arbitrary and that there may be a considerable variation in the estimated costs with different stocks conserved and in different circumstances.

2. BENEFITS FROM CONSERVATION

There are aesthetic and cultural benefits from conservation of breeds of livestock, just as for conservation of buildings machinery, art, books and other items of historical, social or commercial importance. Fortunately with farm livestock there are many individuals and groups, such as the Rare Breeds Survival Trust in the UK, prepared to devote time and money in conservation. However, here concern is with posible economic benefits in the future from conservation now. Such economic benefits are often implied by conservationists, and examples are often cited (e.g. Mason 1974), but there have been few attempts to quantify them. Predictions from current conditions or trends are unlikely to be helpful, for they are part of the cause for the reduced commercial use of breeds at risk of being lost. Since the future and its requirements are unpredictable it is not possible to quantify benefits. Instead a method, outlined in Table 6, is given to estimate what probability of future use is required to justify conservation. Benefits from livestock- improvement accrue to the consumer (e.g. Smith 1978) rather than to the breeder or producer, and so a national viewpoint is taken. Any benefits from conserving a stock will depend on the total value of the national (or international) market (T), on the costs of conservation (C), on the proportion (x) of its genes used in future commercial production, on the proportional gain (y) in economic efficiency over the then current stocks, on the number of years (m) until commercial use and on the period of years (n) of use. No cost has been attached to the dissemination of the conserved stock since the normal dissemination systems can be used. However, the time involved in dissemination or substitution, or to achieve the required breed mix, may reduce the benefits obtained (Smith 1983). As would be expected, the larger the industry served and the lower the cost of conservation, the smaller the extent of use required to justify conservation. Similarly the sooner the use of the conserved stock and the longer the period of use, the easier it would be to justify conservation.

An example of the application of this approach is given in Table 7 for the UK. The value of livestock production for different sectors is shown as farm gate prices. These might be reduced to a net value if crop costs were removed, but would be increased with added value of product processing and marketing costs. As an example suppose the conserved stock is reused after 20 years, and for a further period of 20 years. An inflation free discount rate of 5 percent is used (Bird and Mitchell 1980). The estimated costs of conservation for 20 years are also shown. The values of the factor (xy), (the product of the proportion of genes used (x) and the increased economic efficiency (y)) which would justify conservation are also given.

Table 6 EXTENT OF USE AND GAIN IN ECONOMIC EFFICIENCY NEEDED TO JUSTIFY CONSERVATION

T	Total annual value of national production
c	Annual cost of maintaining a stock, or frozen stock
s	Cost of freezing a stock
x	Proportional use of genes of conserved stock in future commercial production
y	Proportional gain in economic efficiency from use
m	Time until use made (years)
n	Length of period of use (years)
d	Discount factor = 1/(1 + 0.05)
A net benefit from conserving a stock will accrue when: Cost of conservation < Extra returns obtained C $< T(xy)\ d^m\ (1-d^n)/1-d$	
For breeding stock : C = mc	
For a frozen stock C = mc + s	

Table 7 ANNUAL VALUE OF UK LIVESTOCK PRODUCTION, AND EXTENT OF FUTURE USE OF CONSERVED STOCK TO JUSTIFY CONSERVATION

Product	(T)* Annual value (£ million)	(C) Cost of conservation for 20 years (£ 000) (xy) Size of factor to obtain a benefit from conservation ($x10^6$)					
		Breeding		Frozen		Frozen	
		C	xy	C	xy	C	xy
Milk and milk products	1900	100**	11	13	2	85	9
Beef and veal	1500	100	14	13	2	85	11
Sheep meat and wool	400	60	30	13	7	60	30
Pig meat	800	240	60	33	8	-	-
Chickens (meat)	400	60	30	15	8	-	-
Chickens (eggs)	500	60	24	15	6	-	-

Use made after m = 20 years, for n = 20 further years
$d^m(1-d^n)/(1-d) = 5$

* 1980 value (farmgate) (CSO, Annual Abstract of Statistics 1982)

** Cost (C) = 20 (£5000)
Factor (xy) = C/5T
(x = proportion of genes used in future commerical production;
y = proportional gain in economical efficiency obtained)

The results are quite overwhelming. Benefits would be obtained even with both quite small gains in economic efficiency and with low proportions of the genes from conserved stocks used. In the example for a conserved stock of dairy cattle in the UK, the factor xy equals 0.000011 (or 0.11 x 100^2) showing that conservation would be justified with a 0.1 percent use of the stock and a 1 percent gain in economic efficiency. The figures are even lower for frozen semen conservation. Similar results hold for all the species. Thus, from a national point of view, even if there is a very small chance that a stock will be useful in the future, *it* would be worthwhile *to* maintain it because the potential returns are so large relative to the costs incurred in conservation. With the large disparity between possible returns and costs, there is scope for conserving a large number of stocks, on a gamble that they may contribute something useful in the future.

However it may not be worthwhile to use a conserved stock either as a purebred, crossbred or in a synthetic, unless the gain in economic efficiency is more than 5-10 percent, since it would be possible, during the time of testing and substitution, to select and improve the current stocks to be competitive (Smith 1984). Thus only gains of over 5-10 percent in economic efficiency would be worthwhile. If such gains were obtained the national economic benefits from them would be very large indeed.

Using a minimum gain in economic efficiency (y) of 5 percent, the figures in Table 7 can be expressed as the probability (q) needed for the use of a conserved stock to justify its conservation as: $q = (C/(x(0.05)T) . (l-d)/(d^m (l-d^n))$. With complete substitution x=l, for a two breed cross or synthetic x=0.5 and for a specialized use x may be 0.1 or less. For the UK dairy production, and the situation in Table 7 (m=n=20), the probabilities needed are about 1/5000, 1/2500 and 1/500 for a conserved stock and about 1/35000, 1/17500 and 1/3500 for frozen semen, respectively for x=l, 0.5 and 0.1. Thus the probabilities of use needed are very low indeed, and similarly for the other species. With n stocks conserved these probabilities would be multiplied by n, but with more stocks conserved there would be a higher chance that one of them would be useful.

3. DISCUSSION

An important factor mitigating against the future use of conserved stocks, or of rare and minority breeds, is that the main current stocks are being continually improved genetically for commercial production. This makes it increasingly difficult for conserved unimproved stocks to compete, or to contribute through crossing. It will thus take substantial changes in the conditions or methods of production, in disease or in the product required by the market, for the conserved stocks to make up for their increasing deficiencies relative to current stocks and to be useful.

A cost not included here would be that of evaluating the conserved stocks, and comparing the performance for a range of traits, relative to each other and to the current commercial stocks. This might be done on a continuing basis, on animals surplus to breeding requirements or on special test groups, so that a reliable description of the performance levels and special merits of the stocks conserved would be built up. As before the costs of such tests are likely to be small relative to possible benefits. When conditions and markets change, then any conserved stocks known to be suited to the new situation could be picked and retested on a larger scale to assess their economic merit in the new conditions of production.

In developed countries with continuing genetic improvement of current stocks, it will take substantial changes in production conditions before currently uneconomic rare breeds are likely to be useful. Conservation is thus a gamble, with a high probability of no pay-off and a low probability of large benefits if the conserved stock is used. Conservation to retain some genetic diversity may be worthwhile, but to conserve all rare breeds and stocks seems unnecessary. There is, however, often considerable interest and enthusiasm by individuals and groups, such as the Rare Breeds Survival Trust in the UK (Steane 1983) and this may suffice.

The situation is more serious in developing countries. Money for conservation is scarce and many local breeds are in danger of disappearing as the more productive breeds from temperate climates are introduced. Often there are insufficient comparative tests over a range of production environments to evaluate the local breeds. Their special traits in acclimatization, in disease resistance and their tolerance of poor nutrition and environments may be lost. Here the probability of the use of conserved stocks (perhaps in new synthetic breeds or in crossing programmes with the exotic breeds) will be much higher as improved performance may depend on disease resistance and acclimatization of the local breed. This seems to be the main area for input of international resources in conservation. While the costs of conservation may well differ for developing countries (e.g. Parez 1984), it is hoped that the costs derived here may act as a rough guide to the size of the resources required, and form the basis for an international plan for conservation. Teams of technicians could then travel to developing countries and freeze semen from local breeds, storing the material at national and international semen storage centres. Monies might also be raised by allowing individuals or companies to identify with the conservation of a particular breed.

The conclusions from this paper are simple. The costs of conservation are small relative to possible future economic gains in national production. In developed countries enough conservation is probably already being done and this should continue. In developing countries the loss of locally adapted breeds is more serious and is occurring more rapidly. The time has come for international organizations to fund conservation in these countries, or to set up teams to carry out the conservation for them before it is too late.

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GENETIC ASPECTS OF CONSERVATION IN FARM LIVESTOCK1

Charles Smith2

ABSTRACT

Concern about loss of genetic diversity in farm animals can be effectively met by storage of frozen semen or embryos. Genes may be stored in gene pools, but generally breeding stocks should be kept in pure form. The possible returns from retaining genetic diversity may be large, while the costs by comparison are trivially small on a national basis. Thus any stocks at risk should be conserved without further ado. Some principles in conservation are: (i) to store small samples of many stocks; (ii) to choose diverse stocks; (iii) to store stocks with special traits; and (iv) to store locally adapted breeds (especially for developing countries). However, continuous genetic improvement in current stocks may make it increasingly difficult for unimproved conserved stocks to compete, unless there are reversals in breeding goals, or drastic changes in husbandry conditions.

1. INTRODUCTION

There are aesthetic and cultural reasons for conserving different breeds and strains of farm livestock, just as for the preservation of buildings, works of art and museum collections of diverse materials. However, concern here will be with genetic conservation for possible long-term use in production and for economic benefits in the future.

Current trends in livestock breeding may lead to appreciable reduction in the genetic variation available in the future (Mason 1974; Maijala 1974; Miller 1977; FAO/UNEP 1980). These trends include the worldwide concentration on a few specialized stocks and on continuous directional selection within these stocks. If husbandry and market requirements change in the future, as they have in the past, different types of stock may be needed. But without conservation no alternative stocks may be available, and there would be less genetic variation for changing the then current stock to meet the new requirements. Genetic conservation could offset these trends, if useful genetic variation were available and could be exploited. Alternatively, it might be argued, that if concern about genetic stocks and variation in the future were removed, current breeding policies could be pursued with more vigour and so with greater genetic response.

2. EXAMPLES

Some examples in the use of (planned or unplanned) conserved germ plasm in improving current breeding stocks are available (Mason 1974). Several relatively rare breeds have recently become important, either as purebreds or in crosses, in current production, such as the Finnish Landrace sheep, the Pietrain pig and the Gotland sheep. In poultry, Cornish game stocks are important components of current broilers. In pigs, the use of prolific native Chinese pig breeds is being considered. There are also several good examples of individual genes from special stocks now being used in current stocks, such as sex-linked slow feathering and dwarf genes in broilers, the halothane gene in pigs, the double muscling gene in cattle and the Booroola gene in sheep. These examples show that there have been benefits from having a diversity of stocks in the past, and so there may well be further benefits in the future, as the variety of stocks and breeds otherwise available gradually declines.

3. STORAGE METHODS

Until recently genetic conservation in farm animals has been largely unplanned, but small remnants of earlier stocks and breeds are found. Use of living stocks with normal reproduction is costly in facilities and supervision and is subject to several hazards, including loss due to disease, genetic bottlenecks from fluctuating numbers, accumulative genetic drift, inbreeding depression, contamination from other stocks and changes due to natural selection. Methods to minimize these effects are discussed by Smith (1976) for genetic control populations.

Storage of frozen semen or embryos is now the best way of preserving genetic stocks. One or both methods are now available for all farm species. High recovery rates are not required, since a few animals bred from stored material can produce large numbers of progeny. While collection costs may still be moderate, or even high, storage costs are low (Brem *et al.* 1983). The various hazards cited above for breeding stocks are reduced or removed with frozen stores. Experience with regenerating stocks from frozen semen and embryos has been good (e.g. Whittington *et al.*1977). To avoid accidental loss, several replicate stores of the same material should be maintained. As a further safeguard, the stores should be shielded from possible irradiation damage.

4. GENETIC DRIFT

It may be useful to review the inbreeding and genetic drift variance generated by different systems of conservation. The effective breeding size (N) of a population is defined as that which gives an inbreeding rate of F = 1/2N per generation. The genetic drift variance for a trait is then VG/N, where VG is the genetic variance for the trait.

In setting up breeding lines or frozen stores, the initial drift variance is:

$$\frac{VG}{4}\left(\frac{1}{s} + \frac{1}{sd} + \frac{2}{sdn}\right)$$

with s unrelated sires, d dams per sire and n offspring per dam. With frozen semen n = d = 1 and the drift variance is

$$VG/s$$

The subsequent inbreeding in a breeding line (with balanced pedigree mating) is (e.g. Hill 1972):

$$\frac{1}{2}\left(\frac{3}{16s} + \frac{1}{16sd}\right)$$

per generation, and is cumulative. With frozen semen, using sires rotationally on each other's daughters (Smith 1977), no inbreeding would be generated until the circle of sires was completed (s generations) and even then it would only rise to a maximum of (4/3) ($1/2^s$ +3), a quite trivial amount if s is not small. There would be no further inbreeding until the frozen semen stocks were exhausted and another set of sires had frozen semen stored when the above results would be repeated. With frozen embryos there would be no inbreeding or drift until stocks were used up, and a new set of embryos was produced. In multiplication, inbreeding could also be avoided by rotating over the original embryo lines.

These results show how very effective the frozen storage methods are in minimizing drift and inbreeding in genetic conservation compared with breeding stocks. Choice between semen or embryos will depend on the costs of collection and the number of progeny required. With frozen embryos the original stock can be regenerated at any time. Frozen semen needs a small permanent female breeding group or a small store of frozen embryos to reproduce the original stock. The alternative is a period of backcrossing to breed up the original stock; with 50, 75, 87, 94, 97, 98, 99 percent of its genes in generations 1-7 respectively.

5. GENE CONSERVATION

Distinction should be made between storage of individual genes and the conservation of stocks each with its combination of traits and genetic characteristics. The methods of storage and of extraction and use of the material will differ in the two cases.

If it is the gene itself which is required, it can be extracted from any form of storage and substituted into current stocks by repeated backcrossing. It may thus be stored in pure line, synthetic or gene pool form. The size of the store or the frequency of the gene need not be high since only a few copies of the gene are required. Genes with deleterious effects may need to be maintained by selection, the special stocks often being recorded in a registry (e.g. Somes 1978). If special or novel combinations of genes are required, simple random mating will be adequate and can provide a wide variety of genotypes which can be extracted (Weller and Soller 1981).

For individual genes the most efficient and effective storage methods are in gene pools, with frozen semen or embryos. Pure line forms will be preferred only if linkage groups, epistatic or genetic background effects are considered important.

The probability that a gene occurring in a population is not included in a store depends on the frequency of the gene and on the size and form of the store. If the frequency in the original population is p, the probability that none of N individuals in store have the gene is $(l\text{-}p)^{2N}$. This would apply to frozen semen store from N sires. With an embryo store of a large number (>10) of embryos per mating, the probability that none of the embryos contain the gene approximates to $(l\text{-}p)^{4N}$. With stores where N is not small these probabilities become very small, unless p is very low (less than 0.1). Thus the risk that a gene present in the original population is lost is very low, unless it was originally very rare.

In addition to known genes (identified either by phenotype or by quantitative effects, i.e. major genes), there will be other genes as yet not identified which may be detected and exploited on exposure to new conditions. The wider the genetic diversity of stock stored, the greater the chance of finding such genes.

6. QUANTITATIVE TRAITS

When many genes are involved in the expression of a trait, as for most quantitative traits, it will not be possible to extract them as a group and to use them independently of the rest of the genotype. Thus the genotypic value for <u>all</u> traits in a stock are relevant, for they will affect the overall performance both as a pure line and in combination with other lines. The genotypic value of the cross will tend to the average of the contributing lines. If the economic effects were linear and there was no heterosis, then the best pure line (at any time) would be as good or better than the best cross. However, with heterosis and non-linear economic weights (curvilinear, plateaus, thresholds, intermediate optima) which depend on the performance level for the trait, the best line or combination of lines would need to be derived for each situation. The value of a line will then depend on the requirements, and on the other lines in the array and on how well they complement one another. Storing of lines in purebred form allows full flexibility in their use, and so is preferred.

7. CHOICE OF STOCKS

While the intention would be to store genetic variation which may be useful in the future, it is hard to predict what this may be. Since prediction is uncertain, one course may be to store samples of all available stocks, even if these samples were very small due to limited storage facilities. However, since very large numbers of stocks and substocks could be listed for most species, this approach may be impractical.

More feasible would be to select stocks for conservation. Selection might be on their genetic diversity, as judged by genetic analysis and history (e.g. Kidd 1974). Or it might be on their high overall performance, or on special attributes in performance, including physiological or biological traits, or types, or extremes (Land 1981). It would seem obvious that the lower the genetic similarity and higher the diversity of types and traits among conserved stocks, the greater the probability of finding a gene or a stock, or a combination of stocks, with the set of properties and traits to cover the widest range of conditions possible in the future. Thus, with limited facilities, a choice among stocks based on their diversity would be recommended. This choice would require reliable genetic and performance information on candidate stocks. However, it should be stressed that it is the overall economic performance involving a combination of many traits in the future that is important, rather than extremes for specific traits.

8. SAMPLING

The main aim in sampling will be to get a representative and adequately sized sample of the stock to be conserved. The past breeding history and geographical distribution will need to be considered, so that a representative stratified sample can be collected. Within strata, relationships among sampled individuals should be avoided. In rare stocks, or those liable to contamination, parentage testing and genetic marker tests to ensure purity may be worthwhile.

The number of parents sampled and number of sperm doses or embryos stored will depend on the eventual usage of the stock. If the stock is to be used as a purebred, or as a maternal breed in a crossbreeding programme, inbreeding (leading to inbreeding depression) and loss of genetic variation (leading to lower respones to subsequent selection) should be avoided. A maximum level of inbreeding incurred by the storage process might be set at about 2 percent, equivalent to about 4, generations of inbreeding for many breeds of livestock in practice. The 2 percent would also be the percentage loss in genetic variation in forming the store, due to limited numbers. It would be equivalent to an effective population size in storage of 25, and would be met by 25 unrelated sires with frozen semen, or (conservatively, d = n = 1) by 25 parental pairs with frozen embryos. Thus moderate numbers are likely to be adequate, though these might be increased in practice for a margin of safety. The number of frozen embryos or semen doses to store from each mating or each sire depends on the reproductive success with the frozen material and on the amount of testing, multiplication and additional uses to be made of the conserved stocks.

9. ECONOMIC BENEFITS

Economic benefits from genetic conservation are hard to quantify because future needs and conditions cannot be predicted. However, the benefits from genetic improvement, on a national basis, are large. Further inputs to increase rates of response for current objectives in current stocks show diminishing rates of return and are restricted by the reproductive rate of the species (Smith 1981). By contrast small inputs in conserving stocks, as insurance, for alternative conditions and requirements may yield large returns if these conditions or requirements materialize.

The expected benefit (B) in any year might be expressed by an equation of the form

$$B = P\ (R - R_o) - nC$$

where P is the probability that one of the conserved stock has a performance greatest than for the original stock and so has an economic return R which is higher than the return R from the original stock, and n stocks are stored each at cost C. With frozen germ plasm the costs are likely to be small, so many stocks could be stored. With many stocks stored the probability of getting one stock (or a combination of stocks) better than the original is increased.

10. TESTING

Some information on performance will be available on the stored stocks at time of storage. However, before reuse in new husbandry and marketing conditions, further testing will be needed. These tests may proceed sequentially, starting with small samples of many candidate stored stocks and subsequently testing larger samples of the best stocks. Accurate performance data, relative to the current stocks, are needed for <u>all relevant</u> production traits, and over the range of production systems. The costs of these tests and comparisons are likely to be small relative to any achieved gains on a national scale if a better stock were identified. But any net economic advantage needs to be reliably estimated, else the benefits predicted may not materialize or may turn into losses. However, any substitution of a new stock would probably be gradual, with continuous comparisons of the different stocks until their relative economic value was well established in practice.

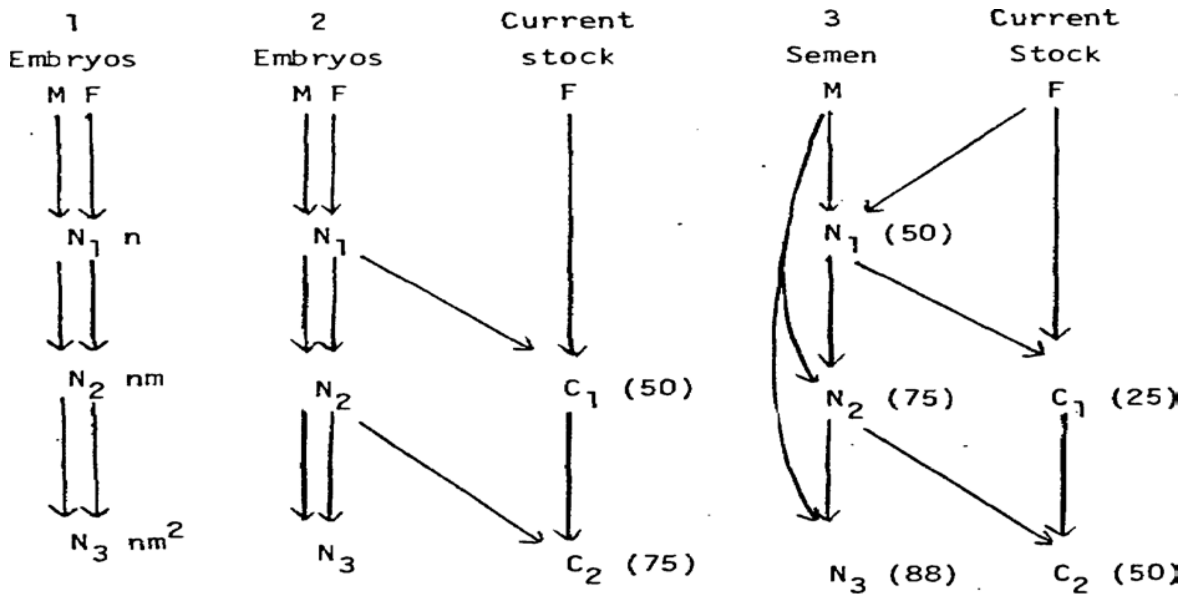
11. SUBSTITUTION

It will take time to substitute one stock for another, or to combine one with another, and to multiply and repopulate for commercial production. Three possible systems are shown in Figure 1. The first shows the multiplication of a pure stock from an embryo store, and its substitution for the current population. The rate of substitution will depend on the number of ova used (2n) and on the reproductive rate (2m) of females, which may be enhanced by embryo transfer techniques. Numbers of females would increase exponentially (n, nm, nm , nm , etc.) over the generations. The second system relies on grading up the current population, while also maintaining and multiplying the pure stock. The third shows grading up from a semen store. The relative rates of improvement by substitution over the generations are graphed in Figure 2A. The generation length might be reduced on the male side in the semen system to speed up the grading up process somewhat.

It is important to consider selection during substitution, for the time spent in substitution could also be spent in selecting the current stock for the new requirements. With no selection during substitution (taking say 4-5 generations to over 95 percent substitution), the new stock would have to exceed the current stock by more than 4-5 times the current genetic response rate in overall economic merit per generation if the substitution is to be worthwhile. In Figure 2A, a superiority of 8 times the generation improvement rate is used. Figure 2B shows the value of selection during the substitution. Selection will be possible in the purebred groups bred from embryo stores, with selected individuals forming the breeding nucleus for the eventual pyramidal breeding structure of the population. A delay of 2 generations for multiplication, followed by normal selection and response in the nucleus group (straight dashed lines) is shown in Figure 2B, with the substituted commercial population eventually lagging by one generation. With frozen semen, selection cannot proceed (on the male side) during grading up, because a fixed panel of sires is involved. Selection should replace grading up when the slope for merit on the substitution line is less than the response slope, as shown in Figure 2B. However, having lost several generations of selection, substitution by frozen semen is likely to lag behind the genetic merit of stocks from embryo stores. The value of maintaining a small pool of frozen embryos to complement the semen store and allow production and multiplication of purebreds, as for frozen embryos, would be large in this case.

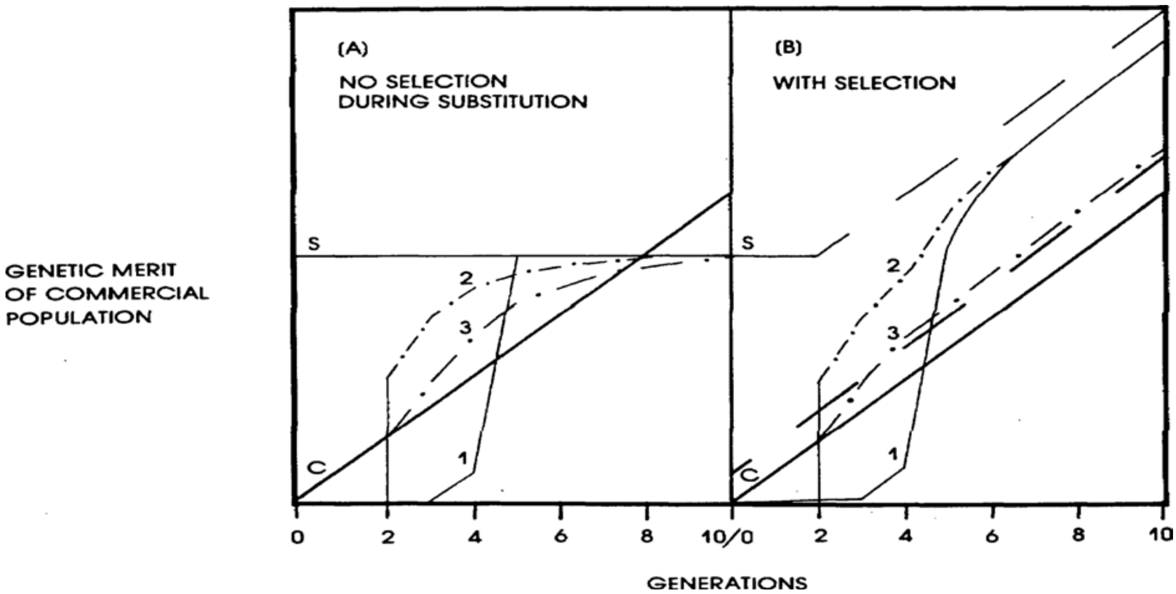
12. DISCUSSION

Intuitively, conservation at first appears a sound investment because once genes or genetic variation are lost they cannot be replaced, except by mutation or by culmulative selection. The idealist might thus advise storage of all genetic stocks since we cannot predict what will be required in the future. Quite small genetic samples (25 sires or matings) of each stock would be sufficient, but with adequate stores for future testing and multiplication. Any stocks or substocks which are closely related or similar to other stocks might be omitted. Further, with some beliefs about requirements in the future, choices among stocks could be made, though these might be mistaken and not worth the costs saved.



Method 1 represents direct substitution by multiplication from embryos (2n), for female reproductive rate (2m). Method 2 is for grading up, while maintaining and selecting a pure bred stock. Method 3 represents grading up from a semen panel. (M are males, F are females, n, nm and nm^2 are the numbers of females and the figures in brackets are the percentages of the genes from the new stock substituted.)

Fig. 1 Three methods of substitution from stored stocks



The merit of the stored stock (S) and its derivatives are shown, relative to genetic improvement in the current stock (C) . Methods 1, 2 and 3 are shown in Figure 1. A is for no selection during substitution, B is with selection. The straight dashed lines show the merit in the nucleus breeding groups in the two pure stocks. The original superiority (S-C) is 8 generations of selection response.

Fig. 2 Diagram of levels of genetic merit on substitution

Three principles in conservation might be proposed: (i) to conserve many stocks in small numbers rather than a few stocks with large stores; (ii) to choose stocks which are as genetically and phenotypically as diverse as possible; and (iii) to store the stocks as pure lines rather than as gene pools so as to allow use of the unique combinations of traits and flexibility in combination of stocks.

Some conservation will occur in farm animals in the normal course of events. There are often health and official barriers to the import and use of stocks from outside. The number of years required for substitution is greater for the larger farm livestock, compared with poultry or plants. There is also usually a greater conservation among livestock breeders and producers (with differences in requirements and locations) tending to restrain, or in some cases prevent, the full substitution process. Further there may be other bodies, such as the Rare Breeds Survival Trust in the UK, which foster the preservation of old breeds. These and smilar factors may do much to reduce the concern about conservation in practice.

Rather large changes in economic requirements or husbandry conditions will be needed to make the conserved stocks competitive. Current stocks are being continuously selected for improved performance. Moreover, many of the traits (such as fertility, survival, number of progeny, efficiency of food use and functional fitness) are likely to always have positive economic value. By contrast stored stocks are not being selected and will not benefit from improvements in these traits. These differences will accumulate over time, making it progressively harder for the stored stocks to compete. A similar result was shown for the efficiency of index selection, where reversals of sign in the economic weights of important traits are needed to reduce the efficiency of selection to zero, or to make it negative (Smith 1983). This suggests that it might be best to store stocks which are currently undesirable in traits which may only have temporary current value (such as market or grading requirements, carcass or product composition, or special behavioural adaptations to current husbandry conditions). An alternative might be to select and develop further such currently undesirable stocks, so that the full range of performance in such economically variable traits would be available in the future. For example, with changing energy costs, future requirements may be for livestock able to produce fat carcasses, as was the requirement in the past century.

Concern about conservation arises from current breeding trends, in the loss of many indigenous breeds and strains, and the possible exhaustion of useful genetic variance or balance with natural selection in selected stocks, leading to selection plateaus. Strategies for introducing genetic variation from improved stocks which have plateaued are presented, with experimental results, by Osman and Robertson (1968). Choices need to be made as to which unimproved stocks to use, on the numbers of generations of mixing before selection, on the percentage mix and on the intensity of selection used. The time taken to reach the original plateau and the further selection response obtained will depend on many of these factors.

However, Hill (1982) has recently suggested that populations of moderate effective size ($N>100$) should be able to sustain indefinitely an appreciable rate of selection response in a quantitative trait, due to the occurrence and continuous selection of favourable mutations at many loci affecting the trait. If correct, as supported by some large long term selection experiments, this would offset much of the value of conserving other stocks to preserve genetic variation.

The value of conservation may be less important in the future with the development of new technologies of molecular biology in genetics, and the possibility of manipulating genes and genetic variation and even of developing new genetic materials. On the other hand it might also be argued that all current stocks should be preserved so that the existing genetic variation can be exploited by these techniques in the future.

Perhaps the most serious concern in conservation at present is the possible imminent loss of locally adapted breeds, with their special behavioural, physiological and disease resistance properties. Conservation of samples from these stocks is important especially in developing countries, since the special genetic systems evolved by natural selection may be crucial to continued animal production in these areas. The preservation of native adapted breeds, and of stocks for special niches or conditions might be the most important role for genetic conservation.

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TRYPANOTOLERANT LIVESTOCK NETWORK IN WEST AND CENTRAL AFRICA1

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1. BACKGROUND

The exploitation of genetic resistance to infectious diseases is being given increasing attention in developing countries, where conventional disease control measures are often not effective, do not exist, or cannot be implemented because of lack of finance or trained manpower. However in animal breeding programmes, disease resistance can be only one of many aspects of production that have to be considered. In the vast majority of selection programmes, practical breeders usually select on overall viability, probably the poorest defined character in livestock breeding work. Major problems in making progress from such selection decisions are that the heritability of overall viability is generally low, mainly because of the large environmental variance component. In contrast the heritability of well defined resistance to specific diseases, or of traits correlated to resistance, is likely to be higher than that of overall viability. Controlled challenge conditions would also be expected to increase heritability by reducing environmental variation.

Trypanosomiasis is found over about 10 million square kilometres, or roughly one third of Africa. The disease occurs in nearly every country between the deserts of southern Africa and the Sahara. Approximately 7 million square kilometres of this area are tropical savanna which could support an estimated 125 million additional cattle without environmental stress. Many African livestock producers traditionally brought their herds and flocks into trypanosomiasis areas in search of grazing during the dry season when there were few tsetse flies and moved quickly back to drier areas which were free of disease when the rains began. As populations have increased and grazing land is used for farming, this type of herding system has become less practical and grazing pressure has increased in the drier, disease-free zones.

2. TRYPANOTOLERANT BREEDS

The exploitation of trypanotolerant breeds of cattle such as the N'Dama and West African Shorthorn offers one of the most important approaches to the utilization of tsetse-infested areas in Africa. The ILCA/FAO/UNEP report on trypanotolerant livestock in West and Central Africa (ILCA 1979) emphasized the importance of trypanotolerance by indicating that West African taurine breeds are at least as productive as other indigenous African breeds in areas of low or medium trypanosomiasis risk. In areas of high trypanosomiasis risk, comparative data are not available because only trypano-tolerant breeds can exist. This report illustrated the major effects of level of trypanosomiasis risk for which only rather subjective measurements have been available in the past; and the effect of management and nutrition as indicated by ranch or village production systems. Major interactions exist between breed type; level of trypanosomiasis risk; and other nutritional, physiological, disease and management factors.

Many small scale experiments carried out in West Africa indicate similar dramatic differences between N'Dama and zebu in susceptibility to natural infection when judged by mortality levels and associated prevalence, level and duration of parasitaemia and anaemia. Similarly, evidence is available on the effects of level of challenge on subsequent anaemia. Using animals that had never been previously exposed to trypanosomes, it has been confirmed that N'Dama are significantly more resistant than zebu to experimental challenge with wild caught infected tsetse (Stephen 1966; Roberts and Gray 1973), natural field exposure (Touré *et al.* 1978; Murray *et al.* 1981) and to trypanosomes inoculated by syringe (Murray *et al.* 1977; Saror e*t al.* 1981). The resistance of the West African Shorthorn appears to be intermediate between N'Dama and Zebu (Roberts and Gray 1973).

Further evidence that trypanotolerance has a genetic basis and is not only due to resistance acquired to local trypanosome populations has been provided by the successful establishment of cattle from West Africa in distant tsetse-infested areas of West and Central Africa, e.g. the introduction of Lagune in 1904 and N'Dama in 1920 into Zaire and more recently N'Dama into the Central African Republic, Gabon and Congo (1LCA 1979).

On the basis of this knowledge, N'Dama heifers and bulls are now being imported by several countries in west and central Africa to form the nucleus of livestock development programmes in tsetse-infested areas.

There are now several reports from Kenya and Upper Volta that differences in resistance to trypanosomiasis have been found in certain *Bos indicus* types. However, as the animals in these studies had all been previously exposed to trypanosomiasis, it is not possible to assess the relative contribution of innate and acquired resistance. While critical comparative studies on the differences in susceptibility and productivity remain to be carried out, the degree of genetic resistance in *Bos indicus* types is probably significantly less than in the recognized trypanotolerant breeds.

While there is evidence in cattle that the level of innate resistance to trypanosomiasis can be supplemented by previous exposure, it must be emphasized that trypanotolerance is reduced under certain adverse conditions. In order to realize the full potential of trypanotolerant breeds, it is essential that the main factors affecting the stability of trypanotolerance be identified and the extent of their impact quantified, e.g. it is known that as tsetse challenge increases, the productivity of N'Dama falls (ILCA 1979) as a result of stunting, wasting, abortion and even death. Therefore, the ability to quantify tsetse-trypanosomiasis risk critically is required in order to determine at what level of risk the N'Dama ceases to be productive. Similarly, factors including the stress of overwork, pregnancy, parturition, lactation, suckling, poor nutrition and intercurrent disease have been identified as affecting the susceptibility of cattle to infection with trypanosomes (reviewed by Murray *et al.* 1982).

3. NETWORK OF TRYPANOTOLERANT LIVESTOCK SITUATIONS

Thus, a network of trypanotolerant livestock situations is being built up throughout West and Central Africa. In total cooperation with national research organizations and with the help of a number of donor agencies, ILCA is coordinating in-depth investigations on an eventual ten sites. These cover a range of trypanotolerant and trypanosusceptible livestock breeds under different levels of tsetse-trypanosomiasis risk and different management regimes. Additional work in East Africa by ILRAD and ILCA has led to similar studies being developed on sites in four countries in this region. The technical training and supervision is being provided jointly by ILCA, 1LRAD and ICIPE. By defining the parameters to be measured, through well organized training and supervision it is hoped to standardize the technology being used throughout Africa, in order that the results obtained in different study areas can be critically compared.

3.1 <u>Objectives</u>

The objectives are to evaluate the productivity of different breeds of domestic ruminants living under different levels of tsetse-trypanosomiasis risk, under different management systems, in different ecological zones. These results should allow a critical evaluation of genetic differences in susceptibility to trypanosomiasis between breeds throughout Africa. In addition they should permit critical evaluation of the role played by acquired resistance in field situations and enable between-breed comparisons of the rate at which it develops.

Once the essential baseline data are established and meaningful productivity indices, based on production, economic, health and tsetse data, are computed, it should then be possible: (i) to predict the productive capacity of different breeds of domestic ruminants living under different levels of tsetse-trypanosomiasis risk. This knowledge will lead to more efficient use of different breeds, and, consequently, to increased livestock production; (ii) to evaluate the cost effectiveness and impact of the introduction of current or new methods of control, e.g. the strategic use of chemotherapeutic or chemoprophylactic drugs, tsetse control, trypanotolerance, improvements in management and nutrition and, possibly in the future, immunotherapy and genetic selection.

3.2 Parameters and Techniques in Data Collection

A training manual has been produced jointly with ILRAD and ICIPE (Murray *et al,* 1983), describing the parameters and techniques used in the collection of data in the matching animal health, tsetse-trypanosomiasis risk, and animal productivity areas, and indicating how relevant information is extracted, analysed and interpreted. The manual will be reviewed after 18 months to include additional experience gathered in the field operations and during training sessions.

3.2.1 Animal health

The most reliable indication that a herd is affected by trypanosomiasis is the detection of parasites in the blood and the presence of anaemia. When evaluating the importance of trypanosomiasis in a field situation, it is also essential that other anaemia-producing pathogens are identified. thus, this manual decribes the basic techniques for estimating anaemia, detecting trypanosomes and diagnosing other anaemia-producing diseases.

3.2.2 Animal productivity

The important performance traits are reproductive performance, viability, growth and milk production. These are then amalgamated into suitable indices of overall animal productivity. To allow concurrent evaluation of animal productivity and the prevailing health and tsetse situations requires recording of all animal numbers, dates of parturition, birth, death, sale, movements in or out of herd, etc. and sampling at appropriate intervals, of body weights and milk production. Economic evaluations aim at providing useful information to development project planners and managers on production potentials and cost effectiveness of introduction of improved practices.

3.2.3 Tsetse situation

The collection of essential concurrent data on degrees of risk from tsetse infestations is essential for the appraisal of livestock production and entails general surveys of the location of foci of infestation infringing on the study areas, and the monitoring of seasonal alterations in tsetse density distribution and infection rates.

4. CURRENT NETWORK SITUATION

Approximately ten sites will be involved in in-depth investigations. Sites cover a range of trypanotolerant and trypanosusceptible breeds, under different levels of tsetse-trypanosomiasis risk, under different management regimes. In some sites, attempts are being made to improve the productivity of trypanotolerant breeds by the use of chemotherapeutic or chemoprophylactic drugs. Following staff training in Nairobi, work has commenced in situations in Zaire, Gabon, Nigeria and Ivory Coast. Further sites will include Togo, Benin, The Congo, The Gambia and Senegal.

In Zaire implementation focuses on the N'Dama breed raised both in ranches and "metayage"-village operations under various levels of trypanosomiasis risk. The field operations started in November 1982. Recording is operating at full scale in the ranches and will be operating in the metayages by the end of September 1983.

In Gabon, the ranch of the Office Gabonais d'Amelioration et de Production de Viande at Okouma maintains N'Dama and Nguni cattle and their crosses under two levels of trypanosomiasis risk, with a range of trypanosomiasis control interventions. In October 1982, herds were reorganized, and data collection according to ILCA's protocol commenced.

In Nigeria, the ILCA humid zone programme in 1981 extended its existing production recording with small ruminants to collect matching data on trypanosomiasis risk and incidence. A veterinarian from ILCA Nigeria spent four weeks in April 1982 in specialized training while three further researchers were trained in February and March 1983.

In Nigeria, the ILCA humid zone programme will monitor an importation of Gambian N'Dama cattle in cooperation with the Federal Livestock Department and Western Livestock Company, commencing September 1983. Heifers from low, medium and high trypanosomiasis risk situations in The Gambia are being maintained in low and medium ranching situations in Nigeria, with and without initial prophylaxis.Comparison is also being carried out with progeny of previous importations, born in Nigeria.

In Ivory Coast, during 1981, work on sheep in the SODEPRA Nord operations was extended with ILCA support to cover all the recording requirements in a village situation in the semi-humid savanna around Korhogo. The work is being carried out in collaboration with SODEPRA (Ministry of Animal Production), the Veterinary Laboratory of Korhogo, and a FAO project on tsetse control. A project document has also been presented to GTZ in Germany and the Ministry of Animal Production in Ivory Coast, proposing the extension of the operations to a higher tsetse challenge area and to cover both sheep and cattle (zebu, Baoule, N'Dama). Agreements have now been signed.

Togo and GTZ proposed the extension of the activities of CREAT Avetonou to carry out comprehensive work involving the station cattle and metayage operations enlarged to cover 300 N'Dama females in village herds around the station. ILCA will provide technical advice, training to local scientists and carry out the data analysis. The same recording scheme will also be applied to an ongoing village cattle project funded by Togo and GTZ in the Centre region working with Somba and Borgou cattle. Two Togolese scientists have recently completed the training course in Nairobi.

In Benin, a package of six small livestock development projects has been proposed by FAO for funding by UNDP. Two of them concern the creation and development of a unit of veterinary and animal production research, with an important goal being the study of the trypanotolerant breeds and their potential. The first phase will last three years. The operations will focus on three farms: Samiondji (Lagune), M'Betecoucou (Borgou) and Okpaha (Somba, zebu), together with surrounding village herds. It has been agreed that ILCA will organize necessary training and provide technical supervision and data analysis. The project is currently delayed for lack of funds.

In the Congo, contacts have been established with the Dihesse ranch where N'Dama are raised under low and medium trypanosomiasis risk. Currently arrangements are underway to allow the analysis of production and health data collected on the breeding herds since 1975, through a four month fellowship to a Congo scientist.

In the Gambia, a recent major development in the exploitation of N'Dama cattle is that the Government is establishing an N'Dama Centre with which ILCA and ILRAD will have major links and inputs. The main objectives of this centre are, firstly, to provide channels for marketing and export of stock, and, secondly, to undertake epidemiological studies to evaluate the productivity of N'Dama exposed to different levels of quantified tsetse-trypanosomiasis risk.

Senegal has requested ILCA to organize and support similar research work on Djallonke sheep and N'Dama cattle in Casamance and Senegal Oriental which encompass different ecological zones and tsetse challenges. This proposal has been linked to the request to EEC for the Gambia. The two research projects will therefore constitute an integrated operation.

4.1 Initial Data Analysis

Data covering the initial 12 to 18 months of operations in Gabon, Ivory Coast, Nigeria and Zaire are currently being prepared for analysis. It is anticipated that preliminary interpretation of these analyses will lead to more precise protocols being devised in all situations.

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CONSERVATION BY MANAGEMENT

AN EXAMPLE OF A NATIONAL PROJECT ON MANAGEMENT OF ANIMAL GENETIC RESOURCES (N'DAMA CATTLE BREED): A CENTRE AT BOKE FOR SELECTION, MULTIPLICATION AND IMPROVEMENT OF N'DAMA CATTLE IN THE REPUBLIC OF GUINEA

Jean-Marie Devillard1

This short-term mission was achieved for an FAO/UNDP Project, in the Republic of Guinea (République Populaire et Révolutionnaire de Guinée). This is a national project. Its title is "Centre de Sélection, multiplication et amélioration du troupeau N'Dama", i.e. Centre for Selection, Multiplication and Improvement of N'Dama Cattle.

One third of the total N'Dama cattle population is located in the Republic of Guinea (1 154 000 head on 3 423 000) (FAO 1980). The Futa Djalon mountainous region in Guinea is considered as the original territory of the breed, from which it spread progressively to Senegal, Mali, Sierra Leone, Ivory Coast, Liberia and, more recently, to Zaire, Congo, Ghana and Nigeria.

This regional breed, considered as trypanotolerant, is widespread (12 countries).

FAO and UNDP accepted to fund a "Centre for Selection, Multiplication and Improvement of N'Dama Cattle" located in Guinea. Until new, not much selection has been done in the N'Dama population. The evaluation of this breed, in rather improved or fairly improved conditions, has been partly achieved.

1. THE GOALS OF THE PROJECT

- Setting up of a 300 head herd with animals bought from farmers.
- Selection of the criteria of trypanotolerance, adaptability and meat productivity.
- Multiplication to provide African foreign countries with improved N'Dama.
- Evaluation of the N'Dama breed in slightly improved conditions.

2. THE TRAITS TO BE SELECTED

2.1 Trypanotolerance

The genetic determination of trypanotolerance and the biochemical aspects are not perfectly known:

The certitudes:

i. Trypanotolerance partly depends on genetic factors, but the genetic determination involved is probably complex (several loci, some of which responsible for the immunity response).
ii. Trypanotolerance of an animal also depends on its conditions (nutrition, stress, etc.) and on the challenge (intensity of exposure to infected tsetse flies).
iii. There is a great range of sensibility, to trypanosomiasis (or of trypano tolerance) in the N'Dama breed.

iv. As a matter of fact, the N'Dama trypanotolerance is not absolute. Trypanoso-miasis is responsible for mortality (calves, stressed animals), morbidity (persistent anaemia, etc.) and for lowered performances (growth, milk production, reproduction[1]).
v. The high trypanotolerance of the N'Dama population considered as a whole is due to its ability to control and limit the parasitaemia.

The uncertainties

i. Quantitative measure of phenotypic trypanotolerance has not yet been described and practised
ii. The heritability of the trypanotolerance trait is not known.
iii. Safe genetic markers, indicators of trypanotolerance, are not yet known, though studies on enzyme Erythrocyte glucose 6 phosphate dehydrogenase are being done.

2.2 Adaptability to Hard Conditions

The N'Dama breed shows a real ability to survive in difficult conditions2. One will consider that the level of performance of an animal of the Centre is an indicator of its resistance and its adaptability. The traits taken into account will be morbidity, longevity and, in general, the level of performance.

For this reason, the animals of the Centre must not be reared under too improved conditions.

2.3 Meat Performance

A moderate selection on meat performance can be done. The mean daily gain between 1 and 3 years will be used for this purpose. There are also large differences in the body construction (animals more or less bulky), which are partly genetic.

3. TECHNIQUES OF COLLECTING AND STORING DATA

3.1 In the Centre

Identification of the animals and setting up of a card index: 1 card per animal with information (pedigree, mother line only, growth (3 months to 3 months), reproductive career of the cows, sanitary information (diagnosed diseases, symptoms, analysis, health events).

3.2 In Traditional Herds

Data will be collected in traditional herds (for each cow: how many calves, how many weaned calves).

4. RECOMMENDATIONS FOR THE ORGANIZATION OF THE CENTRE

4.1

The animals to be bought now in traditional herds will have to be chosen more carefully (the average quality of the 100 animals in the Centre is not higher than the average quality of the animals in the traditional herds).

There are great difficulties to get very good animals from the farmers, who do not want to be paid in national currency and are very reluctant to sell females, either heifers or cows.

4.2 Is the Location of the Centre Suitable?

The pressure of infected flies must be at least medium on the territory of the Centre. If this was not true, selection on trypanotolerance could not take place. Capture of flies and dissections must be done, and should have been done before the location of the Centre was decided (in 1981, 150 flies captured, 30 dissected, none of which infected).

4.3 Recommendations for the Rearing of the Herd

- To recruit a skilful Fulani herdsman, who must not be allowed to milk the cows (difficult to check).

- Heifers must not be mated before 30-32 months (160-170 kg). Elimination of some animals of the present, herd (approximately 1/10).

- Purchase of new animals, from traditional breeders (20 to 40 percent of the animals are satisfactory from the point of view of morphology), in areas where the challenge is medium or high, chosen on different criteria: age (female 2.5

years, male 3.5 years), morphology, reproductive performance of their mothers, etc.

4.4 Recommendations about Selection

A 300 head herd (number of reproductive animals) is not enough to do serious selection. The size of the reproductive herd should be at least 1000 head. Figure 1 indicates the career of one generation of calves[1]. The renewal of the reproductive herd is both internal (selected animals born in the Centre) and external (animals chosen in herds reared by cooperating or non cooperating traditional farmers). The animals born in the Centre are selected on their performance or characteristics, thanks to a simple index combining:

-	the mean daily growth (between 1 and 3 years)	50%
-	a morphology mark	25%
-	a trypanotolerance mark[2]	25%

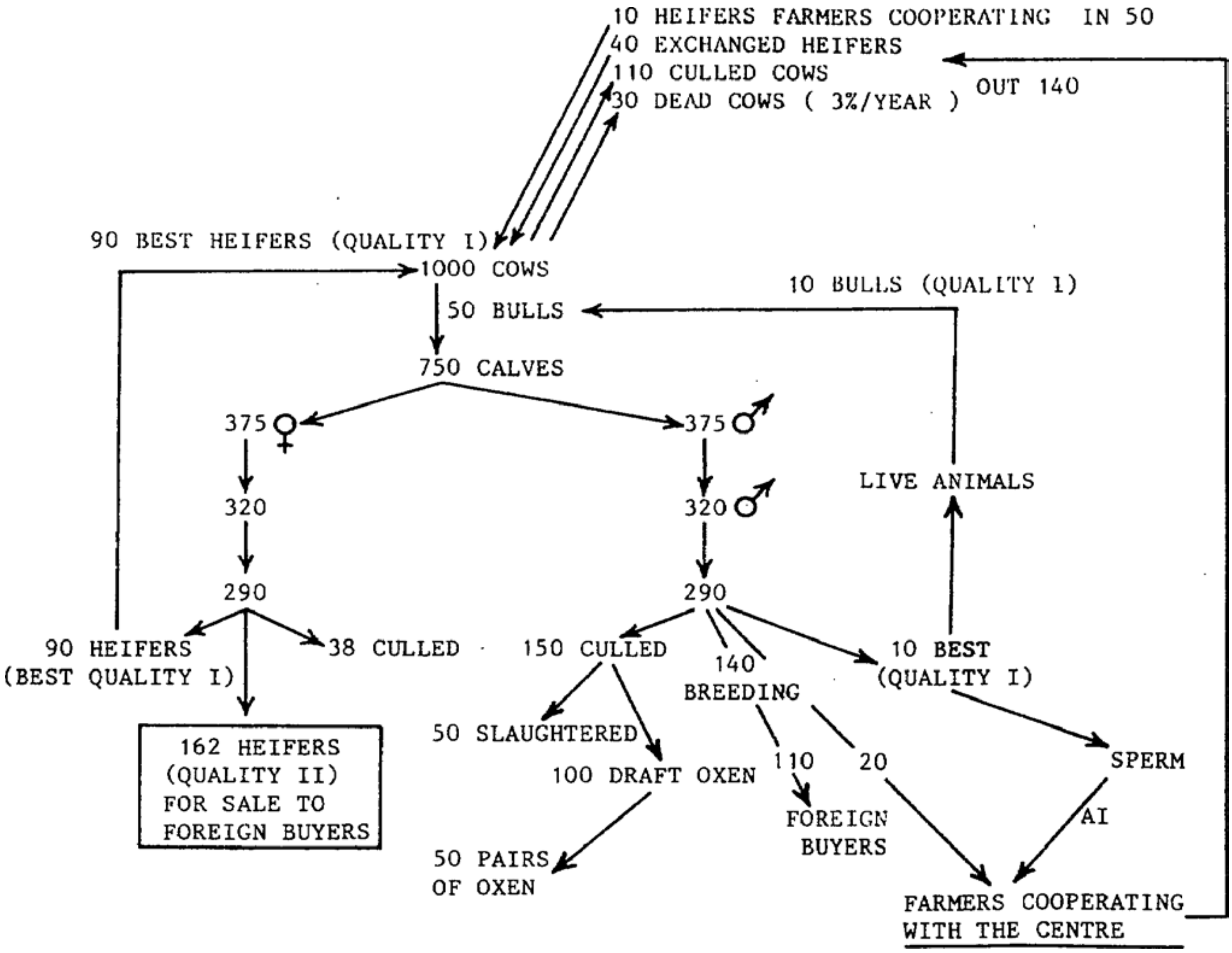

Fig. 1 The use of one year's crop of 1000 cows in a nucleus herd

Table 1 EFFECTS OF THE PROJECT ON DIFFERENT REGIONAL LEVELS

Level	Genetic progress				Progress by improvement
	Time needed (years)	Increase of daily growth gain after this time	Genetic increase of adult weight (kg)	Supplementary weight of meat from each adult animal (kg)	Improvement of meat productivity per cow, by deworming of calves
Herd of the Centre	10	22 % 183 g*	30	14	
Traditional herds cooperating with the Centre (1/3 of the herds of the project area)	25	9.3% 165.6 g	13	6	60 kg meat/year of reproductive life of the cow (calf mortality: 40%) ↓ 80 kg meat/year of reproductive life of the cow (calf mortality: 20%) i.e. + 25%, in 3-4 years
Traditional herds of the project area	25	2.6% 154 g	3	1.4	
All traditional herds in Guinea (with AI in some cooperating	25-30	2 %	2	1	

- Mean daily growth gain

Table 2 STATISTICS OF GEOGRAPHIC REPARTITION OF N'DAMA CATTLE (PER COUNTRY)

			Thousands of heads of N'Dama	%
Zone d'extension naturelle	Guinea		1 154	33.7
	Senegal		746	21.8
	Mali		465	13.6
	Gambia		296	8.7
	Sierra Leone		207	
	Guinea Bissau		166	
	Ivory Coast		70	
	Liberia		11	
		Sub-total	3 115	
Zone d'implantation	Zaire		240	7.0
	Congo		33	1.0
	Ghana		17	0.5
	Nigeria		15	
		Sub-total	308	
		TOTAL	3 423	100

Source: Bétail trypanotolérant en Afrique de l'Ouest et en Afrique Centrale. Vol. 1. Etude générale. OAA, Rome (1980).

The performance of the mother (reproductive performance, growth) is also taken into account to discriminate between the candidates for reproduction.

5. GENETIC EFFECTS OF THE CENTRE ON THE REGIONAL AND NATIONAL N'DAMA POPULATION

It is possible to evaluate1 the genetic gain on mean daily growth which will be obtained if the herd of the Centre is reared according to Figure 1. The genetic improvement on growth and size is very low compared to the progress which can be done in 3-4 years, only by deworming campaigns (see Table 1).

It is obvious that such a project requires the confidence of the farmers. For different reasons, it may be difficult to get this confidence back.

6. A REGIONAL COORDINATION OF THE SELECTION, MULTIPLICATION AND EVALUATION ACTIVITIES OF THE N'DAMA BREED MUST BE SET UP

This breed can be found in 12 African countries. Nine of these countries represent 98.6 percent of the whole N'Dama population (see Table 2). The Boké Guinean project for selection and multiplication of the N'Dama could play an important part in the set up of this regional coordination, if it is a success. Technical institutes such as ILCA, economic and political organizations such as the Commission Economique des Etats de l'Afrique de l'Ouest have a part to play, too.

IMPROVEMENT, MULTIPLICATION AND CONSERVATION OF TRYPANOTOLERANT CATTLE BREEDS

C. Hoste1

1. INTRODUCTION

The trypanotolerant cattle can be divided into two main groups: the N'Dama and the West African Shorthorns. The latter group can be subdivided in terms of overall size into Savanna and Dwarf Shorthorns. The N'Dama can be considered as a single breed but in each group of the Shorthorns different breeds can be found.

The ILCA/FAO/UNEP study (ILCA 1979) has estimated the numbers in these groups as: 3.4 million head for the N'Dama; 1.7 million head for the Savanna Shorthorn and 0.1 million head for the Dwarf Shorthorn. Numbers and economic interests are quite different for each group. Therefore even if the improvement and the multiplication of each breed is desirable, present priorities for breeding plans are (or should be):

- improvement and multiplication for the N'Dama
- multiplication and conservation for the Savanna Shorthorn
- conservation for the Dwarf Shorthorn.

2. IMPROVEMENT AND MULTIPLICATION FOR THE N'DAMA

Improvement of the productivity of a breed can be undertaken either within the breed through selection or by crossbreeding operations with "improved" breeds. But even in that case, it is necessary to start with a good basic herd, which also implies selection of the pure breed. Results of both policies will successively be reviewed and some proposals made for the N'Dama breed.

2.1 Selection

Selection of the N'Dama can be done with two rather different approaches: the improvement of productivity at the national level or the production of breeding groups which are representative of a certain phenotype for export. Undoubtedly the first objective should be the priority because it leads in the long-term to food self-sufficiency. In reality an inversion of priorities is seen with the implementation of improvement and multiplication centres for a certain type of N'Dama rather than for the N'Dama breed as a whole.

Selection for the "typical" N'Dama is usually the responsibility of research stations. This choice should be reconsidered for several reasons:

- Research stations have rather small areas (a few hundred hectares at the best) and numbers of cattle for breeding are rather small (a few hundred head). Genetic variability and consequently selection efficiency are limited.
- Research stations tend to intensify the environment (fodder crops) to increase their cattle population. In addition, stations are usually considered as show-windows of the country and animals must be in good condition. Therefore they are bred more and more artificially. Results are apparently satisfactory but miss the main objective, because improved animals become totally unadapted to the commercial environmental conditions in which they will have to live and reproduce.

Therefore selection cannot be efficiently done in stations but should be carried out by large multiplication units using a breeding system which is much closer to the natural conditions. To be viable and efficient these units should have a minimum of 3 to 5 thousand head.

It is essential and crucial to implement a selection programme which can be applied by all the multiplication units. This programme must be simple, efficient and easy to implement. Several organizations (such as FAO, ILCA, IEMVT) have certain experience in this field, but they used different schemes. As no irreversible choice has yet been taken, it is vital to plan a meeting to present and discuss the different selection programmes. The final result should be a united decision on the scheme to be adopted; or at least to agree on a minimum package of information to be collected in each situation. That will lead at a later stage to the definition of a standard of the N'Dama breed.

The management of these multiplication units should be based on extensive grazing with natural pastures. This is vital. The success of ranches is directly linked to bush control, the increase of good natural fodder species, the availability of good pastures all the year round, etc. All of this implies a strict fire policy and rotation of herds on the different pastures. A workshop on this subject should also be organized or could be joined with the one on selection programmes.

2.2 Crossbreeding

Nearly all research stations or national organizations which were in charge of the improvement of the N'Dama breed were tempted into crossbreeding with exotic and mainly Euopean breeds. N'Dama crossbreds have been produced with:

- Charolais and Friesian in Bissau Station in Guinea Bissau,
- Krasnaya Steppnaya, Jersey, Ayrshire and Holstein in Guinea,
- Sahiwal in Teko Station in Sierra Leone,
- Brown Swiss in Liberia,
- Jersey, Krasnaya Steppnaya and Brahman in Sotuba in Mali,
- Jersey in Bouake and Abondance and Fleckvieh in the North of Ivory Coast.

Most of these programmes have stopped because, while crossbreds usually survive on stations (usually with many problems), they have never been successfully distributed outside these favourable environments. Crossbreeding programmes cannot be encouraged, but on-going operations should be carefully monitored.

2.3 Role of Research Stations

If the research stations were no longer in charge of selection programmes they would still have a preponderant role to play in the improvement of the N'Dama breed.

In traditional environments they have to work out the methodology of data collection and to study with a multidisciplinary approach all the constraints to the livestock development systems; they can also participate in data recording and assist in data analyses.

Within stations, with their own cattle, scientists should study the different parameters which can increase productivity in different environments, such as weaning time, dipping and/or deworming frequencies, feeding regimes, reproduction cycles, sperm collection, dilution and conservation, etc.

3. MULTIPLICATION AND CONSERVATION FOR THE SAVANNA SHORTHORN

Substantial populations of the Savanna Shorthorn are still found in Ghana (616 000 head), Upper Volta (484 000 head) and Ivory Coast (250 000 head). These three countries have more than 80 percent of the total Savanna Shorthorn population.

The main problem for these breeds is crossbreeding with zebu which is widespread. Measures must be taken urgently of substantial numbers of pure breeds are to be preserved. The best justification for doing this lies in the high productivity figures shown in the ILCA/FAO/UNEP study (1LCA 1979).

Two different types of action can be undertaken to face the problem:

- to convince national governments of the value of the local breeds kept as pure breeds. Then, when they are convinced, to assist them in the implementation of breeding policies to limit anarchistic crossbreeding;

- FAO and UNEP should start immediately an appraisal study for a livestock development project through inter-country (Ghana, Upper Volta, Ivory Coast) cooperation, based on local breeds and including a multiplication centre of the pure Savanna Shorthorn (named Ghanaian Shorthorn in Ghana, Lobi in Upper Volta and Baoulé in Ivory Coast).

In this group, only two breeds are in real danger of extinction or absorption: the /?/oayo and Kapsiki breeds in Cameroon. In spite of recommendations made since 1978 no conservation measures have been taken and it seems that at present it is too late to take action. Including the Bakosi breed, this makes a total of three breeds extinguished in Cameroon in the last ten years. Certainly, these places should be visited in the near future to decide if these names have to be finally scratched from the maps.

4. CONSERVATION FOR THE DWARF SHORTHORN

With only 1 percent of the total trypanotolerant population, the Dwarf Shorthorn group is the one most in need of conservation measures.

Fairly large populations still remain in Nigeria (38 000 head), Benin (20 000 head) and Liberia (15 000 head) but are under heavy pressure from both N'Dama and zebu. Conservation measures, combined with improved utilization, should be directed towards these larger groups.

However, as these populations live in small and relatively isolated pockets, it is much more difficult to propose inter-country cooperation for the conservation of these breeds than for the Savanna Shorthorns.

In Nigeria many state farms exist and one of them could easily be devoted to the Dwarf Shorthorn (named Forest Muturu). The Pota ranch in Lagos State which is located in the Forest Muturu area would be the ideal place. If the purebred Muturu herd could be kept under the same management conditions as the N'Dama or crossbreeds and individual recording reinstated, that would permit good and very interesting comparative studies.

In Benin a case study has been undertaken by ILCA (Lazic 1978) and results indicate that in terms of productivity, the Lagune breed (Dwarf Shorthorn) is superior to the Borgou (stabilized cross between Savanna Shorthorn and zebu). This should encourage the livestock development projects in that area to keep a large herd of pure Lagune.

In Liberia, like in Nigeria, a state farm should be devoted to the breeding of the Liberian Dwarf and the N'Dama to allow comparative studies and preserve large numbers of the Dwarf Shorthorn. A ranch has already been identified by Mason (1982).

5. CONCLUSION

Actions for the improvement, multiplication and conservation of trypanotolerant cattle breeds are rather well defined.

The problem is that most of them are urgent and have already been mentioned in the ILCA/FAO/UNEP study in 1979, but nothing has yet been undertaken in these lines. Consequently, the extinction of two additional breeds has occurred; also more and more difficulties will be encountered to initiate conservation measures for the others.

The recommendations of this meeting should be strong enough to be followed by programmes in the field.

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SUDANESE INDIGENOUS CATTLE BREEDS AND THE STRATEGY FOR THEIR CONSERVATION AND IMPROVEMENT

A.H. Osman1

1. INTRODUCTION

1.1 Sudan Animal Wealth

The Sudan is predominantly an agricultural country with a large livestock fund estimated at about 18 million head of cattle, 30 million sheep and goats and 2.6 million head of camels. The livestock population compared to the human population is as follows:

Year	Total animal units thousands	AU/Human
1977/78	25 044	1.51
1978/79	26 332	1.55
1979/80	27 961	1.58

Animal Unit (AU) equals one cow or its equivalent.

In spite of this large animal population there is a shortage of milk and dairy products in many parts of the country. The *per capita* consumption of milk and dairy products is estimated at about 38.8 kg liquid milk, 3.8 kg cheese and 0.8 kg (clarified) butter. The total amount of meat produced annually is 700 thousand tons. Though lamb and mutton is the meat of choice for most Sudanese and represents 20 percent, beef represents about 70 percent and goats and camel meat represent about 10 percent of the total meat consumption. The Sudan exports annually about half a million head of sheep to the Middle East countries.

1.2 Physical Environment and Climate

The Sudan is a vast country with an area of about 2.5 million square kilometres extending over 18 degrees of latitude (4^0 N to 22^0 N) and hence displays a great diversity of climatic conditions. Parallel to this, the country also exhibits great variation in soil types. The interaction of these two factors created various ecological niches which affected in many ways the people and their animals. The flow of the Nile and its tributaries throughout the entire length of the Sudan from south to north adds further variation and amelioration of the environment.

According to the annual precipitation, which is the most important single factor, the Sudan may be divided into three main ecological zones: the arid (north of 16^0 N), savannah (10° - 16°N) and the tropical forest swamps south of the 10th parallel.

For most parts of the country (except the extreme north and extreme south), the climate is characterized by long dry summers and a very short rainy season (July-September). Summers are very hot with mean maximum temperatures rising several degrees above mammalian body temperature. The rains are erratic and consequently there is tremendous fluctuation in the feeding and nutrition of livestock in the different seasons and years. Livestock depend on natural grazing and crop residues. The pattern of animal husbandry is mainly nomadic.

The animal health situation is far from satisfactory. Besides nutritional diseases resulting from seasonal malnutrition, many endemic diseases affect both cattle and sheep. Tick-borne diseases like theileriasis, cattle infectious diseases and trypanosomiasis still prevail in some parts of the country.

2. CATTLE BREED TYPES

According to origin and physical characteristics, the cattle of the Sudan can be classified into two main groups viz. Northern Sudan Shorthorn Zebu and Nilotic cattle in southern Sudan. The older of the two main groups is undoubtedly the Nilotic which is to be classified as "Sanga", a cross mainly derived from the longhorn humpless and the longhorn zebu which infiltrated from Asia into Africa in dynastic times.

2.1 Northern Sudan Shorthorned Zebu

This group includes the following distinguishable breeds: Kenana, Butana, Baggara. All of these breeds are predominantly raised by nomadic tribes in central Sudan. Because of some common grazing areas some admixture of blood is seen in some herds.

Kenana:

This breed is named after the Kena tribe who inhabit the western bank of the Blue Nile. Kenana and Rufaa El Hoi are both semi-nomadic tribes who raise Kenana cattle. The colour of the breed- is light grey on the body, while the head, neck, shoulders, legs and tails are usually black. The calves are born red and change colour gradually to light grey at three months of age. The hump is large, the dewlap is pendulous and the horns are short. The home of the breed is mainly between the White and Blue Nile almost up to Khartoum. For details of production traits see Appendix.

Butana:

This breed is named after its homeland, the Butana plain of central Sudan which lies between the Nile, River Atbara and the Blue Nile. The area is composed mainly of non-cracking clay with few seasonal rivers some of which drain into the Nile. It is mainly grazing land for sheep, camel and cattle nomadic tribes.

The colour of the breed is solid red, with some black on the mouth, eyes and some joints. Both in size and production characteristics, it resembles the Kenana breed (Appendix).

Baggara:

The name of the breed "Baggara" means cattle herders. This breed is found in western Sudan and is raised by nomadic tribes in Darfur and Kordofan. Its homeland is the savannah belt of central Sudan.

It represents the majority (about 80 percent) of the northern Sudan shorthorn zebu cattle. The breed shows great diversity of colour but has mainly dark colours. The horns are short and the dewlap is large. For production see Appendix.

2.2 Nilotic Cattle

These are the cattle of southern Sudan. The whole area is a flat clay plain sloping very gently from southeast and southwest towards the main river channels. During river flood the whole area is inundated for about six months annually. The area is infested with biting flies which necessitate cattle housing at night.

Nilotic cattle are nondescript, with medium body size, large horns and the hump is muscular and cervical to cervico-thoracic in position. These cattle have very low milk production potential.

3. GENETIC IMPROVEMENT PLANS

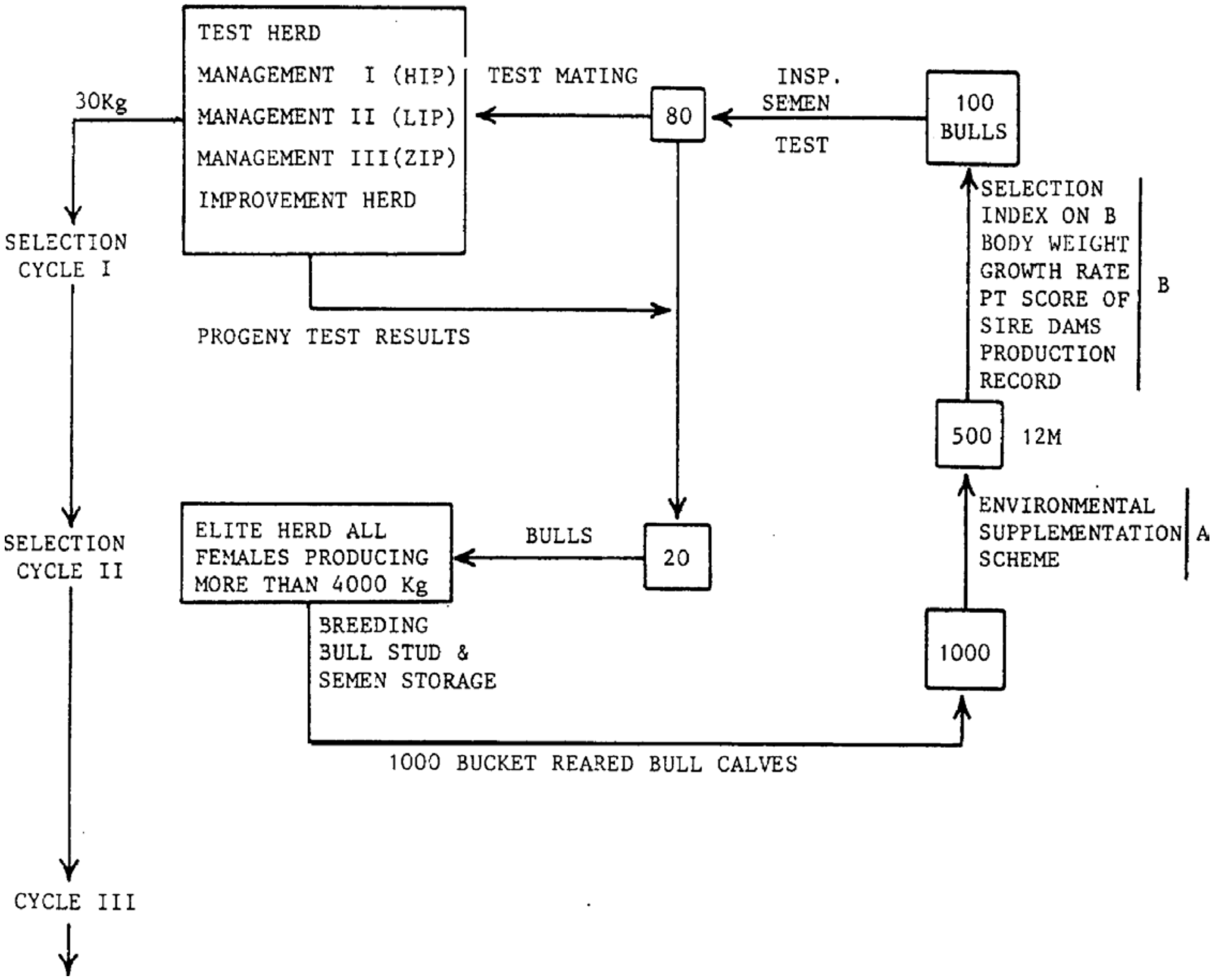
3.1 Conservation and Within Breed Selection

Early attempts at conservation and improvement of indigenous cattle breeds were conducted in 1940 (Boyns 1947) when a total of 223 Butana cattle were purchased from nomads and put in a government farm where good feeding, management and selection were practised. The results of this endeavour were very encouraging: thirty-two cows of this herd averaged more than 2000 kg in such a short period.

A similar herd of Kenana cattle was established in Medani Agricultural Experiment Station.

Shortly after independence in 1956, the Sudan Government established two more livestock experiment stations viz. Urn Benein for Kenana cattle and Ghazal Gawazat for Baggara cattle. While Kenana and Butana cattle were recognized as dairy breeds and selected mainly for this purpose, Baggara were selected mainly for growth rate and beef production.

A further development in animal breeding is the establishment of Kuku Research Centre in Khartoum North, with relatively good feedlot and meat laboratory facilities as well as a nutrition laboratory and poultry unit.



The results of selection for milk yield in institutional herds were as follows:

Farm	Breed	Milk yield genetic gain/year	h2
Medani1	Kenana	0.74	24
Atbara2	Butana	0.70	30
University3	Mixed (indig)	0.58	36

References:

1 Alim (1960);
2 (1962);
3 Osman (1970).

The institutional herds succeeded in preserving and maintaining few purebred Kenana and Butana herds, but due to their small size (about 200-300 cows) not much selection progress can be attained. In addition due to the lack of effective Al and extension services these herds had but little impact on the national herds.

3.2 Using Foreign Breed Resources

Early importations to the Sudan of exotic cattle and their frozen semen are shown in the following tables:

EARLY IMPORTATIONS OF EXOTIC CATTLE TO SUDAN

Year	Imported bulls	Breed	Origin
1925	1	Shorthorn	UK
1927	1	Friesian	USA
1929	1	Ayrshire	UK
1950	2	"	"
1960/61	3	Friesian	"
"	1	Guernsey	"
"	2	Ayrshire	"
1970	2	Friesian	"

IMPORTED FROZEN SEMEN

Year	Doses	Breed	Origin
1976/80	10 500	Holstein/Friesian/Jersey	UK
1981	3 000	Friesian	UK
1981	2 500	Friesian	Finland
1982	10 000	Friesian	Switzerland

The only reliable data on the performance of crossbred cattle is with the Belgravia Dairy in Khartoum. The results of crossbreeding in this farm over a period of about forty years were analysed (Osman and Russell 1974). The reproductive performance of crossbred cattle was satisfactory though inferior to that of indigenous contemporaries. Total lifetime milk yield increased with percentage of European blood to a maximum at 75 percent. High grade cows also had high milk yield per year of productive life, but a shorter productive life and higher death rates and infertility problems.

4. ORGANIZATION OF GENETIC IMPROVEMENT AND CONSERVATION

4.1 Ministry of Agriculture

By and large the Ministry of Agriculture is the main site of animal breeding and development activities. For this purpose, it has established four experimental stations and two AI centres for cattle breeding and development.

Experimental station	Breed	Herd cows	Feeding	Breeding plan
Um Benein	Kenana	250-300	irrigated pastures	selection for milk production
Atbara	Butana	100-150	"	"
Ghazal Gawazat	Baggara	400-500	range	selection for beef production
Shukaba	Crossbred	just starting	irrigated pastures	crossbreeding for milk production

4.2 Other Institutional Herds

4.2.1 University herds

The University of Khartoum has the largest and oldest herd. A foundation herd of about 200 North Sudan Shorthorn Zebu was selected for milk production for about forty years (Osman 1970). More recent development included establishment of a nucleus of purebred Kenana and Butana cattle as well as crossbreeding with dairy European cattle.

The University of Gezira Farm is keeping a herd of Kenana cattle as well as some crossbred cattle.

4.2.2 Belgravia Dairy

The largest farm in the country with European x zebu crossbred cattle is still continuing its upgrading programme which includes the use of other European dairy breeds (Ayrshire, Guernsey) besides Friesians.

4.2.3 Dairy Project in Khartoum

A new development which will have a great impact, at least in Khartoum province, is the newly established Dairy Project in Khartoum with an expected target of about 5000 dairy cows mainly of the Holstein/Friesian, Brown Swiss and Jersey. This project will provide an excellent opportunity for the study of the performance of purebred European cattle and their relative efficiency when compared to the indigenous breeds.

5. STRATEGY FOR UTILIZATION OF INDIGENOUS BREEDS

It is admitted that the indigenous cattle are low producers in terms of milk and meat yield. However, this low production is part of their adaptation to the local environment. In many instances indigenous cattle are also used in farm work and at times walk for several hundred kilometres in nomadic herds. Moreover, indigenous cattle have better resistance against endemic diseases such as tick-borne.

It is to be noted however that the indigenous cattle in view of their number produce the largest portion of milk and meat, therefore any genetic improvement programme, involving crossbreeding or importation of purebred European cattle to the country for replacement of the indigenous cattle, is not only impracticable but also undesirable. The use of exotic stock is at best a restricted activity in certain farms that can afford provision of improved feeding and management conditions not at present available in small farms and nomadic/transhumant herds.

Therefore genetic improvement of the indigenous cattle by selection continues to be the most advisable policy. However, due to the lack of scientific recording resulting from the mobility of herds (nomadic) or the small size of most herds and the magnitude of the expenses incurred under these conditions, the traditional methods of selection involving progeny testing of bulls must be modified to suit the prevailing conditions. The establishment of "nucleus" herds for the Kenana and Butana breeds through the purchase of very high milking cows and the application of embryo transfer may be a worthwhile effort in this connection.

Even though Kenana and Butana are the best milking breeds, while Baggara are mainly for beef production, selection for both milk and growth rates is important in all these breeds. In the former two (Kenana and Butana) a selection index, giving more emphasis to milk and less to growth rate should be applied. In the latter (Baggara) the reverse situation should be applied.

In order to encourage genetic improvement and conservation of the indigenous breeds, the Universities and agricultural and veterinary schools should be encouraged to maintain purebred herds of the indigenous breed of the locality-Genetic improvement and conservation require development of the AI, recording and extension services.

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APPENDIX

PRODUCTION TRAITS OF SUDANESE INDIGENOUS CATTLE

Table 1 REPRODUCTIVE RATES OF SUDANESE INDIGENOUS CATTLE IN INSTITUTIONAL HERDS

Trait	Kenana*	Butana*	Baggara**
Age at first calving, months	42±8	47±11	66±7
Calving interval, months	13.1+3	13.2±2.5	14.9±0.3
No. of services per conception	1.17±3	1.27+0.6	1.25±0.04
Gestation, days	286	290	287

* Kenana and Butana raised on irrigated pastures

** Baggara raised on natural range

Table 2 BIRTH WEIGHTS AND ONE YEAR OLD WEIGHT (kg)

Breed type	Birth weight		One year weight	
	Males	Females	Males	Females
Kenana	23.6	22.1	148.0	138.6
Butana	24.6	23.4	160.0	140.4
Baggara	22.2	20.6	148.4	NA

Table 3 FEEDLOT PERFORMANCE

Trait	Kenana	Butana	Baggara
Daily gain, kg	0.78±0.28	0.8910.20	1.00±0.23
Age at slaughter, months	17.8	11.5	21.8
Weight at slaughter, months	231.8	159.6	274.3
Feed conversion (kg feed/ kg gain)	8.15	6.2	6.44

Table 4 FIRST LACTATION MILK YIELD AND LACTATION LENGTH

Breed type	Farm	Lact. (days)	Milk yield (kg)
Kenana*	Um Benein	251	1 423
Kenana*	Nisheishiba	287	1 204
Butana*	"	242	1 095
Butana*	Atbara	220	1 213
Baggara**	G. Gawazat	244	671

* Kenana and Butana herds raised on green pastures

** Baggara herd on natural range

Table 5 MILK PRODUCTION (kg) OF KENANA CATTLE ABROAD

Year	Young cows		Mature cows		Lact.(days)	Calving int. (days)
1957	1 671	(1)	-		-	-
1958	1 726	(6)	1 543	(1)	305	388
1959	-		2 029	(6)	282	412
1960	-		1 856	(4)	304	412
1961	-		1 540	(3)	305	419
1962	1 508	(2)	2 214	(4)	305	366
Total/ Average	1 671	(9)	1 923	(18)	300	399

NB: In 1956 ten cows and two Kenana bulls were exported to the Livestock Experiment Station, Entebbe, Uganda. Ref. ABA (CAB). Annotated Bibliography No. 107.

BREEDING PLANS FOR IMPROVEMENT OF INDIGENOUS BREEDS AND SPECIES

P.N. Bhat1

SUMMARY

This paper discusses the strategies for preventing the loss to posterity, the fruits of thousands of years of natural and artificial selection of indigenous breeds and species through conservation by effective management and improvement. The need for conservation of indigenous breeds and species has been discussed and the breeds and species in danger of extinction indicated. The systems of husbandry and management under which these exist at present have been outlined. The available inputs for schemes of conservation have also been outlined. Breeding plans for improvement of indigenous breeds and species have been indicated. It has been shown that the current genetic improvement programmes in existence today involve either within population selection of indigenous breeds or a scheme of crossbreeding with improved germplasm. A number of genetic designs have been suggested for improvement. Earlier designs have been reviewed. Operational breeding plans for improvement of indigenous breeds of cattle like Shaiwal, Hariana and Jamnapari goats have been detailed. Similar plans for buffaloes and sheep have been discussed. It has been shown that for implementation of any breeding plan for improvement of indigenous breeds, it is necessary that the inputs should be available in their entirety at the very start.

1. INTRODUCTION

The growth in human population and man's interference with natural ecosystems has accelerated the pace of extinction of species and of genotypes within species. According to the estimates of the International Union for the Conservation of Nature and Natural Resources (IUCN), on an average one animal species or subspecies is lost each year. Since 1960, more extinctions have occurred than during the period from 80 AD when the extinction of the European lion was recorded. About 1000 birds and animals are now believed to be in jeopardy. Highly specialized adaptations resulting in a narrow genetic base could lead to an evolutionary blind alley and thereby ultimate extinction.

While the need for arresting species extinction is urgent, there is even greater need for preventing the loss to posterity, the fruits of thousands of years of natural and artificial selection through inadequate efforts in conserving genetic variability within the species. Asia has immense diversity of genetic resources in respect of animals and birds but these are fast vanishing because no systematic effort has been made in the past to conserve them. This is a gap which needs to be filled on a. priority basis. Due to large variation in the soil, climate and plant combinations in various parts of Asia, a large number of breeds and types of domesticated livestock and birds have evolved over a period of many centuries. These breeds have considerable adaptability to local environments, possess good resistance against certain diseases and are eminently suited for economic purposes in their areas of origin. It is well known that the breeds of livestock and poultry which have been evolved in the region are well adapted to the tropical heat and diseases.

According to the FAO Yearbook (1978) a resource inventory of these countries shows that about 1.8 billion people live in the tropics, out of which one billion depend on agriculture and forests for their livelihood, on a land area of 5.4 billion hectares. Out of 1.4 billion domestic livestock excluding poultry, there are 618 million cattle, 8.3 million buffaloes, 120 million pigs, 357 million sheep and 256 million goats. In spite of such large resources of renewable protein and carbohydrates the human population of this region cannot be properly fed on these animals; they suffer from serious shortages of protein, and general malnutrition. This is a paradox; in spite of these large numbers of farm animals they cannot produce sufficiently to feed the human population. The gap between availability and demand is primarily a result of bad management of these vast animal genetic resources.

Experimental evidence has proved that zebu herds of cattle have lower metabolic heat production which suits them well in the hot climate and make them comparatively better utilizers of low grade roughages available in the tropics. For these traits the Indian breeds of cattle have been in demand for crossing for evolving more adapted breeds of cattle in the Latin American countries, in Australia and the warmer regions of the USA. Purebred herds of zebu cattle like Gir, Kankrej and Sahiwal are found in Brazil, West Indies, Australia, Kenya, etc. The zebu breeds have helped to produce high yielding beef cattle like Santa Gertrudis, Brahman, Brangus and Indo-Brazil. These have also served as a base for evolving new breeds like Jamaica-Hope and Australian Milking Zebu (AMZ). In Australia, zebu breeds have been valued for their resistance to tick infestation and for their heat tolerance.

Little effort has been made on evaluation, conservation and improvement of available genetic resources of indigenous livestock. Such an effort must be made without any loss of time. Some of the breeds have extremely limited breeding tracts, are of relatively little economic value currently and for various reasons are fast declining in numbers; efforts to conserve, multiply and improve them must be made. For example populations of Sahiwal, Red Sindhi and Tharparkar cattle in India, Toda and Ganjam breeds of buffaloes, Mandya, Magra, Hissardale and Nilgiri breeds of sheep, Jamnapari and Barbari breeds of goats have declined seriously and would deserve immediate attention.

Most developing countries are embarking on large-scale animal improvement programmes often accompanied by the introduction of high yielding breeds from temperate zones with a resultant decline in the number of local livestock types. The latter have, through natural and artificial selection, developed characteristics which made them well adapted to the often harsh environmental and climatic conditions. It is, therefore, important that this valuable genetic material be used in the building up and improvement of the national livestock resources. Ways and means must be found by which rapid genetic progress may be made through intensive selection and/or the introduction of breeding material from outside without jeopardizing the genetic adaptation to environment and nutritional condition.

Before the advent of fossil fuel, animal energy was the only source of farm power. This came mainly from bullocks and a number of cattle breeds had to be specifically developed for this purpose. India thus possesses the best draught breeds of cattle in the world today. It has been estimated that a bullock is capable of generating on an average half a horsepower of energy. The bullock population in India alone generates 36 million hp, equal to approximately 27 138 MW of electric power. The total installed capacity of electric energy in India is around 26 000 MW. It has been estimated that two thirds of the energy input into our farm operations comes from animals, a renewable source of energy. Of the rest 15 percent comes from human exertion, and only 10 percent is derived from other forms of energy like fossil fuels (petroleum and coal) and hydro power. This would indicate that renewed effort should be made not only in conservation of the different draught breeds of various species of livestock available in Asia but also on their multiplication and further improvement.

Barring a few attempts at evaluation mainly connected with animal improvement programmes there has been very little real awareness of the resources we possess, or appreciation of the dangers they face. The wealth which has been gifted to us by our ancestors and nature needs to be carefully managed. In our legitimate concern for assuring animal products for today we should not forget to conserve and manage resources for the benefit of our future generations.

There are two major problems which are relevant today as far as animal genetic resources utilization is concerned; one is that of breed displacement through crossbreeding and another and more serious one is that of dilution and negative selection from urbanization as in the case of the Indian buffalo. It is not possible to preserve all the breed populations. Conservation primarily for reasons of their genetic uniqueness or their beauty or their history are reasons which cannot support conservation effort in under developed or developing countries. The only possible method of conservation is through proper management through scientific improvement programmes of the indigenous livestock, so that these breeds or species which have innate adaptable merit can stand on their own under harsh environment.

2. SYSTEMS OF HUSBANDRY AND MANAGEMENT

In large parts of the developing world animal husbandry is a normal adjunct to crop agriculture and animals are kept as a source of power for farm operations, transportation, irrigation and production of manure. They are generally maintained on crop residues and byproducts of agriculture for milk, meat and wool. The bulk of animal rearing is done by small and marginal farmers and landless agricultural labourers with land holdings of 1/4 to a hectare. This kind of input is available in most of the Asia and Oceania region. In parts of the Middle East, North Africa, parts of Latin America and Southern Asia large land holdings are also common. Size of holdings and total inputs available are rather small. Governmental improvement programmes are fairly clearly drawn out with respect to breeding structure but the implementation of these plans and programmes suffers due primarily to lack of inputs in either technology or finance or both.

In some of these countries an institutional structure funded by the government also exists which maintains herds of livestock as nuclear or multiplier herds and for research and training in various colleges and universities. Some countries have large farms run by the government for commercial production of milk like military dairy farms in India and Pakistan and national livestock farm complexes in Iraq and Egypt. These are also used for spreading superior germplasm to the rural population for improvement of their stock. This is primarily the structure available on which any breeding plan has to become operational.

3. BREEDING PLANS

Why should the indigenous breeds or species be improved The reason is obvious, because a high proportion of total human food requirement is produced by these animals, they are adapted to village or small farmer conditions, they utilize low quality feeds, crop residues and human waste and thus have low energy and low economic inputs, they provide an important source of income and work to the villager and small farmers who are under employed for most parts of the year. The indigenous breeds have developed an adaptation to the environment (climate, system of husbandry and health and input level which are generally low) which enables them to produce and reproduce where exotic breeds have serious survival and reproduction problems (Bhat 1981a).

Bhat (1977; 1981a) has detailed the kind of indigenous breeds available in large parts of the Asia and Oceania region and their production potential. He concluded that the levels of production and reproduction were relatively low when compared to improved breeds of Europe and North America. The total intake nutrient levels were, however, low and the survival was superior. Under certain environmental situations (foraging, supplemented by kitchen waste) the improved exotic breeds had genotypic value of zero for most production traits.

A number of critical gaps were observed from the information available on evaluation. The data were inadequate, being either incomplete, based on small numbers of animals or based on inadequate definition of traits and environments. A comtemporary comparison of indigenous breeds under a given environment has never been attempted. Consequently it is very difficult to even guess what would be the kind of ranking of various breeds within a region. One can only draw very general conclusions because of the lack of properly designed evaluation studies which could lead to specific recommendations with respect to breeds/species and regions. It is therefore necessary that the breeding plans should involve such comparisons under various agro-ecological conditions so that our data base is widened and proper breeding designs can be developed. Two conclusions which can, however, be drawn with some quantitative vigour are:

i. that large variability exists in most economic traits;

ii. the selection experiments wherever undertaken have given genetic gains of 1.5 to 5 percent of the herd average.

Most genetic improvement programmes in existence today, are those which involve the basic genetic hypothesis that if an inferior genotype is crossed with a superior one and continuously backcrossed, it would lead eventually to a locally adapted purebred. This is the main plank, in those countries whose investment in animal husbandry is limited by the financial constraints. In some of the oil rich countries this policy has been supplemented by a large transfer of temperate dairy cattle from Europe and America. Similar approaches have also been adopted by a few South Asian countries. All these policy decisions have been based on research findings in animal breeding and genetic improvement in the temperate and developed countries.

There is no method currently known for measuring genetic improvement or the deterioration in populations which have neither been recorded for the performance nor subjected to any organized effort at selection. Most programmes of genetic improvement through crossbreeding have been haphazardly drawn and poorly implemented and crossbreds are produced without any clear breeding plan. In many areas of the world this technique has raised more problems than it has tried to solve.

The most important part of this problem is to set up a system which would permit selection within populations. One such system is detailed in Figure 1. In developing the strategies for genetic improvement within these populations, location specific parameters have to be given first preference. The selection scheme should give consideration to input situations which according to me are generally of three types HIP (high input), LIP (low input) and ZIP (zero input). All these three environments exist at the same time and location in most countries, hence the challenge to animal geneticists and breeders is to develop genotypes which will produce efficiently under all these three environments.

A number of genetic designs have been suggested for improvement of indigenous breeds. These are based on either within population selection (Fig. 1) or crossbreeding and within population selection of indigenous breeds (Hickman 1979; Cunningham 1979; 1980) involving crossbreeding and selection programmes together. The essential feature of these plans is to improve the local population from within through selection programmes and/or crossing with exotic strains for a few generations in order to make rapid progress and then backcrossing the progeny to the improved local breed/strain, or to mould the synthetic genotype to the local environment by selection (Bhat 1977; 1981b). Rotational crossbreeding designed to maintain high level of heterozygocity and at the same time achieve specific proportions of indigenous and exotic inheritance or variants of this concept. The reciprocal backcrossing between indigenous and exotic strains which would require selection within the local indigenous population from which sires for crossing would be derived (Cunningham 1980) have also been suggested. Grading up to F_1 males and combination thereof suggested by Hickman (1979) has also been proposed. These breeding plans rely on crossbreeding and exploitation of heterosis to achieve breed replacement or to establish and maintain a combination of two or more strains. They all require an indigenous selection programme as part of the operation.

4. OPERATIONAL BREEDING PLANS

In India we have tried to solve this problem through two different alternatives. One alternative refers to associate herd programmes. This has so far been tried with two breeds Sahiwal and Hariana. The population of Sahiwal breed in various herds is around 3000 breeding females. The herd size varies from 50 breeding females to about 250, spread over a number of locations. Initially three locations were involved. At present about 9 locations are in the programme with a breedable population of about 900 females. Most of these herds had varying levels of inbreeding ranging from zero to about 12 percent. Average milk production in 305 days was about 1600 kg bodyweight at first calving around 320 kg, and the mature weight of 360 kg. The calving interval is 450 days and herd life about 9 years. Most of these herds did not register any improvement in milk over their period of existence. The reasons are obvious. Smaller herd size, use of sires selected on the basis of their dams' records, and conformation, resulted invariably in a negative genetic trend. In two of the herds, one at NDRI Karnal and the other at Lucknow, some of the outstanding bulls were produced and therefore progress in milk yield was observed through these bulls over varying periods. Some of the sons of these bulls which were retained as sires later we found to have a negative breeding value on the basis of their daughters' performance.

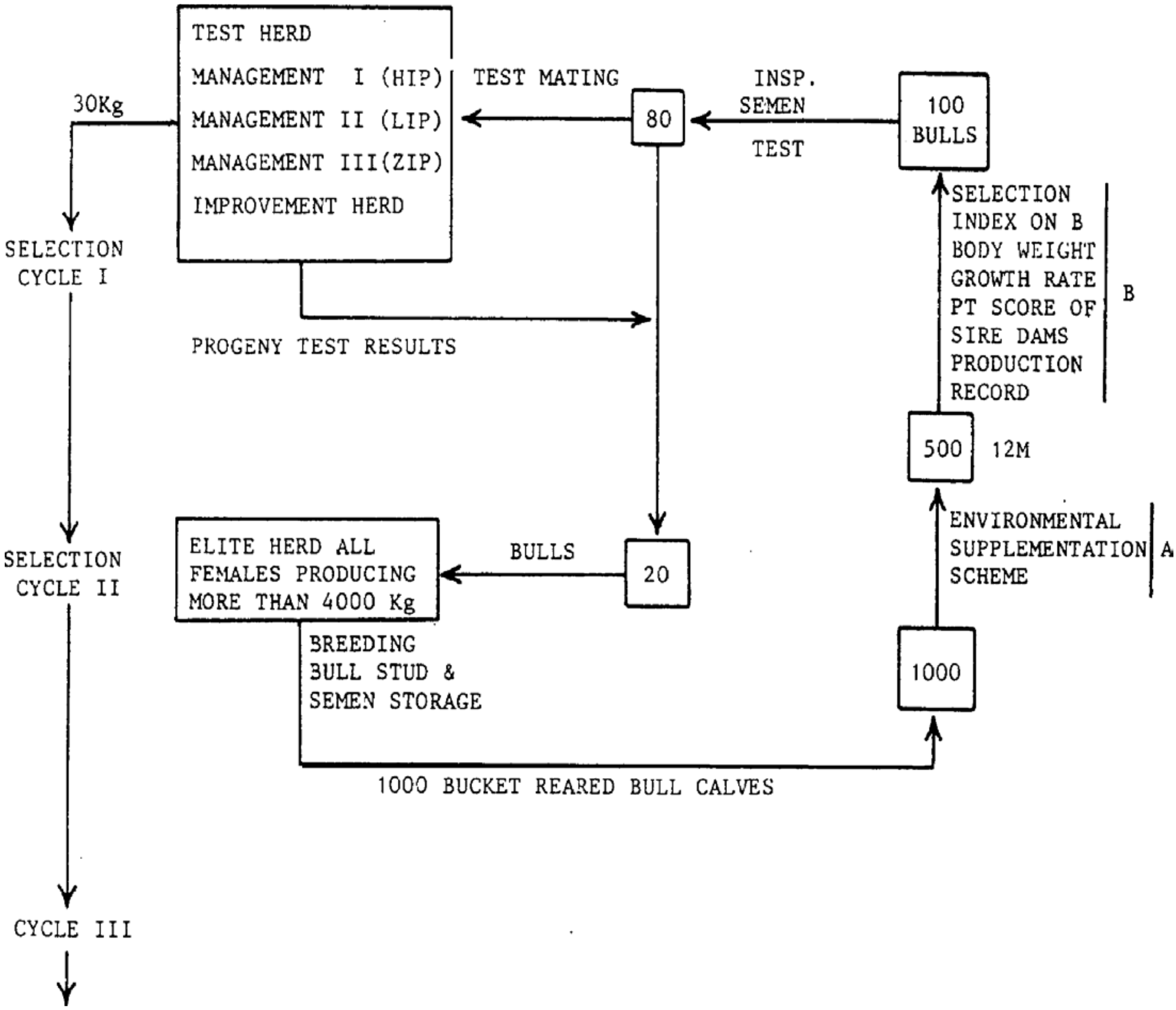

Fig. 1 A breeding plan for genetic improvement from indigenous livestock (cows and buffaloes) foundation population

For the purposes of this breeding plan it was decided that this herd should be treated as one breeding nucleus and out of all the bulls in service in 1980 based on their progeny, dams' and sisters' performance, six bulls were selected for breeding whose semen was frozen and distributed among these 8 herds. Another set of 13 young bulls was also selected out of which another six bulls would be selected on the basis of their growth performance and semen test. These six will become the next set of six sires to be tested. This programme is now in its third year of operation and the breeding plan involves progeny testing of a set of the six bulls and their subsequent ranking and selection of the two best bulls for nominated matings and improvement. After the first cycle it is hoped that every year two bulls would become available whose estimated genetic merit would be around 20 to 30 kg over the herd average. These bulls will then be used on Sahiwal pockets in the country or outside.

A similar but much larger programme has been finalized for the Hariana breed. Hariana is the most important cattle breed in India and is widely used in the Indo-Gangetic plains as a dual purpose (draught and milk) animal. This programme initially involves six breeding farms with a total breedable population of 1500 females. The major aim is to conserve the Hariana breed through its improvement in draught quality and milk yield. The programme involves 20 bulls whose semen will be frozen and distributed to all the farms and efforts will be made to have all the 20 bulls available at each farm. The workability and work efficiency of these 20 bulls will be taken into consideration for selection. As soon as the programme gets well set, the herds of small land holders' and breeders' herds under the Central Herd Registration Scheme operational in districts of Rahtak (which is the breeding tract of the Hariana breed), Ajmer, Mahendargarh and Bhiwani, 10 000 cows registered under this scheme will be involved in progeny testing through field recording and subsequent selection. It is proposed that 25-50 percent breedable cattle population of the herds will be used for this scheme. For selection of young males for further breeding 5 sons of each sire will be selected at random and tested for draught capacity at the age of *2 1/2* years using a draught capacity index.

The Indian Council of Agricultural Research (ICAR) considering the importance of conservation and improvement of indigenous breeds of cattle has sanctioned an All India Coordinated Research Project (AICRP) on improvement of indigenous cattle breeds. This project is to involve three major milk breeds, three dual purpose breeds and three draught breeds in this programme. This project will use within population selection based on milk and work for improvement. This project will be initiated within this plan period and two institutional programmes discussed above will also be coordinated through this project. The project will introduce selection criteria based on milk production survivability, disease resistance indicators and measures of work efficiency.

Under the development programmes of various states the well defined indigenous breeds like Hariana, Gir, Kankrij, Ongol, Nagor, Rathi are being improved through the use of semen of selected bulls. No crossbreeding is permitted in these tracts.

Similar programmes for improvement of indigenous breeds have also been taken up in Syria with Shami cattle and goats, with trypanotolerant cattle in Africa and zebus in Kenya.

5. BUFFALO

The buffalo is the most important milk, meat and draught type animal of the tropics. It has received least attention. The main components of low productivity of buffaloes are (i) delayed age of maturity and first calving; (ii) long calving interval; (iii) short lactation; (iv) low average milk yield. Any attempt to increae the productivity of indigenous buffaloes must, therefore, be concerned with some or all of these component traits. Estimates of genetic variability of these traits do indicate the possibility of improvement through suitable methods of selection and breeding programmes. Progeny testing of buffalo bulls and intense selection of suitable breeding females are the only ways which lead to rapid genetic improvement in milk yield and other desirable characteristics.

Considering a heritability of 8 percent for milk yield in 300 days and different selection intensities (culling at 10, 20, 30 percent of the herd), the improvement (G) will be as follows:

Rate of Genetic Improvement

% culled	i	h^2	p	ΔG per Generation (kg)	ΔG per year (kg)
1	0.195	0.08	600	9.4	2.4
20	0.340	0.08	600	16.3	3.2
30	0.498	0.08	600	23.9	4.8

p will vary from herd to herd depending upon the variability in the population for milk yield. The variability in the population for milk yield for nondescript buffaloes is rather high. With the selection intensity of 0.50 which is rather high for buffaloes where calf mortality is also high, it will take around 250 years to double the milk production in a herd with an average lactation yield of 800 kg. Much quicker results in the improvement of milk production, reduction in age at maturity, improvement in breeding efficiency, and economics of milk production have to be obtained if buffaloes have to survive as milch animals vis-à-vis crossbred cows.

A Breeding Plan for Buffalo

The important steps which need to be taken to break the yield barriers in buffaloes are:

i. Large buffalo breeding farms of at least 1000 adult units should be set upwhere a minimum of 30-40 bulls can be progeny tested in sequential order, and the females selected on the basis of an index incorporating traits of growth, reproduction and production.
ii. The information needed on distinct breed differences for characters of production is not available which makes a definite recommendation with regard to any breed improvement difficult. However, crosses between breeds may be attempted to develop new strains breeds by incorporation of genes from different sources.

The second method of attaining this goal with much less expense is to create bull farms in all cities having a buffalo population of 10 000 and above, and tie these together so that the buffaloes can be registered, branded and then regularly given sexual health control help. Using the nominated bulls from the breeders herds on this population and then recording progeny for growth, production and reproduction could be undertaken regionally or centrally so that bulls could be progeny tested and better females selected. This programme could be more vigorously implemented in milk colonies and cooperatives established by various State Governments or private organizations.

The facilities for freezing the buffalo semen should be generated forthwith and semen banks created and an intense programme of progeny testing of the bulls at village level be introduced. The recording of daughters should be the responsibility of an independent agency.

In recent years, reproductive physiologists have devoted much attention *to* methods of augmenting fertility of animals with multiple ovulation and embryo transfer (MOET). There are a number of methods by which MOET can be utilized in buffaloes. In the context of Figure 1 it will be observed that even if the infrastructure and the resources could be found to test 400 bulls out of which 40 could be used for propagation, a genetic improvement of 1 to 11*/2* percent is all that can be hoped for in milk production. If this needs to be increased to 3 percent, this innovation (MOET) offers the only possibility.

It is necessary that an intercountry action programme, for its improvement, be initiated for improvement in meat, milk and draught.

6. IMPROVEMENT PLANS FOR INDIGENOUS BREEDS OF SHEEP

Indiscriminate crossbreeding during the last few decades has endangered a few important indigenous breeds, e.g. Guraz, Karnah, Gadi of J&K State, Magra, Pugal and Chokla breeds of Rajasthan. The major reasons for serious reduction in numbers are difficulties of climate, insufficient attention to the development of feed and water resources in their home tracts. The number of animals of Mandya breed of Karnataka is also fast coming down because most of the land in its home tract has been brought under irrigated cultivation. Due to high incidence of cryptorchidism resulting from selection for meaty conformation known to be related to this condition has also caused some reduction in numbers. There is no major programme for conservation of these breeds. The programme involving cooperation among breeders and development of a nuclear farm for these breeds created from selected male and female from the cooperating flocks is to be used for selection of superior rams. State departments are establishing large stud farms where within population selection will be practised and such rams will be distributed to the breeders' flocks for improvement.

The Indian Council of Agricultural Research is in the process of considering establishment of an All India Cordinated Research Project on Carpet Wool Production using selection within indigenous breeds as a major instrument to attain the goal of producing better carpet wool breeds. This coordinated project will involve a large number of indigenous breeds whose numbers are fast declining and are in danger of extinction. It is hoped that this will act as a focal point of action and other associated activities like establishment of cooperative breeders' flocks and state farms will take care of rejuvenation of these flocks.

7. BREEDING PLANS FOR IMPROVEMENT OF INDIGENOUS GOAT BREEDS

A number of important indigenous breeds *of goats* have shown a decline in numbers. Two of these breeds Jamnapari a good tropical milch breed and Barbari are in serious danger of extinction. It is reported that only 5000 animals of the Jamnapari breed exist at present in its purist form. Major action programmes need to be taken to conserve these two breeds. Apart from the normal channels of slaughter these two breeds are in great demand for export to other states of the Indian Union and to various countries of southeast Asia. The number of animals going out of the breeding tract is not keeping pace with the numbers of animals being raised.

The Central Institute for Research on Goats (CIRG) has therefore started two major flocks of these two breeds, each comprising 300 females and followers. These two nucleus herds have been established at the main campus of the institute. A comparative breeders society has been established in the breeding tract of the two breeds. The breeding plan envisages selection of 10 sires in each breed selected on the basis of their own performance with respect to growth and the relative performance for milk yield, and subsequently on the basis of daughters' performance for growth and milk yield. The frozen semen of these sires will be used on the breeders' flock for improvement. This programme will be conducted for 7 generations. The recording of milk and body weights in the breeders' flock will be done by the staff of the Institute. The Government of Uttar Pradesh, the state in which the breeding tracts of these goat breeds are located, is establishing a large farm in the breeding tract of these two breeds.

8. CONCLUSION

Among the Indian breeds of horses, there has been a gradual and progressive decline in almost all breeds but in the case of Zanskar breed the decline has been very sharp. In order to take up effective measures of conservation, ICAR has established a National Centre for Horse Breeding. Similarly a national centre on camels, Mithun and yak has also been established to undertake work on conservation of these species. The National Bureau of Animal Genetic Resources is concerned with identification, evaluation and conservation of the animal genetic resources and is to act as coordinating agency for national and international programmes.

Breeding experiments are generally of long duration and a system where paucity of trained animal breeding scientists makes it imperative to induct people from related disciplines in the project.

Many of the breeding experiments suffered from dilution of the objectives. Consequently the pressure on genetic component gets diluted and other issues take priority.

Most of the research projects even of applied nature had to perforce be modelled on structure of developed countries and many were also manned by scientists trained in developed countries, the gap between developed and developing countries in their application of research in animal production is nearly 100 years, at least in large livestock whereas the first and foremost necessity was to gather factual data on the resources available and make use of proven technology. A large outlay on experiments which are not even relevant was made with technologies which had neither been proven nor had any relationship with the social milieu in which it had been applied.

Information on the productivity of various livestock species in the developing countries under the environment in which these are raised is generally lacking. The concept of herd recording has not been initiated in most of these countries.

The gap between research and development has been widening. The research workers have been able to develop new technology but its use in the actual improvement of the livestock of the country has been marginal. Recognizing this the Indian Council of Agricultural research has developed the concept of national demonstrations, operational research projects and laboratory to land programmes. These projects are based on a package of practices developed by scientists in their laboratories which are tried in a field area by the scientists themselves involving such development agencies who would eventually be responsible for extending these programmes in the field. These projects are basically for the scientists to develop confidence in their technology. They would also learn from actual field conditions the lacunae in the transfer of this technology to the field. They would have an opportunity to make such modification in the technology package which would be necessary to make it effective under the given set of conditions.

In most developing countries the development programmes are run by extension services which are not tied up with the research organizations. The research programmes are also isolated and there is no linkage between research stations and the field programme. Two programmes where such a linkage has been effective are the operational flood programme and the programmes of Kerala livestock marketing and meat board. These two programmes are directed primarily at increasing income levels of small and marginal farmers and landless labourers as an instrument of social change through dairying and livestock development. Initially the Kerala programme started as a programme of genetic improvement through crossbreeding of cattle with Brown Swiss and Jersey breeds. But when the crossbreds came in milk it become obvious that an artificial insemination programme supported by a veterinary service could not lead to success unless the milk produced was marketed at a remunerative price to the producers and the feed to be given to cows was compounded centrally, and farmers given advice on cropping patterns to include high yielding forages in their crop rotation calendars. This naturally called for development of infrastructure for milk marketing establishment of dairy plants, feed mills and vaccine production units and forage seed production, programmes, all to be backed up with research programmes. From small beginnings in the middle fifties this programme has grown into a state milch herd of 0.7 million crossbred cows. The programme has undergone tremendous changes during the past 25 years due to a number of constraints of feed resources, population numbers and training of personnel; these have been overcome and improvement of 1200 kg per unit cow has been achieved. In 1979 when a review of the enitire programme was made it was observed that the total milk and milk products requirements of the entire state could be met from 1 million crossbred cows, a target which would be obtained in the next three years. Once this target population was obtained 0.3 million crossbred cows would be surplus to the system and no feed was available for them. Therefore, a breeding decision was called for, a new objective had to be defined, from extensive breeding to increase in productivity per unit animal by intense selection through use of progeny tested, crossbred bulls and a reduction in the number of foundation population by sale or slaughter.

An integral part of a progeny testing programme is a good field recording system so that accurate information on sire's daughters becomes available along with other production parameters. This programme is now entering a phase where genetic improvement is the most important part of the programme and sophisticated genetic knowledge is now an absolute necessity, if the programme is to make any headway. This example has been given to show that if a breeding plan is properly implemented, it can lead to substantial improvements within a reasonable time frame.

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1 Death of embryos.

2 Ability to live on poor pasture, relative resistance to protozoan diseases (babesiosis, trypanosomiasis, anaplasmosis, etc.)

1 Calves born in one year.

2 Depending on the level of parasitaemia, on pathologic events attributable to trypanosomiasis, and on individual performance.

1

$$\{ E(\Delta G) = \frac{1}{2} \; i \; R_{G\hat{G}} \, \sigma_G$$

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CONSERVATION BY MANAGEMENT

CONSERVATION OF GENETIC RESOURCES THROUGH COMMERCIAL UTILIZATION
A case for the improvement of the Brazilian milking zebu breeds

F.E. Madalena 1

1. INTRODUCTION

Measures to preserve animal genetic resources presently in use are needed because these resources may be lost in a relatively short period of time. In Brazil, the Criollo cattle populations were practically completely graded up to zebus for beef production in the tropical areas of the country, a process that started on a large scale around 1910 (Santiago 1967) and changed in about fifty years the genetic composition of some sixty million cattle. Since more recent evidence indicates that zebu:criollo crosses excel both parental types in reproductive efficiency (Plasse *et al.* 1975) and carcass weight (Muñoz and Martin 1969), it would appear that going to purebred zebus was not the wisest choice of genetic resources for the beef industry. Unfortunately, by the time experimental evidence was available the criollo breeds had become nearly extinct.

Evaluation of breeds and crosses, and the diffusion of its results, in time to aid decisions before they have irreparable genetic consequences, are basic for efficient animal production. As a result of these evaluation studies some breeds could become more widely utilized, thus removing the need for special conservation practices, particularly if those breeds were under some kind of improvement programme. Conservation through commercial utilization would be possible only for breeds of present economic value, but it should receive attention along with other methods. After all, if the conservation of genetic resources is meant to serve mankind through improved animal production in the future, one could as well start by presently promoting a more efficient use of those resources, which would also favour their preservation.

Gir and Guzera (Kankrej) are the breeds generally used by farmers in the tropical areas of Brazil to maintain their cattle at intermediate gradings between zebu and European types. In this article, some experimental evidence on crossbred performance is presented, along with a brief description of the breeds, which justify their improvement for dairy purposes.

2. GERMPLASM EVALUATION

The Brazilian Organization for Agricultural Research (EMBRAPA) has initiated some comparisons of dairy breeds and crosses, at the National Dairy Cattle Research Centre. Background and rationale for this project were described by Madalena (1981). The aim is to define crossbreeding strategies for the utilization of European and zebu germplasm in the Southeast Region, which produces fifty-five percent of the milk in the country. In the main trial the performance of six Holstein-Friesian:Guzera grades is being compared in sixty-six cooperator farms. The six grades were chosen because they are similar to the ones that would be obtained utilizing four strategies of interest: (i) upgrading to Holstein:Friesians; (ii) forming a new breed; (iii) crisscrossing; (iv) modified crisscrossing alternating two generations of Holstein-Friesian and one of zebu bulls. A total of 527 heifers was produced and reared at an experimental farm up to approximately 22 months of age, when they were distributed to cooperator farms for further evaluation under the farmer's own management practices. Some results, of a very preliminary nature, are shown in Figure 1. There was a significant grade x farm group interaction for first lactation traits. At the farms with poorer management, performance tended to decline as grade departed from 1/2, whereas at the better managed farms there were small differences between the 1/2, 3/4, 7/8 and Holstein-Friesian grades.

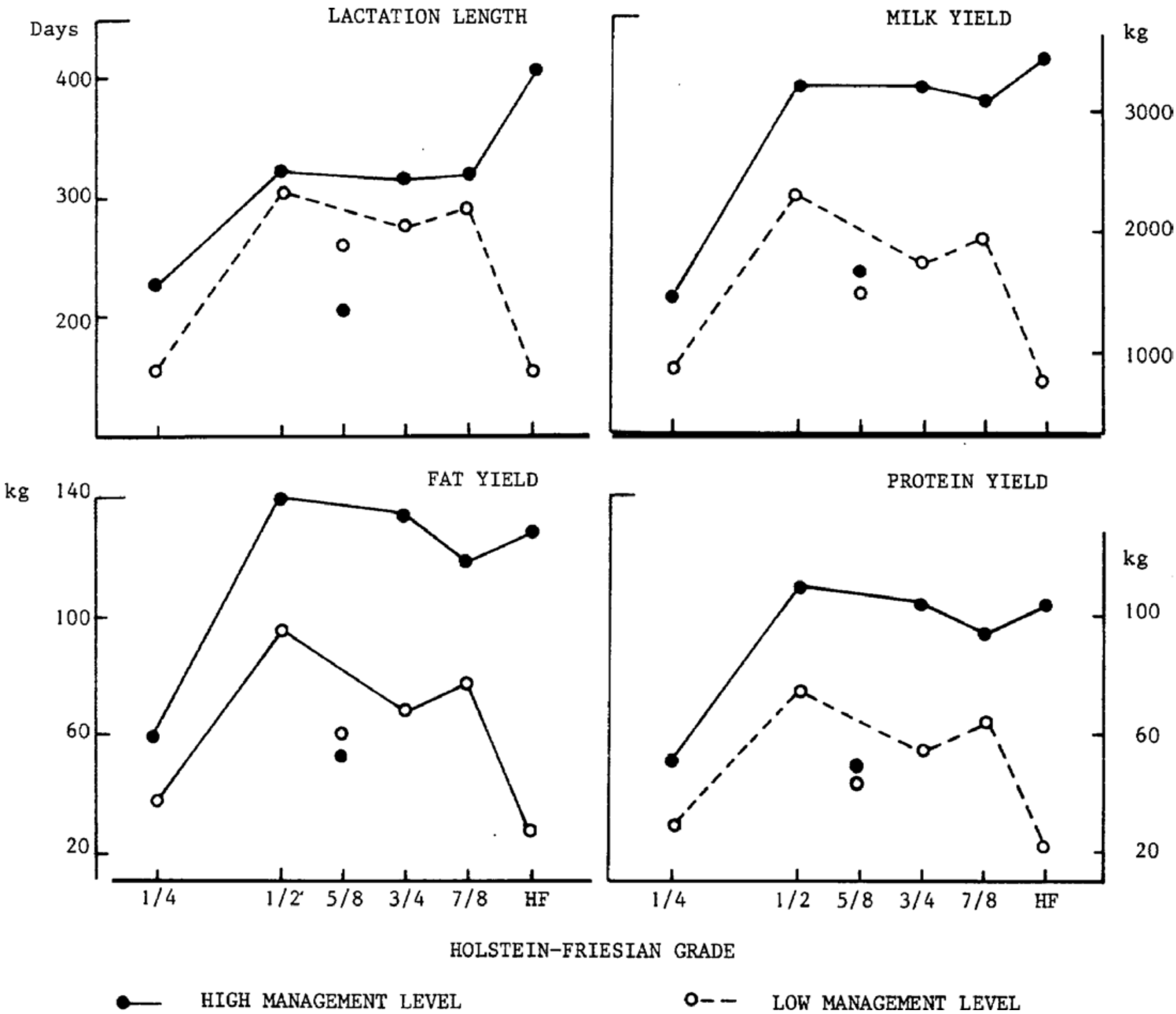

Fig. 1 Performance of six Holstein-Friesian:Guzera grades at 28 farms classed into two management levels (N = 4 to 15) Source: Madalena *et al.* (1982)

Age at first calving was lower for halfbreds (Fig. 2). Teodoro *et al.* (1983) found important heterosis effects reducing age at puberty by 86 - 34 days and age at first conception by 119 ± 37 days, while increasing eight at puberty by 44 ± 17 kg. Significant breed additive effects were found only for age at first conception, the difference Holstein-Friesian minus Guzera being -102 ± 46 days.

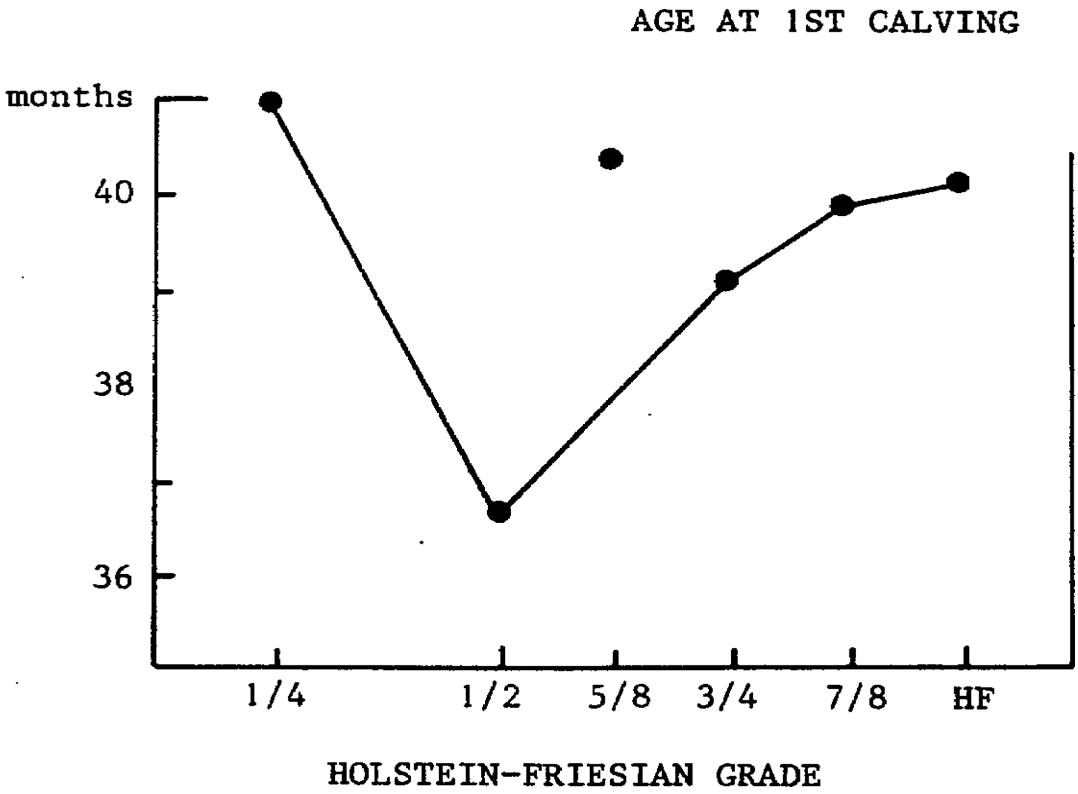

Fig. 2 Age at first calving of six Holstein- Friesian:Guzera grades (N = 22 to 43)

Crossbred animals carried lower tick" *(Boophilus micro-plus)* burdens than purebreds (Lemos *et al.* in preparation) and lower burdens of gastrointestinal parasites (Paloschi 1981). Calf mortality was much lower for the F_1 s, increasing as grade tended to purebred Holstein-Friesian or Guzera.

Additional results were obtained from individual herds (Table 1 and 2) where data allowed comparisons of contemporary animals of Holstein-Friesian:Gir grades, which confirmed the trends of Figures 1 and 2.

Table 1 COMPARATIVE PERFORMANCE OF COWS OF THREE HOLSTEIN-FRIESIAN GIR GRADES UNDER POOR MANAGEMENT1

Trait	Holstein-Friesian grade		
	1/2	3/4	Purebreds
Age at 1st calving, months	39.5	42.8	45.0
Calving interval. months	15.3	17.4	18.0
Lactation length2, days	262	246	218
Lactations shorter than 120 days3, %	13	25	35
Lactation milk yield2, kg	2471	2347	1898

1 Adapted from Frietas *et al.* (1980) and Madalena *et al.* (1980)

2 Only for lactations of at least 120 days duration

3 Manual milking without the presence of the calf

Table 2 COMPARATIVE PERFORMANCE OF THREE HOLSTEIN-FRIESIAN GRADES UNDER GOOD MANAGEMENT1 2

Trait	Holstein-Friesian grade		
	3/4	7/8	≥ 31/32
Calving interval, months	13.3	14.2	14.2
Lactation length, days	305	301	318
Lactations shorter than 200 days, %	2	5	3
Lactation milk yield, kg	4034	3894	4149
Milk yield/day of calving interval, kg	10.1	9.4	9.9

1 From Madalena *et al.* (1983)

2 Machine milking without the presence of the calf

3. THE ROLE OF ZEBU BREEDS FOR MILK PRODUCTION

The results shown above agree with other experimental evidence obtained in Brazil and elsewhere indicating that European:zebu crosses are better suited than both purebred types for dairy production in tropical regions when the production systems have restrictions of nutrition, health or managerial ability.

Diverse production systems coexist, in the tropical regions of Brazil. Some very specialized dairy farms, using European cattle and modern inputs can be found in the higher altitude areas. Farms of intermediate production level (in the range of 2000 to 3000 kg per lactation) are not rare. Typically, these maintain crossbred cattle populations either by periodically switching the breed of bull from European (mainly Holstein-Friesian) to zebu, or else by utilizing both types simultaneously. A large section of the farms is composed of smallholdings, with zebu cattle milked only once a day. Still another production system is found in some zebu beef cattle ranches, where a portion of the herd is milked once a day during the rainy season only. Average milk yield is 666 kg per cow/year. Yield for Holstein-Friesians under official milk recording (a selected sample) in the State of Sao Paulo was 4209 kg (Ministry of Agriculture 1975).

It is possible to utilize only high yielding European breeds in the cooler(higher) tropical areas, provided management is improved to a level presently restricted to the more progressive farmers. However, for the vast majority of farms some zebu breeding is necessary. Whether zebu genes will become unnecessary in the future because milk production systems will evolve towards capital intensive systems like the ones presently used in the industrialized countries, is a matter of speculation. It seems apparent however that because of geographic and socio-economic regional differences the various production systems will persist for many years thus justifying the need for both European and zebu germplasm suitable for each environment. Fortunately there is a wide scope for manoeuvre, because even at the reasonable level of 10 kg milk per day of calving interval zebu genes may not be a hindrance, as shown by the results of Table 2.

Zebu genes may be incorporated through crossbreeding, utilizing purebred bulls, or by forming a new breed after an initial crossing. Ongoing research will quantify the merits of both alternatives, but both would benefit from the existence of zebus improved for dairy production.

4. THE G1R AND GUZERA BREEDS

Introduction of these breeds to Brazil and their further development was described by Santiago (1967). The Gir used to be the predominant zebu breed, but has lost this position to the Nelore since the late sixties. Numbers of registered Gir cattle are declining, while those of Guzera are stationary (Table 3). The Nelore Breed Association registers some 230 thousand animals per year. Milking Gir and Guzera are not separate breeds, but some breeders have been practising within herd selection for milk production for many years, so the term "milking" has some biological justification. Gir cattle have a very docile temperament. While purebreds cannot be milked without the presence of the calf, F_1 s or higher grades of European crossbreds do not have this problem, as indicated by the small proportion *of* short lactations in Tables 1 and 2.

Table 3 NUMBER (THOUSANDS) OF REGISTERED GIR AND GUZERA CATTLE IN BRAZIL1

	1974	1975	1976	1977	1978	1979	1980	1981	1982
Gir	37	38	37	29	25	23	21	16	14
Guzera	11	13	14	13	12	12	11	11	10

1 Source: Ministry of Agriculture

Data on lactation length and milk yield in some of the elite dairy herds are shown in Table 4. Fat percentage at the officially recorded herds was 5.07 and 5.48, respectively, for the Gir and Guzera breeds. Data on reproduction traits are presented in Table 5. These include beef as well as dairy herds, as do data in Table 6, showing average weights of pastured cattle from an on-farm weighing programme.

Reported heritability estimates for Brazilian zebus are not different from those obtained elsewhere. Pereira (1983) reported three estimates between 0 and 0.06 for the heritability of calving interval and one estimate of $h^2 = 0.24$. The average of twelve estimates of heritability of weight at 18 months was $h^2 = 0.38$. Three estimates of heritability of lactation milk yield of Gir cows were $h^2 = 0.23$, $h^2 = 0.37$ and $h^2 = 0.43$ (Verneque 1982; Lôbo *et al.* 1981; Cardoso *et al.* . 1982). Heritability of lactation length in Guzera was $h^2 = 0.18$ and its genetic correlations with lactation milk and fat yield were both r = 0.99 (Barbosa and Pereira 1983). It then appears that these breeds have enough genetic variation for milk production and growth rate to justify improvement of these traits by artificial selection. More reliable estimates of genetic parameters, based on larger data sets, are nonetheless required.

Table 4 MILK YIELD OF GIR AND GUZERA COWS

	Lactation yield (kg)	Lactation length (days)	No. of lactations	References
Gir	1945	256	1147	Rehfeld (1975)
	2345	278	322	Teodoro (1976)
	2666	282	185	Silva *et al*. (1976)
	1646	270	N/A	Cardoso *et al.* (1982)
	2348	279	481	Min. Agriculture (1975)
	2788 1	316	1978	Lôbo *et al.* (1980)
Guzera	1155	262	401	Benintendi *et al.* (1966)
	2134 1	265	47	Min. Agriculture (1975)

1 Official milk recording

Table 5 REPRODUCTIVE PERFORMANCE OF ZEBU BREEDS. NON COMPARATIVE AVERAGES FROM DATA OBTAINED AT DIFFERENT HERDS[1]

		Gir	Guzera	Nelore	Indubrasil
Age at 1st calving, months		47.2	46.7	42.2	44.3
	Herds	3	3	7	4
	Records	1008	352	1049[2]	419[2]
Calving interval, months		17.3	17.6	17.0	18.2
	Herds	7	4	4	4
	Records	1814	2917	3907	1525

1 Adapted from Pereira (1983), Balieiro (1976) and Aroeira (1976)

2 Minimum, because some reports did not state numbers

Table 6 WEIGHTS AT 550 DAYS OF ZEBU BREEDS. NON COMPARATIVE AVERAGES FROM DATA OBTAINED AT DIFFERENT FARMS[1]

	Males		Females	
	N	kg	N	kg
Gir	312	231	441	203
Guzera	331	256	591	227
Nelore	2384	272	3668	239
Indubrasil	184	289	282	263

1 Source; Pereira (1983)

5. SOME BASIS FOR AN IMPROVEMENT PROGRAMME

Since several stud breeders and institutions would be willing to include their herds in an improvement programme organized on a modern basis, it would be easy to enrol some 20 herds with a purebred Gir population of the order of 1500 to 2000 cows (smaller numbers of Guzera would be available). A similar number of crossbred herds can be found in commercial farms which use artificial insemination, keep good records and would be willing to associate in an improvement scheme. Thus, the breeding programme would have a tester population composed mainly of European:zebu cows, which is very convenient since improvement of crossbred performance is being sought.

A conventional progeny testing scheme is quite feasible. Selection should initially be practised for milk yield only, but records should be kept on other traits (fat and protein composition, age at first calving, calving interval, cow stayability and calf survival, milkability and temperament, plus tic? ratings and periodical weights at experimental farms) so as to allow reconsideration of the selection criteria after data become available for this purpose. Milk recording of the entire herd and fat and protein testing at centralized laboratories would have to be organized. Present practice is to record part of the herd and test for fat at the farm.

There are several factors in Brazil that would favour a selection programme of this kind. Besides its acceptability to breeds and research institutions, a modern technical infrastructure is available in supporting fields such as data processing, artificial insemination and even modern reproduction biotechniques. The existence of an active extension service and an excellent specialized agricultural press would indeed facilitate further expansion of the programme.

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APPENDIX

CONSERVATION OF ANIMAL GENETIC RESOURCES IN BRAZIL
(information kindly provided by Dr. A.J. Primo)

The following description indicates the organization of animal genetic resource conservation in Brazil:

> In Brazil the need for conservation of animal genetic resources has now become clear, and the lack of necessary documentation and evaluation has been recognized. The evaluation and conservation of animal breeds is being undertaken by EMBRAPA/CENARGEN-Centro Nacional de Recursos Genéticos. In the case of cattle, actions are being taken to save the Criollo before it is too late as it is rapidly disappearing by indiscriminate crossbreeding. The National Center for Genetic Resources has the following functions: (i) to fully document productivity of local strains and to assess their adaptation to specific climate-management-production systems; (ii) to ensure that such local strains are not displaced by so-called "improved breeds" before their present or potential value is known; (iii) to take steps for the preservation of germplasm both as live animals or by setting up frozen semen and embryo banks; (iv) documentation of pertinent information in regard to identity of herds and flocks on a computer readable format. There is already considerable information on the local livestock breeds, strains and varieties in Brazil. A number of breeds, strains or varieties that are rare and in danger of extinction have been identified by CENARGEN. Such strains are being documented and specifically evaluated, particularly to determine if they possess any unique or special inherited characteristics that would warrant their conservation. Until such evaluation is completed, steps are being taken to ensure preservation of these populations.

RECOMMENDATIONS FOR SPECIFIC BREEDS AND SPECIES FOR CONSERVATION BY MANAGEMENT AND PREFERRED TECHNIQUES

K.O. Adeniji 1

SUMMARY

In Africa, the only avenue to conserve a breed endangered is in the living form since techniques for storage of embryos for example have not yet been adequately developed. Furthermore, most countries might not be able to meet the financial involvement of such a programme. This is why it is highly recommended that Multiplication and Breeding Centres should be established for the endangered breeds of Africa. In cases where governments are unable to finance such centres international organizations and donor agencies could be approached for aid in funding these centres. A case in point is the African Development Bank which is financing the conservation effort on the Lagune breed in the Republic of Benin.

It is also recommended that pure bred herds of the endangered breeds of high potential e.g. the Butana, Kenana, Kuri, and Mpwapwa should be established with the aim of exporting males. The foreign exchange generated will help in maintaining the centres.

In countries where there are no breeding programmes and policies, efforts must be made to develop one in order for conservation measures to have a lasting effect. It is also not out of place to suggest the formation of breeding societies and breed societies at the national level to coordinate livestock production efforts in the country.

1. INTRODUCTION

Authors in general are agreed that cattle were first domesticated over 7000 years ago in southwest and south-central Asia and were derived from one ancestral strain, the wild aurock or urus, *Bos taurus primigenius*. However, in Africa, three major types of cattle appear to have been the principal progenitors of the indigenous breeds (Payne 1964). The first to arrive were the humpless hamitic longhorns *Bos taurus longifrons,* followed by the humpless shorthorn *Bos taurus brachyceros* and then by the humped zebu *Bos indicus* (Colonial Office 1951; Epstein 1971). It was from these early times that interbreeding between humpless and humped cattle took place which gave rise to the various kinds of indigenous cattle encountered all over Africa today (Oliver - personal communication; Malbrant *et al,* 1947). Their hardiness and ability to thrive under traditional management and African rangeland is unchallenged. Any selection that has taken place over the many years that they have lived in Africa has been natural selection. Thus, man in Africa has produced a number of morphologically and functionally different types adapted to the prevailing conditions of the environment.

The cattle population of Africa, according to the 1BAR 1981 census is 162 267 000, representing 13 percent of the world's total. In addition to the meat and milk produced they also serve other functions: animal traction for cultivation and transport, manure for fertilizer and fuel, a variety of other products such as hides and skin, food security and year-round employment for millions of people in the rural areas.

2. FACTORS THREATENING EXISTENCE OF INDIGENOUS BREEDS

The factors threatening the existence of indigenous breeds include the following:

- Lack of breeding policies and breeding programmes to maintain and improve pure indigenous breeds.
- Indiscriminate crossbreeding programmes.
- Productivity potential of indigenous breeds.
- Livestock diseases

2.1 Breeding Policies and Programmes

Animal breeding policies in Africa are as many and as varied as there are countries. In some countries, breeding of livestock has been left to continue as it has always been done traditionally. Other countries have tried different types of breeding programmes in an attempt to improve the indigenous breeds.

In countries where the breeding of livestock has been left to continue as it has always been done traditionally, the local breeds have retained their genetic material in their naturally adapted environment. However, nomadism and pastoralism have occasionally brought the zebu from the producing areas into contact with the trypanotolerant breeds in the tsetse infested areas, resulting in crossbred populations which have become stabilized e.g. the Borgu in Benin, Mere in Mali, Djakore in Senegal, Keteku in Nigeria, etc. The same thing could be advanced in other countries which though not practising the traditional system in an attempt to improve the indigenous breeds, have been upgrading through crosses with indigenous breeds of higher productivity. Crossbreeding with indigenous breeds has shown that the amount of heterosis obtained in the crossbred has not been large, about 1.4 percent at birth, 2.5 percent at weaning and 4 percent in live weight at 2 years (Maule 1973) but the crosses are more efficient in utilizing poor quality feed (Dim 1978). It appears that the effect of such breeding systems, particularly continuous upgrading, results in reduction in numbers of the pure breed.

2.2 Indiscriminate Crossbreeding Programmes

In most of Africa, breeding programmes are neither well planned, coordinated nor systematically executed. This has often resulted in indiscriminate crossbreeding programmes with the consequent result in the dilution or loss of indigenous breeds. There must be a precise description of the crossbreeding plan, the number of animals of various breeds and the extent of the utilization of heterosis, the relative number of breeding females, offspring born, offspring replacement (Wilton 1979). Crossbreeding programmes without an assured supply of indigenous breeds -will threaten the existence of local breeds and result in crossbreds of different exotic blood levels.

2.3 Productivity Potential of Indigenous Breed

Although Africa's cattle population accounts for 13 percent of the world cattle population, they produce only 4.3 percent of bovine meat, 1.5 percent of cow milk, and the annual herd offtake averages 11.4 percent representing about 126 kg slaughter weight per head compared to 34.1 percent and 240 kg in developed countries (ILCA 1981). This low productivity of the indigenous breeds is discouraging the farmers in keeping these breeds particularly in areas where livestock production is secondary to farming. Furthermore, the use of cattle for traction is gradually being replaced by the introduction of tractors for cultivation in some countries. As a result not much attention is paid to indigenous breeds of low productivity especially in relation to growth rate and mature weight. This is one of the reasons why the small trypanotolerant breeds are endangered e.g. the Lagune of Benin Republic and Ivory Coast, the Muturu of Nigeria. These breeds, however, have high reproductive rates.

2.4 Livestock Diseases

IBAR and other international organizations with the help of donor agencies have been able to control some of the major livestock dieases in the region. However, owing to inadequate follow-up measures and unforeseen circumstances mainly political in nature or as a result of civil disturbances, serious outbreaks of Rinderpest have occurred recently to justify another joint campaign against this disease. The present total numbers of cattle to be involved in the campaign is estimated at 119 915 000 (Pan African Rinderpest Campaign 1982). Livestock diseases therefore continue to take a heavy toll of the livestock population. Annual mortality losses in the region are rather difficult to determine, but it has been estimated at 2.25 million cattle, 3.5 million sheep and 2.0 million goats in Ethiopia (FAO/World Bank 1977). In Kenya, it is estimated that up to 70 000 cattle (one year and over) die from East Coast Fever alone each year while in the young stock 12 000 out of 115 000 heifer calves born to artificial insemination died of the disease in 1974/75 (Vets Clinic 1977).

3. ENDANGERED INDIGENOUS BREEDS

Africa is endowed with a wealth of indigenous breeds which represent a vast pool of genetic material. Their long stay has enabled them to become adapted to the local environment. Any selection which has taken place over the many hundreds of years that cattle have lived in this region has been almost entirely on natural selection.

In the Africa region, it has been discovered that some of these indigenous breeds are endangered or threatened with extinction (Table 1). All efforts should be made to ensure that these breeds do not disappear completely or become extinct. This will safeguard the indigenous genetic material and avoid the problem of intractable rare breeds in future.

Table 1 LOCATION OF ENDANGERED CATTLE BREEDS

Breed	Country	Breed	Country
Baria	Madagascar	Lagune	Rep. of Benin, Ivory
Brune de I'Atlas	Morocco		Coast
Butana	Sudan	Mpwapwa	Tanzania
Creole	Mauritius	Muturu	Nigeria
Kenana	Sudan	Nandi (Small EA zebu)	Kenya
Kuri	Chad	Pabli	Rep. of Benin
		Sahiwal	Kenya

4. CONSERVATION BY MANAGEMENT AND PREFERRED TECHNIQUES FOR SPECIFIC BREEDS AND SPECIES

4.1 The West African Shorthorns

The West African Shorthorn are humpless trypanotolerant cattle found along the coastal areas in an almost continuous belt stretching from Liberia to Cameroon. They are said to have been derived from the humpless shorthorn *Bos brachyceros* and were said to be very numerous in northern Nigeria before the Fulani invasion and have now been replaced by the Zebu (ILCA 1979).

Depending on the location and environment these animals are variously called the Baoulé (Ivory Coast and Upper Volta), Somba (Togo and Benin), savanna Muturu (Nigeria), Bakosi, Doayo and Kapsiki (Cameroon), the Lagune (Ivory Coast, Togo and Benin) and the forest Muturu (Liberia, Nigeria).

The two most affected breeds in this group are the Lagune and Muturu (Table 2). These endangered breeds differ from the other shorthorns in terms of smaller size. They are generally reddish black or black and dun in colour and about three feet high. They have further degenerated as a result of inbreeding, inadequate nutrition and animal diseases. They are humpless, dwarf cattle, tolerant to trypanosomiasis but extremely susceptible to diseases such as rinderpest. They have very high breeding potential. The cows are capable of calving each year and age at first calving for the Muturu in Nigeria is 21 months. The calves weigh 10 kg and 13.7 kg at birth; 48 kg and 71.2 kg at 6 months; respectively in Benin and Nigeria. In areas where these breeds are kept, livestock production is of secondary economic importance. Furthermore, heavier breeds of zebu and N'Dama are being introduced for crossbreeding with the aim of improving herd productivity in terms of size for traction and meat and milk production. Furthermore, interest seems to be waning among farmers as tractors and small ruminants replace these breeds.

The Government of the Republic of Benin having realized the danger of extinction of the Lagune breed set up a multiplication ranch in Samiondji with funds provided by the African Development Bank for conservation purposes. It is suggested that similar measures be adopted for the Muturu in Nigeria. The extinction of this breed particularly in the Republic of Benin will have serious repercussions on livestock populations. It is therefore recommended that the ranch already established should be further strengthened both financially and by provision of experts in order to improve conditions at the ranch. It is also recommended that the government should be encouraged to provide an incentive to farmers to keep the breed.

4.2 The Kuri

This breed of cattle is classified as humpless longhorn (Colonial Office 1957). The very pure type of the Kuri breed is only found in the island regions of Lake Chad i.e. Djibadala, Koremeron, Debada and Bagdal (Malbrant *et al.* 1947). It has also been introduced into the regions of Lake Fittri and the lower Chari in Chad Republic; in the Tillabery region in Niger Republic and in Maiduguri, Nigeria in 1944 by importation of a nucleus breeding herd consisting of 10 cows and a bull. Recently, it was also discovered in the lower regions of the province of llubabor and by the Baro river in the Djikas district in Western Ethiopia (Alberro and Haile-Mariam 1982).

The Kuri is generally either a white coat coloured animal or white speckled with black or greyish black, in particular around the ears, on the head, the neck, and front part of the chest. It is a heavily built animal, about 5 feet in height (151 cm) with massive vertically high and bulbous shaped horns, crossed with tips close to each other. The horns, despite their massive look, are extremely light.

Normal horns are common with the mainland herds while in the island regions abnormal horns are found which seem to be the result of adaptation to the aquatic environment. They possess the ability to swim very long distances.

The breed is adapted to a hot and often very humid environment. The maximum weight attained by mature cattle is around 800 kg and the average carcass weight is 250-300 kg. The average weights recorded at Maiduguri Livestock Centre, Nigeria, were 500 kg for bulls and 360 kg for cows (Epstein 1971). It is a good dairy animal with high fecundity and easy calving. Average daily milk yield is estimated at around 5-8 litres and length of lactation 6/7 months. Average production over a number of years is 1260 kg/lactation, with a record of 2440 kg in 314 days at Maiduguri Livestock Centre (Epstein 1971). The animal is highly susceptible to rinderpest disease which has accounted for its small numbers. It has also been adversely affected by the drought and the political instability in the Republic of Chad.

The conservation measures recommended are the development or establishment of government or internationally funded breeding centres on the islands where pure breeds are found. This will ensure that its adaptive qualities to a humid environment, and ability to swim long distances are retained. The breeding programme should be based on selection for milk yield and the distribution of improved males to farmers to improve their herds. Furthermore, heifers could be produced for export to countries where the breed has been introduced. In Nigeria and Niger Republics where the Kuri has been introduced and Ethiopia where it is also found, the governments should be encouraged to set up multiplication and breeding centres.

4.3 Mpwapwa Cattle

The Mpwapwa cattle is found in the Mpwapwa and Malya regions of Tanzania and the following blood composition prevails among the breed: Red Sindhi, 32 percent; Sahiwal, 30 percent; Tanzania shorthorn zebu, 19 percent; Boran, 11 percent; Ayrshire, 8 percent (Kiwuwa and Kyomo 1971). This breed was developed as a dual purpose animal capable of producing 2280 kg of milk in a 305 day lactation and steers to produce good quality carcass of 230 kg at less than four years from unimproved pastures. The second objective had been accomplished over the years. The herd average milk yield at first lactation is 1000 kg but Kiwuwa and Kyomo (1971) reported 1310 kg for one of the best ten heifers recorded in 1967. Also, the average milk yield for the cow is 1500 kg but Kiwuwa and Kyomo (1971) recorded 1800 kg for one of the best ten cows recorded in 1967 at Mpwapwa station while Bruhn and Mgheni (1977) reported an average of 1715 kg for 9 cows kept on the university farm at Morogoro. In fact these yields are relatively higher than those reported for East African crossbreds (Kiwuwa and Kyomo 1971).

The breed is in danger of extinction as indicated in Table 2. The main reason given for this was lack of sustained effort to develop the breed. Thus concerted efforts must be made to prevent the disappearance of the only composite breed that was developed in Africa.

The breed can be found in 2 regions of Tanzania. It is recommended that two breeding herds of the pure breed should be established and maintained in these regions because of the small numbers in order to avoid losses by disease or other unavoidable causes. In addition, exchange of males between herds will also be possible.

These stations could be established and funded by international organizations. The infrastructure presently exists at the Mpwapwa livestock breeding station.

4.4 Kenana Cattle

The Kenana cattle are found in the central region of the Blue Nile province in Sudan. The average rainfall in this area is 460 mm in the north and 810 mm in the south. The adult animals exhibit variations of colour from white grey to black grey; while the ideal Kenana colour is white grey on the chest and abdomen. The Kenana cow, being nomadic in nature, has a well developed udder attachment which prevents the udders becoming pendulous with advanced age. The average weight of a bull is 500 kg whilst that of a cow is 400 kg. The average milk yield is 1860 kg in 222 days lactation (Osman 1981). In this breed, the peak milk yield is during the 4th lactation and the average length of productive herd life of a cow is 5.42 lactations (Alim 1960). The age at first calving is 45.2 months but with good management, this could be reduced to 32 months (Khalafalla 1977). It is to be noted however that around 61 percent of heifers in a herd calve at 37-48 months. The calves weigh 24.8 kg and 23.5 kg at birth respectively for male and female. With good management considerable improvement could be achieved in the reproductive performance of the breed.

The introduction of crossbreeding in Sudan in 1925 is now threatening the existence of this breed. The Kenana cattle did very well in crosses with exotics and artificial insemination service is widespread with only exotic semen available. The discovery that crosses with this breed are suitable for use in Sudan with the modification of the environment resulted in large scale indiscriminate crossbreeding programmes. In addition, the establishment of a Kenana scheme in the natural habitat of the breed further threatens its existence (Khalifa 1960).

It is recommended that breeding and multiplication centres should be established for the Kenana cattle particularly in its natural habitat so that its adaptive qualities are not lost. If the government is not willing to carry out this assignment because of the Kenana scheme, the centres could be established in other regions with similar ecological conditions.

Table 2 ENDANGERED CATTLE BREEDS

Breed	Present geographical location and production system	Population		Main use	Main reason for being endangered	Specific traits that might justify conservation programme
		Total Number	Number females			
Muturu	Forest and Guinea Savannah of Nigeria (S. West Nigeria; Middle belt of Nigeria). Extensive traditional system.	25 000	12 500	Meat Draught	Kept as relics; crossbreeding with other breeds; interest waning among fanners as tractors and small ruminants replace breed. Nigerian civil war.	Trypanotolerance, Hardiness, Good draught animal; low mortality rate for entire herd, short calving interval.
Lagune Rep. of Benin	Queme region of Benin: Samiondji ranch. Extensive traditional system. Improved extensive system.	40 000	25 000	Meat	Crossbreeding with zebu; lack of attention by farmer because of small size	Trypanotolerance. Adaptation to humid environment.
Lagune Ivory Coast	Along the coastal region of Ivory Coast. Extensive traditional system.	4 000	1 600	Meat	Crossbreeding with zebu. Small size. (Matured adult 120-125 kg.) Neglected by farmers because of poor milk production.	Trypanotolerance. Adaptation to humid environment.
Brune de l'Atlas	Morocco	2 820	2 000		Crossbreeding with imported breeds.	Adaptation to arid zone.
	Algeria	1 433				
	Tunisia	914				
Mpwapwa	Mpwapwa and Malya regions of Tanzania	1 000	650	Dual purpose	Lack of sustained effort to develop the breed.	Adapted to semi-arid plateau of central Tanzania
Baria	Kelifely causse, N. Western Madagascar. Extensive traditional system			Dual purpose		Humpless, adaptation to the environment.
Creole	Mauritius	3 000		Dual purpose, Draught	Upgrading to imported exotic breed introduced about 150 years ago	Adaptation to the environment.
Kuri	Lake Chad Basin of Nigeria (Bornu State). Extensive traditional system	7 000	3 500	Dual purpose	Small numbers; decimated by rinderpest and drought.	High milk production potential; Ability to float and swim in the lake. Heat tolerance and adaptation to humid environment.

Kuri	Island regions of Lake Chad i.e? Djibadala, Koremerem, Debada and Bagdal (Chad Republic). Extensive traditional system				Decimated by rinderpest, draught and political instability.	Good dairy animal; High fecundity; and easy calving. Heat tolerance and adaptation to aquatic environment. Ability to swim long distances.
Kenana	Central Region of the Blue Nile province- Extensive system			Milk	Crossbreeding; establishment of Kenana scheme in the natural-habitat of breed	Good dairy animal; Adaptation to hot arid and semi-arid environment.
Butana	North and East area of river Atbara and Kasala province. Extensive system			Milk	Crossbreeding.	Good dairy animal Adaptation to semi-arid environment.

4.5 Butana Cattle

This breed of cattle is found in the area bounded in the north and east by the river Atbara and to the west by the Kasala province boundary which extends as far as the river Rahad in Sudan. The breed is characterized by a large hump, short horns and pendulous dewlap. They are mostly dark red in colour. The age at first calving is 43 months with calving intervals of 373 days. The birth weights for male are 25.64 kg and for female 24.29 kg respectively (Khalifa 1966). The average milk yield is 2253 kg in 240 days lactation (Osman 1981).

As earlier described for Kenana, the widespread crossbreeding programme is likewise threatening the existence of this breed. It is recommended that multiplication and breeding centres be established for this breed. The males produced in the breeding stations should be available for farmers in order to improve their herd. Furthermore, quality Butana heifers could be produced for export to other African countries as was already the case in some states in Nigeria.

The Kenana and Butana of Sudan are the only dairy type of cattle in the country and have received much attention particularly at the Artificial Insemination Service Centre. It is suggested that the reproductive data collected at this centre on these breeds be analysed. This might be undertaken in the form of a project since a preliminary investigation might be needed to describe the content and volume of the data.

4.6 Creole or Criollo Cattle

The Creole or criollo cattle is a heterogenous population with extremely variable colours, sizes and other external traits (Deaton 1981). In Mauritius, the breed is regarded as dual purpose and sometimes also as a draught breed. The breed, being multipurpose, is considered important as an insurance against unstable markets. It therefore fits the requirement of small farmers who prefer hardy animals with less health care and suffer less under poor management and inadequate feeding systems.

The policy of continuous crossing to an exotic breed introduced about one hundred and fifty years ago will cause the breed to disappear and eventually the genetic variability associated with the breed. It is mainly for this reason that the government should be encouraged to adopt a policy that will protect the breed from extinction.

It is recommended that a multiplication centre be established for the criollo where breeding programmes to improve the breed and produce bulls for loan to farmers for improving their herds be developed. Furthermore, it is recommended that the farmers be formed into associations or breeding societies which will be interested in the protection and improvement of the breed.

4.7 Sahiwal Cattle

The Sahiwal cattle, whose native home is in the Montgomery district of Pakistan, were first imported into Africa through Kenya in 1939 and subsequently in 1945 and 1963 mainly because of their higher milk yield than other zebus (Kimenye 1981) and adaptation to tropical environments. Other African countries where it has been introduced as well are Burundi, Mauritius, Nigeria, Rwanda, Tanzania, Sierra Leone, Somalia, Senegal, etc. This breed, though not indigenous to Africa, is suitable as a dairy breed in semi-arid eco-zones of the region with productivity potential as in its native home. In fact, the Sahiwal cattle from Naivasha, Kenya, have been managed by farmers at various levels of intensity in different production sytems (Wilkins 1974). Production data in India are as follows: average first lactation milk production in 300 days - 1622 kg; average yield pooled over 7 lactations - 1761 kg; average lactation length - 289 days; average calving interval - 450 days (Nagarcenkar 1983).

The production data in Kenya are as follows: average milk yield in 305 days - 1455 kg; average lactation length - 274 days; average calving interval 412 days (Kimenye 1981). The main difference with records in India was due to the plane of nutrition. In India the animals were stall fed whereas in Naivasha, Kenya, the animals were managed on unimproved pastures with hardly any supplementation. Furthermore, semen has been produced from the breed in Kenya, Somalia and so on.

The Sahiwal breed which has already proved its worth in Kenya is now endangered mainly because of too narrow a genetic base. As a first step, it is suggested that information should be collected from other countries where it has been introduced as regards its productive performance compared with the indigenous breeds. Furthermore, it is suggested that a similar procedure be used to collect information from other areas of the world where it has been introduced. On the basis of information gathered, problems to be encountered in the global use of the breed should be identified, and solutions found in order to widen the genetic base of the Sahiwal population in Kenya.

Finally, it is suggested that an analysis of available data at the national Sahiwal stud in Kenya should be undertaken with a view to reviewing the present breeding programmes and to investigating alternative selection strategies in order to maximize genetic progress.

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BREEDING PLANS FOR IMPROVEMENT OF INDIGENOUS BREEDS AND SPECIES - THE SAHIWAL

Proposals for an Inter-country Cooperative Programme

John Hodges1

1. INTRODUCTION

In many parts of the tropics the need is to improve cattle for both milk and beef production at the same time. There are, however, few indigenous breeds of the developing world able to produce adequate quantities of milk. The majority of *Bos indicua* cattle are suited principally to beef production. *Bos taurus* has greater potential for milk production, but is rarely suited to the harsher environments of the tropics, where conditions adversely affect milk production, health and reproduction. The value of *Bos indicus* breeds which are able to produce higher levels of milk, as well as good beef, is therefore very great. There are few such breeds: among the few, the Sahiwal is one of the best endowed with genetic potential for milk and beef, while exhibiting a complete adaptation to the tropics. Native to the Punjab Province of Pakistan, the Sahiwal takes its name from a small city and the surrounding district. It has been considerably improved by many centuries of patient selection in the area, and it reputation has spread abroad to many other tropical countries and semi-tropical countries.

2. DISTRIBUTION OF THE SAHIWAL

In the home country of Pakistan there are today only about 7000 purebred Sahiwal cattle, many of which are in herds of government livestock stations, or on private farms encouraged by government. The level of production of the Sahiwal depends, of course, upon the management system and particularly upon the level of nutrition. However, it is not unusual for the 305 day lactation yield to reach and exceed 2000 kg under good conditions. The Sahiwal has also been used extensively for crossing, and with *Bos taurus* breeds, such as the Ayrshire or Holstein-Friesian cattle yields can be substantially increased. The extent of this increase depends upon the climate and the percentage of Sahiwal in the crosbred (ILCA 1981). However, the attractions of crossbreeding have encouraged many farmers in Pakistan to cross their animals and obtain considerably more milk. Consequently, there are now over 100 000 crossbred Sahiwal type animals, with varying percentages of Sahiwal genes. From a conservation point of view this represents a serious problem. It is obviously essential that the purebred Sahiwal should not only be preserved, but also that it would have a large enough population to permit purebred improvement programmes. The governments both of Pakistan and of the Punjab are well aware of this problem and have taken some steps to preserve any further loss of Sahiwal genes in the purebred population.

In addition to Pakistan, a population of Sahiwal exists in Kenya, to which importations were made during colonial time about 40 years ago and since. Today the purebred population in Kenya numbers about 2500 cows, of which a large herd is at the Government stud at Naivasha, founded in 1962, and others are in private herds. Sahiwal bulls are also available in artificial insemination. As in Pakistan, many farmers in Kenya keep crossbred Sahiwal cattle crossed with *Bos taurus* types, and gain additional milk yield. The percentage of Sahiwal genes again depends upon the climatic location, which in Kenya can be very varied (Trail and Gregory 1982). India also has some purebred Sahiwal animals in government herds on livestock farms or research stations, but the number is less than the population in Kenya, and numbers about 1000-1100 cows (Nagacenkar 1983). Some cooperative improvements work is in progress on 8 institutional herds with 750 cows.

3. THE INTERNATIONAL PICTURE

The Sahiwal is thus already an international breed with small purebred populations in three countries, but unfortunately, not many purebred animals in total. It represents an outstanding example of a breed which requires special attention, for conservation by management. This is already being given by the national governments of Pakistan, India and Kenya at the Federal and State levels. It is a situation, however, in which other countries have an interest either now or in the future. For example, Malaysia has recognized the value of the Sahiwal crossbred for milk production, and during the last 7 or 8 years has imported crossbred Sahiwal-Friesian heifers out of Friesian cows, from Australia and New Zealand. The operation has been a success commercially for Australia and New Zealand, who have *not* had large expenses in maintaining Sahiwal bulls in Al; it has also been a success from a health angle, for strict controls on animal health have been ensured. Some 12 000 crossbred animals have been imported this way, and this has improved Malaysian milk production. The missing factor is a genetic programme to ensure that the Sahiwal bulls selected are part of an internationally recognized population of Sahiwal, which has a united breeding programme to conserve Sahiwal genes by management. In the view of FAO, here is an opportunity for international cooperation in genetic improvement, to safeguard the valuable Sahiwal genes, and to ensure that all countries with an interest now, or a likely interest in the future, may play a part. It is evident that crossbred Sahiwal are very successful commercially. What is needed is an international conservation agreement between the governments with ongoing interests in the Sahiwal to cooperate in improvement, so that they may offer the best Sahiwal genes to the world market, benefit commercially, and also conserve the genetic resource for the future.

Such international cooperation would not affect the freedom of action of national governments to follow their own improvement plans, but would ensure that those having Sahiwal can be aware of each others breeding programmes, and if they wish, to cooperate in the exchange of information, animals or even commercial marketing plans.

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CRIOLLO AND TEMPERATE DAIRY CATTLE AND THEIR CROSSES IN A HUMID TROPICAL ENVIRONMENT[1]

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The early history of the herd at Turrialba involved the introduction of Holstein, Jersey and Brown Swiss heifers. Losses of adults and calf mortality were so high that the herds could not be maintained. The Jersey having shown higher fertility was kept and crosses that would be more adapted sought through the Central American Milking Criollo.

The data analysed come from herd records kept for all cows that were milked in Turrialba from 1952 to 1982.

After screening the data for minimum requirements of 30 days in the milking line, 3902 lactation records were considered. Of these 1124 represented first lactations. A further screening was carried out to represent normal lactations. These were so considered if they lasted at least 150 days and produced at least 450 kg of milk. These decisions were based on the conviction that though some of the foundation Criollo cows had been raised at the foot of the dam or handled as beef animals no calf-suckled cow would produce less than that amount. All records were made on twice a day milking without the calf and under an all pasture feeding regime. Molasses was fed at the time of milking. Quantities of this supplement were not constant throughout the years. Data examined here include parameters pertaining to first lactations only. Twenty-one breed groups could be defined based on the existence of at least 10 records that met the minimum requirements for first lactations. Most of the data is comprised by the Central American Milking Criollo Breed, with 264 first lactation normal records; the Jersey with 113 and their reciprocal crosses with 90 lactations. Some other numerously important groups include a three breed cross of the above to Ayrshire and an outcross to the Durham (a Costa Rican relic of old time Shorthorns that was not selected for milk production). Some of the more important parameters corrected for year effect and means derived by least squares and maximum likelihood procedures are presented in Table 1.

The data so far analysed are partial and do not constitute all evidence available to reach conclusions relating to future policies. Since they comprise only first lactations they would be viewed in connection with calf mortality which has a heavy impact on the dairy business. Attempts to include that parameter have been difficult because they are so intimately tied with management. An earlier analysis (Maltos, Cartwright and de Alba, ALPA Mem. 50:35-47) showed an average mortality for all breeds of 17 percent of all females born, but no breed comparisons were possible. In one section of the herd accurate records were kept of the mortality of calves out of the three way cross cows, Ayrshire X (F_1 crosses) and it was found to range, in a group of 22 cows, from 33 percent to 0 in a period of five years. Whether adaptability to the environment is expresed by breed groups as a factor of calf mortality cannot be answered. Since calves are grown from the time they reach 120 kg to first breeding on second rate pastures, adaptability may be judged by age at first calving. In this respect the lower age and higher weight of the Criollo x Jersey crosses can be interpreted as showing a greater degree of adaptability to the environment.

Table 1 RESULTS ON TRAITS PERTAINING TO FIRST LACTATIONS RECORDS OF SELECTED BREED GROUPS AT TURRIALBA, COSTA RICA NORMAL RECORDS ONLY (1952-1982)

Breed Sire breed first	**No.**	**Age at first calving days**	**Fat %**	**Weight at first calving**	**Unadjusted milk yields 305 or less days**	**Age Adjusted milk yields**	**Age and FCM yield**
				kg	kg	kg	kg
CC=Purebred Criollo	246	1111 ± 11	4.63	320 ± 3	1 298 ± 31	1 282 ± 31	1 383 ± 83
JJ=Purebred Jersey	113	1016 ± 14	4.56	268 ± 4	1 836 ± 40	1 851 ± 40	1 989 ± 42
CC x JJ F_1	40	1035 + 22	4.45	308 ± 7	1 802 ± 73	1 813 ± 73	1 963 ± 77
JJ x CC F_1	50	958 ± 24	4.66	290 ± 6	1 931 ± 66	1 966 ± 67	2 114
CC x (CJ or JC)	25	1051 ± 29	4.51	307 ± 8	1 596 ± 87	1 598 + 86	1 704 ± 91
JJ x (CJ or JC)	18	970 ± 36	4.75	283 ± 9	1 844 +104	1 874 ±104	2 129 ± 90
DD_x (Doran x Cross or CC)	39	1082 ± 24	4.56	328 ± 7	1 582 + 80	1 581 ± 79	1 689 ± 83
AAXX(1/4C x other)	40	1066 ± 47	4.60	320 ±13	2 219 ±138	2 197 ±137	2 314 ± 144
AAXX(JC or CJ Cross)	45	1046 ± 24	4.38	340 ± 6	2 198 ± 71	2 195 ± 71	2 263 ± 75
AAXX(1/4 J x other)	13	989 ± 42	4.45	290 ±11.	2 270 ±121	2 270 ±121	2 372 ± 128

CCXX(J x C) X A)=9/16 or 5/8 *cc*	22	1106 ± 32	4.38	321 ± 9	1 772 ± 95	1 754 ± 95	1 866 ±100

Judged at first calving the introduction of the Doran was not fortunate, and particularly so if compared to the Ayrshire x F_1 Jersey Criollo (reciprocal cross). The fact that these hybrids could outproduce and outgrow the purebred Jersey speaks again in favour of adaptability. But the use of Ayrshire sires on these F_1 dams produces a productive and growthy first calver with equal life in the milk herd as the Criollo and Jersey. The continued use of a three-way cross might be too complicated for a farmer, even if he can use artificial insemination.

The Ayrshire introduces also unpigmented skin; but, with limited resources available the main argument against the three-way cross is that it forces a reduction of the Criollo herd that can be kept.

The success of crossing the Criollo with the Jersey and the fact that it surpasses the Jersey in milk production, growth and longevity (as judged by average life in the milking herd of 4 lactations for the Jerseys and 5.8 for the Criollo x Jerseys) raises the question of defining this line of breeding for future dairying in the humid tropics. The source of superior Jersey semen is assured through progeny testing being carried out in many parts of the world. But the recurrent use of the Milking Criollo is threatened by the lack of testing facilities and the reduction of the true Criollo throughout Central America. The stabilization of a high producing line of Milking Criollos at Turrialba, that are easier to milk than the original population, has been realized. The results obtained by a backcross to pure Criollo bulls (last line of Table 1) are fairly satisfactory and evidence of success in selection of a higher producing line of Criollos.

The herd needs to increase in numbers if it is going to keep free of the pitfalls of excessive inbreeding. Some outstanding Criollo herds remain in Nicaragua and Guatemala. But they are milked with the calf at side. Fear of going back on selection gained for easier milking makes decisions concerning reintroductions very difficult. The policy of incorporating high grade Criollos into the purebred Criollo herd is being proposed. This would allow expansion of numbers and incorporation of productive tropically tested dams through the purity of the original Criollo will be traded for a more homogenously productive population. The characteristics of pigmented skin, short hair and tough thick hide are being kept, and required more on bulls than on dams. A small population of purebred Jersey that would incorporate numerous progeny tested bulls (through semen imports) would be kept, a criss-crossing study with Jersey and Criollo will be started and this line of breeding recommended for demonstration milking units and farm programmes.

SURVIVAL PROBABILITY IN SMALL LIVESTOCK POPULATIONS

Y. Yamada1 and K. Kimura

Very recently, Senner (1980) has published the result of his simulation study on the fate of small populations in captivity. The survival probability of small populations was calculated, based on the mathematical model in which nine variables, i.e. female fecundity, viability of the offspring and sex ratio, etc. are taken into consideration. The conclusions may be summarized as follows:

i. Extinction of small populations is inevitable.
ii. The extinction model is very sensitive to female fecundity.
iii. Viability and fecundity decline upon inbreeding, and the rate of such inbreeding depression may vary among species.
iv. Unbalanced sex ratio decreases the effective population size and thus increases the probability of extinction in small populations.
v. Survival probability is proportional to maintenance size and less sensitive to founder size.

Although the model presented by Senner (1980) was very simple, it still explains the features of extinction of small populations and validates the strategies for maintenance of such populations. However, this model explored only the case in which the population was in captivity and thus any attempt to cover the model for maintaining livestock genetic resources was not taken into consideration. The present note is the result of our simulation study dealing with the situations which may be encountered in livestock populations.

The model employed in our study is essentially the same as Senner's extinction model with minor modifications which resulted in a little earlier extinction than with Senner' s.

1. DISREGARD OF MAINTENANCE POPULATION SIZE

Senner (1980) has imposed the retriction of constant population size because he is concerned with zoo populations. We remove the restriction of constant size and thus consider the case in which all individuals reaching breeding age are used as breeders for reproduction. Figures 1a, 1b and 1c illustrate the results of the simulation for B_1 = 0.5, 1.0 and 2.5, where B_1 is the regression coefficient of the negative logarithm of the proportion of the offspring arriving to reproductive age. The ordinate is the number of female breeders and the abscissa is the number of generations. Figure la shows that the extinction of these populations whose number of female founders is less than 5 is inevitable, even if all living female offspring reaching reproductive age are used for reproduction. If the number of female founders exceeds 6, 7 and 12, in Figures 1a, 1b and 1c respectively, the extinction of the population will never be encountered. In other words, there is a "minimum herd size for restoration" and below this critical value the extinction is the fate of the population. If the inbreeding depression is larger than the increment of the population size, the population inevitably becomes extinct, even if it increased temporarily at the beginning. For the population whose number exceeds the "minimum herd size for restoration" given in Figures 1a, 1b and 1c, the number of female offspring increaes up to 10 000 head by 50, 80 and 67 generations, respectively. In such a population the inbreeding coefficient increases up to a certain level (e.g. F=14% in Figure 2a at approximately generation 30) and remains unchanged thereafter. Consequently, the population is not affected by fecundity depression. On the other hand, in the population whose fate is "extinct", the rate of inbreeding never reaches an equilibrium and gradually increases, whereas the population size increases until the peak (e.g. at approximately generation 80 in Figure 2b) and starts to decrease due to fecundity depression by inbreeding. The population decreases its size to a critical level so that the inbreeding rate accelerates very rapidly, which in turn leads to the extinction of the population.

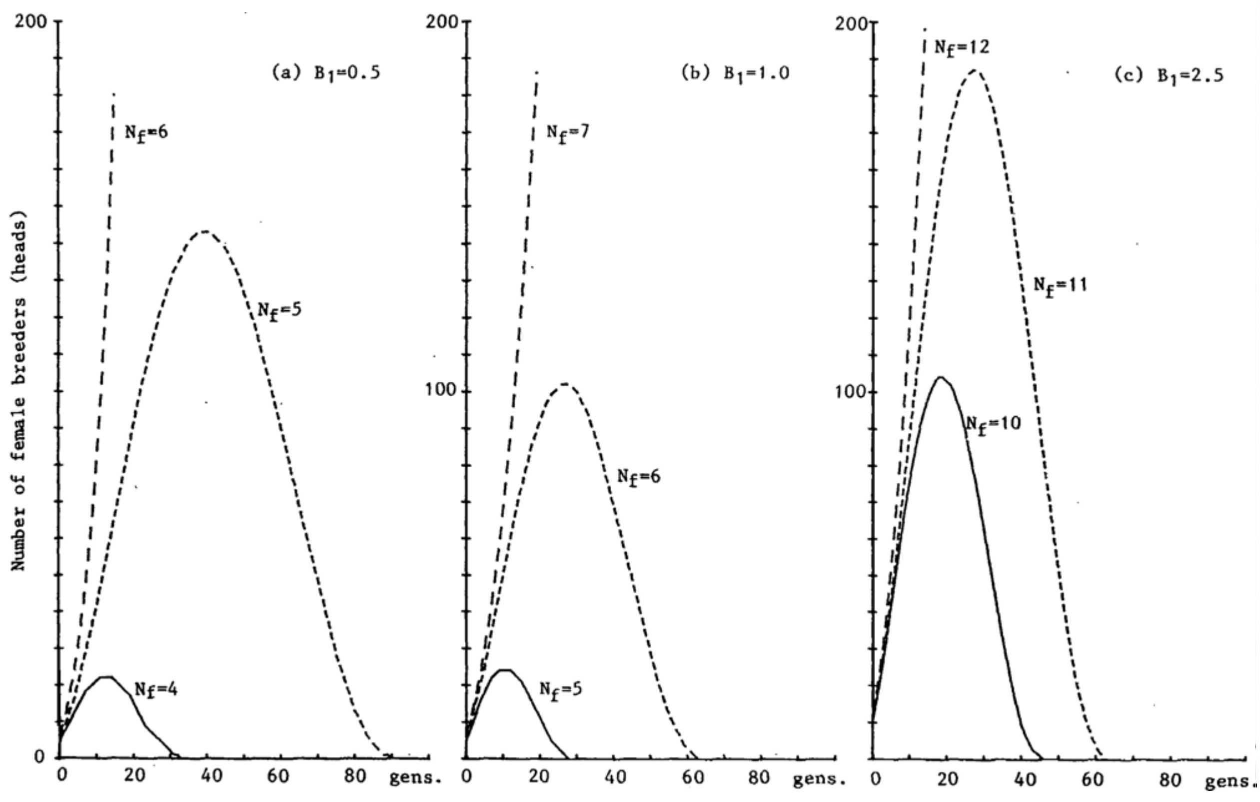

Fig. 1 The number of generations for extinction with varying number of female founders

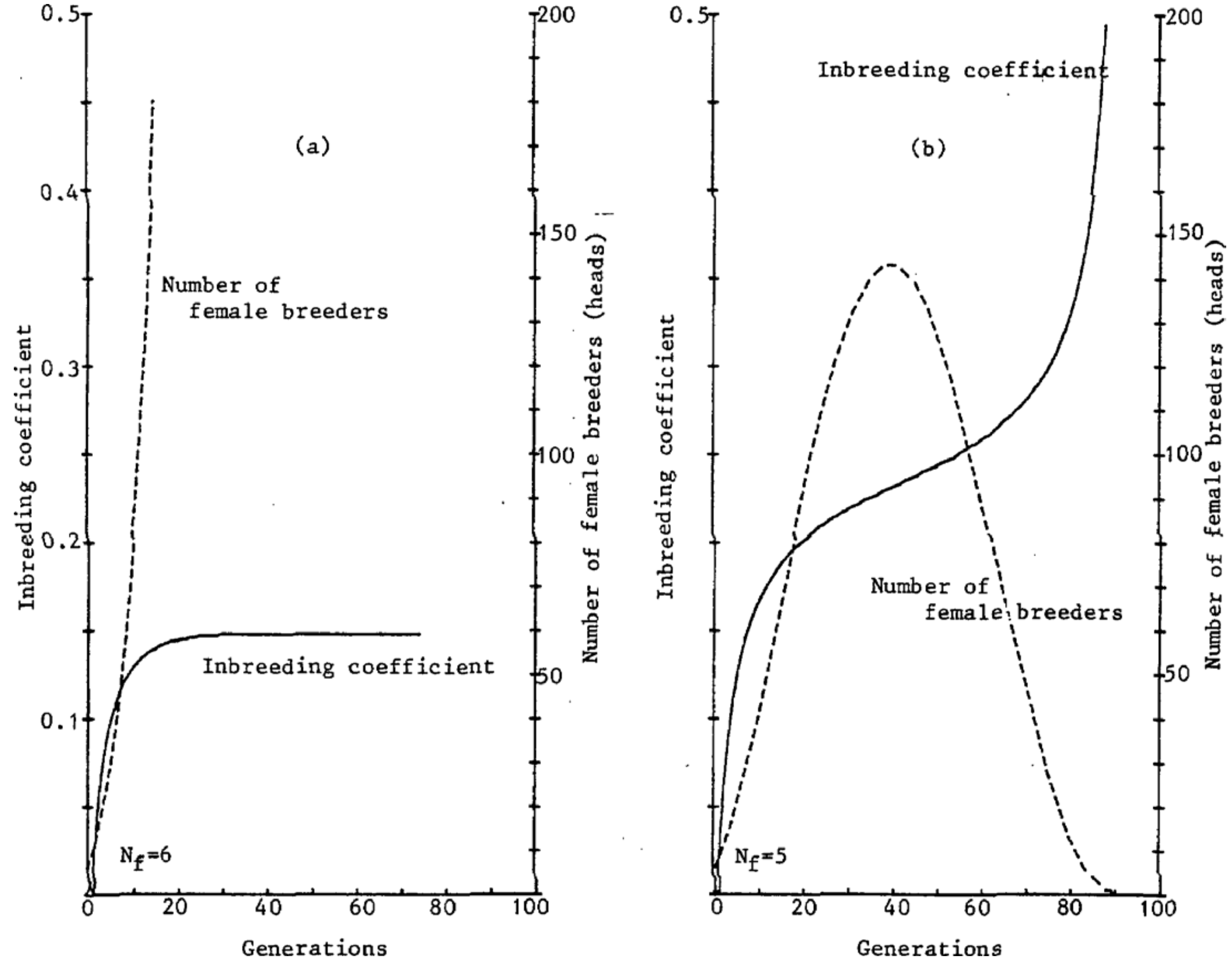

Fig. 2 The number of female breeders and the rate of inbreeding coefficient with the same depression rate (B_1=0.5) and different numbers of female founder (N_f=5,6)

2. SEX RATIO

In livestock populations sex ratio deviates substantially from 1:1, which decreases the effective population size less than the actual census number. This is disadvantageous for maintaining populations. Granting equal effective population size, we may anticipate a longer "life" of the population in which more females involve reproduction of the off-pring. An example is given in Figure 3, where the ratios 7:7 vs 4:28 with the same effective size of Ne=14. In the early generations the survival probabilities of the population with 4 males and 28 females are a little lower than those of the population with 7 males and 7 females, due to higher probabilities of zero male at generation 0 in the former. Nevertheless in the later generations reproduction with more females becomes advantageous and thus the probability of survival should be higher in the population having more females. However, the advantage of retaining more females is so small that the cost of maintaining the stock with 4:28 does not balance with the difference of three more generations before extinction (see Fig. 3).

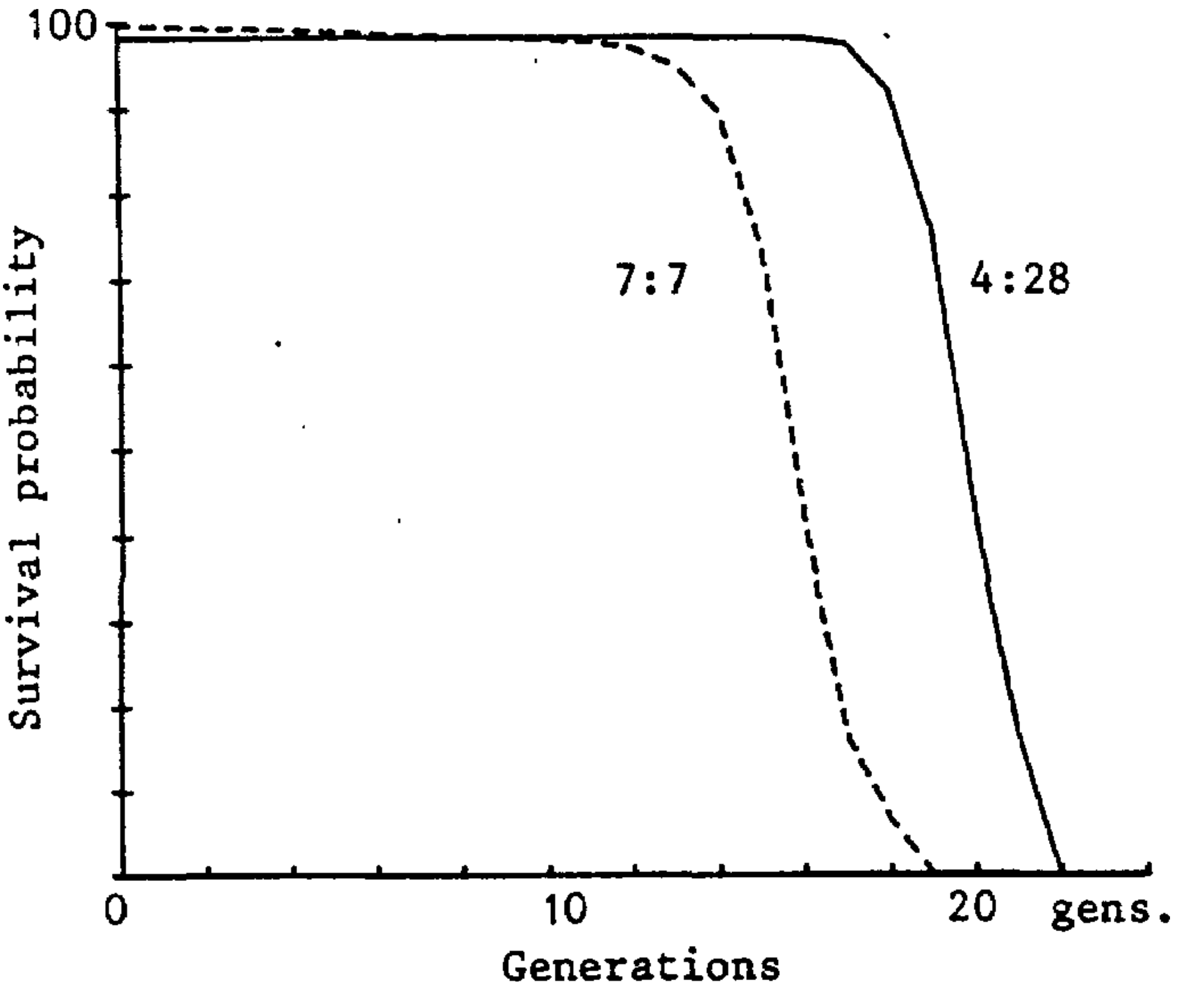

Fig. 3 Survival probability and sex ratio

3. TEMPORAL FLUCTUATIONS IN POPULATION SIZE

If population size varies from generation to generation, the average effective number over generations is given by harmonic means and therefore the size is affected heavily by the smallest population size encountered. In a small population, a sudden drop of the population size due to an accident or any disease could be experienced. Once such a reduction occurs in the history of the population, we can expect the fate of the population. Here, we assume a population which is maintained by 50 males and 50 females and a contraction of the population up to 5 males and 5 females has happened at generations 0, 10 and 20. The case t=0 is exactly the same to the population of 5 male and 5 female founders and thenceforth has been kept at a constant size of 50 males and 50 females. The results are seen in Figure 4, where the extinction comes sooner if the reduction occurs in later generations, because accumulated inbreeding effects may be disclosed by the reduction of population size. Experiencing its reduction at generation 0, the population survives until generation 55. It lasts until generation 82 in case of no reduction. Extinction will come at generation 38, i.e. 18 generations later, in the population which experienced the contraction at generation 20.

A temporal increase of the population size results in a longer life. For example, if the maintenance size of 5 males and 5 females were doubled at generations 10, 11 and 12 and again generations 20, 21 and 22, the life of the population extends twice.

In order to maintain a mall population it is often recommended to subdivide it into many lines (Yamada 1981; Rochambeau and Chavalet 1982). The subdivision may increase the probability of fixing a rare gene in the population as a whole, whereas nbreeding depression in fecundity, viability and sex ratio may increase the probability of extinction owing to the enhanced in-breeding rate. For instance, the longevity of a population will be 83 generations if the population were kept by 50 males and 50 females. If the population were divided into evenly 10 sublines and reunited at the stage when only one female survives in generation 12 in each subline, the entire population will disappear at generation 17.

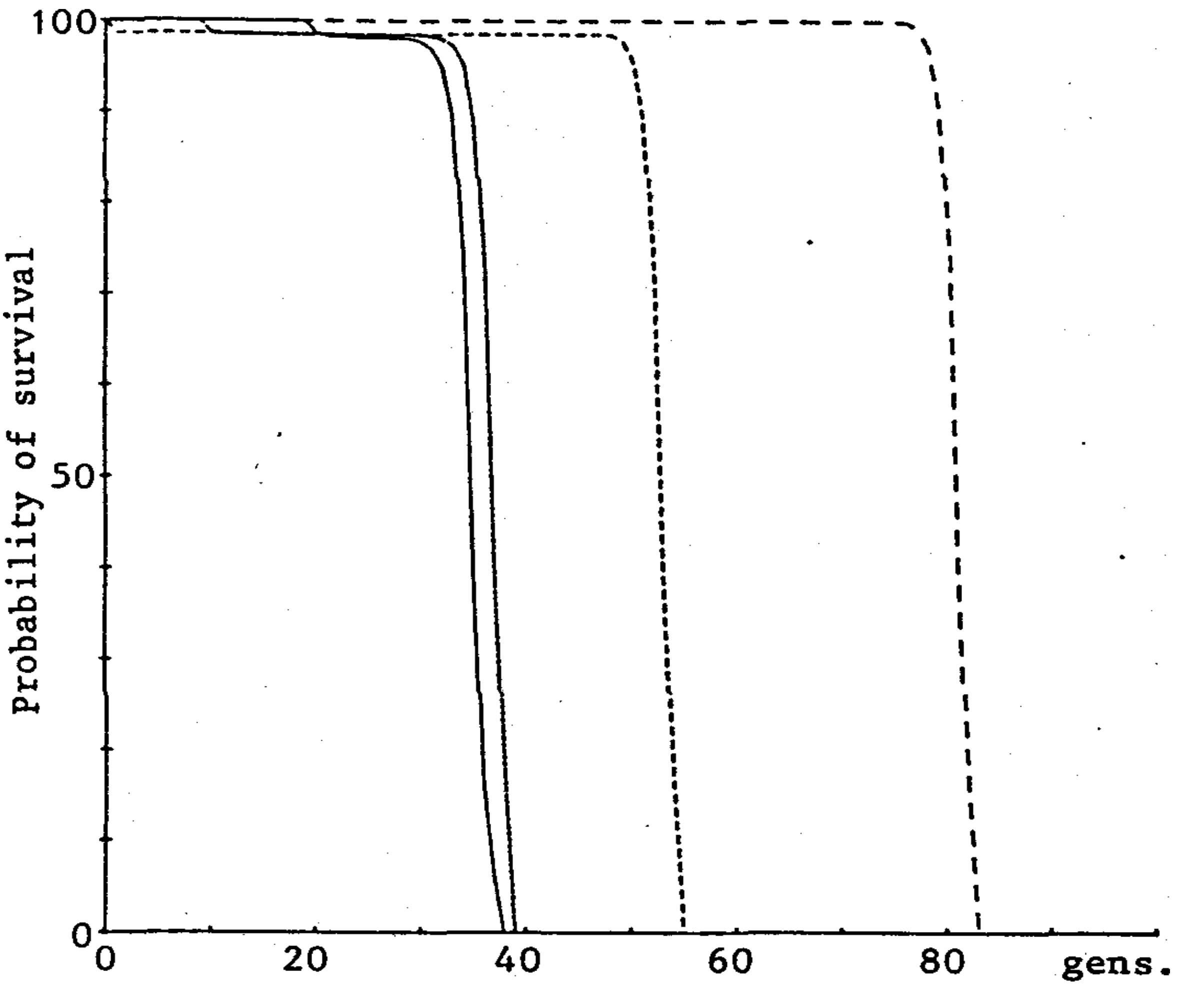

Fig. 4 Sudden reduction of population size and percent survival probability

4. STRATEGIES FOR PRESERVING ANIMAL GENETIC RESOURCES

From the results mentioned above, the following conclusions may be drawn:

i. In a small population, it is very difficult or otherwise impossible to preserve the animal as adult, due to inbreeding depression. Therefore, preservation should be made in the form of semen and embryo banks, provided that the techniques are available.
ii. The number of preserved individuals must be more than the "minimum herd size for restoration".
iii. To start any preservation programme, important parameters such as fecundity, viability, sex ratio and their inbreeding depressions must be estimated.
iv. Equal number of male and female embryos must be preserved if their sex is identifiable. Allowance should be taken to cover the loss due to spontaneous mutations during storage.
v. If it is necessary to preserve the animal as adult, the following should be taken into consideration:

   a. Maintenance size should be kept as large as possible and an effort should be made to enlarge the population size even if for a few generations.
   b. Sex ratio should be equalized.
   c. Preservation should be made in one large unit (or population) rather than in subdivided lines. Consanguineous mating should be avoided as much as possible. Circular mating (Kimura and Crow 1963) is not recommended for preserving a livestock population because the rate of inbreeding in early generations by this method is higher than by the mating of maximum avoidance of inbreeding (Wright 1921).

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ANIMAL GENETIC RESOURCES DATA BANKS

ANIMAL GENETIC RESOURCES DATA BANKS I, CONCEPT, OBJECTIVES, RESOURCES AND USES

Jan Rendel 1

1. BACKGROUND

The importance of maintaining genetic variability within and between farm animal populations, at the same time as these are subjected to improvement and change to suit the needs of man, has been amply stressed and discussed in earlier meetings and publications (e.g. FAO/UNEP 1981; Rendel 1975) and will not be further elaborated here. The action which needs to be taken in order to maintain variability or to utilize specific genetic traits such as adaptability to particular environments, e.g. high trypanosomiasis risk or exposure to high altitudes, requires precise information on a number of matters. In general, information is needed on the productivity of breeds or strains in a variety of environments, their breeding structure and population size as well as on specific characteristics of the environment where production is going to take place. Often the wanted information is incomplete, insufficient or even totally missing.

For obvious reasons the information systems vary considerably between countries and are often weak in the developing countries. This particular session will be devoted to reports on existing information systems and data banks and to discussions on how these may be further developed and strengthened. 1 think it would be useful if we could focus our discussions on the kind of information which is of particular importance to breeding programmes and genetic conservation in the developing countries and on how collection and dissemination of such information and data may be best organized taking full cognisance of existing data banks and remembering that it may prove very difficult to find funds for financing additions to existing international or regional data and information handling programmes.

It is also important to define the term "data bank" from the very beginning. What type of data and information should a unit collect, keep and disseminate in order to classify as a data bank. Opinions may vary. Personally I would like to keep a wide definition and include the whole gamut of information from unprocessed data on individual animals and herds to abstracts of published reports as well as listings of breed associations, breed distributions, and use of artificial insemination, etc.

2. WHAT TYPE OF INFORMATION AND DATA ARE NEEDED?

It should be recognized that data banks and information centres will have to serve many purposes and different types of clients. The level of detail at which a centre will be able to work depends to a large extent on the geographical area it serves, i.e. whether it is national, regional or international in scope. The national data banks may keep unprocessed data on individual animals and herds, while regional and international units, for reasons of economy, will need to limit themselves to processed and summarized data and published and unpublished reports.

For animal genetic resources work one may largely distinguish between four broad groups of data:

a. Information on the number and distribution of breeds/strains of a given livestock species within countries or regions.
b. Information on breeding activities, e.g. breed societies, recording schemes, selection programmes, artificial insemination services, etc.
c. Data on the productivity and adaptability of animal strains in specified environments, preferably in comparison to one or several other strains used in the same environment.
d. Information on breeds in need of conservation and their specific "virtues".

3. PRESENT ORGANIZATION OF DATA BANKS

The national activities for data collection, processing and use are of particular importance to breeding improvement. In the industrialized countries fairly large resources are devoted to livestock recording schemes and the processing and evaluation of data. The data centres have become cornerstones in elaborate breeding improvement programmes. These developments have largely taken place during the last three decades.

In the developing countries there are but a few examples of national production recording schemes. Information on individual animal productivity and adaptability is therefore very incomplete in these areas. This meeting will need to give considerable thought to how data recording, processing and evaluation can be improved in the developing countries.

In order to improve the situation and to collect and make available what information (published and unpublished) there is available on animal genetic resources, praiseworthy stop gap operations have been undertaken by regional organizations such as IBAR, ILCA, ALPA and SABRAO[1]. We will hear details on these activities later on today. ILCA has for instance built up a computerized reference centre from which interested clients may receive reports and summaries on microfiche. A similar data bank dealing with information on the water buffalo is being built up in Bangkok with funds from the International Development Research Centre (Ottawa) (IDRC).

The question as to how regional bodies may realistically be able to collect detailed information on national animal strains has come up in several discussions recently. IBAR has tried to collect detailed information on livestock productivity through Ministries of Agriculture in member countries by sending out/?/ questionnaires. The results were, however, rather disappointing. SABRAO, which is a society for geneticists and breeders in Asia and Oceania, is currently involved in the collection of breed data by use of a rather elaborate questionnaire. Personally I am somewhat sceptical about placing high hopes on getting information by questionnaires. However, lacking better means one may have to rely on them to some extent. In the end it will be necessary to develop some kind of national data base in every country wanting to be involved in breeding improvement.

Internationally there are several data and reference systems. By tradition animal geneticists are utilizing the excellent services provided by the Commonwealth Bureau of Animal Breeding and Genetics and its Animal Breeding Abstracts. On request, and for a relatively modest fee, clients may purchase tailormade bibliographies and abstracts on specified subjects. We will hear more about this in the contribution by Dr. Turton.

4. FUTURE NEEDS

The crucial problem with regard to animal genetic resources data banks, as 1 see it, is how to obtain the very much needed information on animal productivity and related data in the developing countries where there is so little organized production recording. Obviously one has to collect what little information there is and try to apply or extrapolate that information to other locations in the developing countries with similar conditions. However, action will also have to be taken to tackle the root of the problem, i.e. to improve the data recording. FAO has taken a number of initiatives in this regard and I think a part of our discussion will have to be devoted to this basic question. FAO has also employed two consultants to review the data bank systems in Africa and Latin America. Dr. Plasse will report on the latter region at this meeting and Dr. Philipsson's report on Africa has been distributed to you. We will hopefully get comments from the two main parties involved in data banks in Africa, IBAR and ILCA.

The future animal genetic' resources data bank sytems in the developing countries could most profitably be built up around existing national and regional organizations. The obvious place for national units will in most cases be in livestock production divisions of Ministries of Agriculture or Livestock Development where genetic resources information may be collected and kept together with other types of information on livestock production. It is, however, important to connect such national units to existing regional data and information centres and through them to develop uniform reporting routines. The regional data banks may thus have a key role in the future build-up of information systems in the developing regions. One question of considerable importance is to identify and strengthen existing and potential regional information centres so that they may play the role which is called for.

In the title of my little contribution given to me by the organizers of this consultation the word "uses" of the data banks comes last. Perhaps it should have come first as the utilization and usefulness of the data banks must be of prime concern. The participants in this meeting probably take for granted that information on animal genetic resources is useful and will be used. The major international information centre on animal genetic resources, the Commonwealth Bureau on Animal Breeding and Genetics, ha no doubt proved itself indispensable in the minds of many animal geneticists. But how is the situation for the regional units which are in existence or are being built up? What "niches" should they occupy? How much are they now being used by clients from the respective regions? There may be a need for a more precise definition of their roles and perhaps slightly more aggressive information about their existence so that they are more widely used by potential clients.

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THE CURRENT PROJECTS FOR CREATION OF DATA BANKS BY FAO/UNEP

John Hodges1

1. BACKGROUND

The idea of data banks on Animal Genetic Resources was proposed, among other items, at the 1980 FAO/UNEP Technical Consultation. Since then most of the recommendations from that Consultation have been funded by the joint FAO/UNEP Project on the Conservation of Animal Genetic Resources Phase II. This includes provision for the establishment of pilot data banks in Africa, Asia and Latin America in cooperation with existing regional/sub-regional/national institutions. FAO has also included funding for data banks in its Regular Programme.

This paper outline the steps taken by FAO to date. The work is at an early stage. We do not have a comprehensive or infallible method. In fact, we really only have a concept and a list of ways in which it could contribute to animal genetic conservation and management. We have to build up our own experiences in this field, although others have developed data banks in other disciplines. My contacts with them, over the last 12 months, however, have indicated that the style of the data bank depends very much upon the subject matter. We are therefore in need of experience. Consequently, the work of FAO and UNEP in the last 12 months has been in the direction of setting up pilot trials of methodology, which will reveal difficulties and problems as well as, hopefully, successes. Rather than attempt to draw up one large-scale pilot trial for the different regions of the world, we have established different approaches in Asia, Africa and Latin America. Unquetionably people in each country and region will have insights and suggestions to contribute.

Another very important aspect of the work which we in FAO have investigated is the existing system of research and production data which is offered by such institutions as the Commonwealth Bureau of Animal Breeding and Genetics. We do not want simply to duplicate what they are doing, especially as they are now computerized.

2. OBJECTIVES

The purpose of data banks is to provide a comprehensive, and accessible decription of the characteristics of each breed and established crossbred population of livestock and birds, together with characterization of the environments to which the breed or cross are adapted. The characteristics to be described include all the production traits for the food, fibre or work products of the animals concerned, in addition to the distinguishing physical features of the breed. Separate values for genetic and phenotypic traits should be given. Reproductive performance should also be characterized. Estimates of the numbers of animals and their distribution should be given. Facility should be provided for the data banks to include information on newly investigated characteristics, such as blood and biochemical traits, karyotyping, and immunological characteristics. The data banks should provide the opportunity to record the suitability of breeds for crossing and the known performances of the crosses. It is essential that they remain open ended for the addition of later information, and for updating.

3. USES

The data banks will be used for providing easy access to all the known information on a breed or cross, and thus avoid the user having to make an individual search and analysis. The information will then be used to identify breeds which are at risk of extinction, so that preventative action may be taken; and breeds known to make or be capable of making valuable contributions to human welfare in present circumstances, will be identified and genetic improvement programmes formulated. If appropriate these could be on an intercountry cooperative basis, so that the sub-populations of a breed are managed and improved with knowledge of what others are doing with other sub-populations of the same breed. The data banks will also be suitable for research into genetic characteristics, for extension and for the promotion of breeds and crosses to other parts of the region and world to which they may be adapted, but where they are unknown.

An important feature of data banks is that they should not be simply repositories of all the existing reports and research findings on a breed. For the latter, such repositories already exist in the Animal Breeding Abstracts of the Commonwealth Bureau of Animal Breeding and Genetics, which are held in the Lockheed data base in California. Output from that data base consists simply of the abstract of the research publication. The data bank for animal genetic resources is rather visualized as a comprehensive statement of the characteristic of the breed under specific conditions of management and of the environment, arranged in such an orderly format within the data bank using uniform Descriptors for each species, so that comparisons can be made relatively easily between different breeds, and genetic analyses carried out. It would be possible for example to seek those breeds which are adapted to a certain climate, with specific disease tolerance and to obtain full descriptive characterizations of the breeds fitting these categories.

4. METHODOLOGY

The critical point in the creation of the data bank, is the compiling of the data. In our view, this should be done by a compiler, who will be a competent animal scientist, with administrative assistance to help him collect the reports and papers and documents from which the compiling is done. The compiler will seek to characterize the breed he is working with, by studying all the known information on the breed, and compressing it into a valid formal comprehensive record of facts about the breed. The compiler will have to be able to discern between valid and invalid information and give appropriate emphasis to the results from them. Indicator keys may well be used to show the authenticity of the characterization, which may be improved later when more information is published. The compiler will seek to enter as much of the data as possible in numeric form, but where this is clearly impossible, it will be entered in word form. An important stage of the proces will be the design of the format, which will be sufficiently standard to permit exchange of information to other parts of the world at a later stage, and yet be flexible enough to encompass all the facts about a species.

The compiler will thus write compilations of the breed. These will later be entered into suitable data/word processor, which needs to be simply a minicomputer serving a whole region or part of a region. It is not visualized at this stage that each country will need its own minicomputer, but rather that the compilations should be sent to a regional minicomputing centre where they will be entered and checked for errors.

In the early days of gaining experience in this work with pilot data banks in selected countries, it may be an advantage to send all the compilations to a global minicomputing location, where we shall be able to gain experience with the type of machine most suited to the work, as well as to share experiences of compilers.

5. SUB-CONTRACTS

FAO has entered into contracts for local one year pilot projects as follows:

Asia :	Malaysia, Sri Lanka and Thailand
Africa :	Interafrican Bureau of Animal Resources, working with ILCA
Latin America:	Venezuela and Mexico

The representatives from each region will describe what they are doing in detail at this meeting.

At the end of the year, we visualize the need to bring together the findings on methodology and Descriptors which are being documented in each case, to sieve through, to learn collectively, and to move to the next stage of a recommended procedure, which will be more widely applied in each Region. We are also in the process of making initial proposals for a data bank study in the Middle East Region.

PROSPECTS AND PLANS FOR DATA BANKS ON ANIMAL GENETIC RESOURCES

K.O. Adeniji1

1. INTRODUCTION

The Interafrican Bureau for Animal Resources (IBAR), of the Organisation of African Unity (OAU), is the overall organ responsible for coordinating the activities of the 50 member states on animal resources. IBAR, through the Scientific, Technical Research Commission (STRC) of the OAU organizes scientific meetings for the Directors of Livestock Resources in Africa every two years. It was during such meetings that the animal production section of IBAR identified some Indigenous Breeds of High Productive Potential which are in great demand and introduced the concept of Conservation and Preservation of Endangered Indigenous Breeds which might currently seem uneconomic but might have potential for use in future breeding programmes. The discussions that followed revealed that there are several other breeds unknown to IBAR worth investigation with proper documentation. Thus the idea of a data bank for Africa had already been gradually formulated.

2. THE PROSPECTS FOR A DATA BANK ON ANIMAL GENETIC RESOURCES IN AFRICA

In IBAR, there is an established documentation centre which serves as a reference library for all livestock activities in Africa. This library started to function in the early fifties when the office was still called Interafrican Bureau for Epizootic Diseases (IBED). As the functions of the bureau were expanded, so did the library. When finally in 1969 the meeting of the Directors of livestock services of all OAU Member States recommended, amongst others, that the activities of the office be further expanded to include livestock production and marketing, an Animal Production Section was further developed in the library. Since than all efforts continued to be made to achieve the objective of making IBAR library the reference centre on Animal Resources in Africa.

2.1 Livestock Statistics and Distribution Maps

During the OAU/STRC Meeting on Animal Health and Production in Khartoum in 1973, it was discovered that the available data on the livestock industry in Africa was so inadequate and scanty that a reasonable assessment of the existing trends in development could not be made. It was emphasized that any meaningful livestock development programme would require accurate figures of the livestock numbers in individual countries. Since only rough estimates were available, which in most cases were outdated, the animal production section of IBAR was given the mandate to produce reliable figures on livestock numbers in Africa. Thus, an appeal was made by the section to the governments of member states to launch surveys in this field and endeavour to gather more accurate and up-to-date information on a sustained basis. It was agreed that such information should be forwarded to I BAR. As a result data collection, mainly on a desk basis, continues to be received in IBAR.

IBAR in 1976 produced the first ever distribution maps of cattle and in 1981 sheep and goats showing the numbers and producing areas in Africa. The aim is to be able to monitor livestock numbers in various parts of Africa and also to identify areas where developmental efforts should be directed in the region. It was discovered from the cattle distribution map that there is an inverse relationship between tsetse infestation and absence of cattle in a given area. These maps, it was recommended, should be updated every five years. The second edition for cattle that was produced in 1980/81 indicated there was a 10 percent increase in population numbers.

2.2 Breed Distribution and Characteristics

With the successful completion of livestock distribution maps an attempt was made albeit through a questionnaire to estimate the population numbers of indigenous breeds of cattle, sheep and goats. The results have not been very encouraging. The only one available to-date was the feasibility study carried out by the America's Development Foundation on trypanotolerant cattle in West Africa. As a result, it was concluded that member states would require financial assistance among others to undertake estimation of population numbers of indigenous breeds in their countries. Alternatively, specific projects could be set up to gather such information. However, the population numbers of endangered breeds are available because of their small numbers and the attention they are presently receiving.

At the various meetings of the OAU/STRC on Animal Health and Production, IBAR was asked to produce a standard format for collecting information on cattle breed characteristics. An important consideration was that it must be simple and straight to the point. Consequently, in 1977, a simple questionnaire was sent to member countries in order to identify indigenous cattle breeds and their characteristics. The replies were very encouraging and it was concluded that for a quick response from member states questionnaires must not be complicated to fill in. The information gathered was summarized and read to the first OAU expert committee on animal genetic resources in Africa held in Nairobi in 1981.

2.3 Livestock Breeding Policies

The development of animal genetic resources in any country will require systematic and well coordinated breeding programmes based on thoroughly evaluated national breeding policies. In order to document the breeding policies of member states in IBAR, enquiries were made in 1978 and if possible the extent to which such policies have been successful in furthering the national goal in increasing animal production. The few replies were summarized for the Expert Committee Meeting. This was further supplemented by reports produced by committee members on livestock breeding policies or programmes adopted in their countries. Since it was realized that a number of member states do not have breeding policies, the expert committee proposed breeding programmes for the different ecological zones of Africa which have received wide circulation. IBAR has followed this up by liaison visits to some countries. It is hoped that member states will make use of this to develop their own policies and where they encounter difficulties IBAR could be approached.

2.4 Expert Committee on Animal Genetic Resources in Africa

At the OAU/STRC Meeting on Animal Health and Production in Algiers in 1976, the animal production section of 1BAR read a paper on the conservation, preservation and utilization of indigenous breeds. The discussion that followed recommended that I BAR should set up an OAU Expert Committee on Animal Genetic Resources in Africa. The first meeting of this committee was held in Nairobi in 1976 and the agenda included the following:

- to review and discuss problems related to the state of animal genetic resources in Africa;
- to develop or propose breeding programmes for the ecological zones in Africa;
- to further identify, document and evaluate the indigenous breeds;
- to develop management systems to maintain genetic variability and continuous improvement;
- and advise IBAR on lines of action to take in increasing livestock production in Africa.

The report and recommendations of the meeting have received wide circulation in and outside Africa.

3. PLANS FOR DATA BANK ON ANIMAL GENETIC RESOURCES IN AFRICA

An important agenda for the first OAU expert committee meeting was to further identify, document and evaluate the indigenous breeds. At the conclusion of discussion the committee made the following recommendations:

to Member States to:

- regularly collect data on their indigenous breeds and strains;
- assist and support the establishment of a data bank for the documentation of the various indigenous breeds and strains in Africa;
- support the establishment of subregional centres for comparative evaluation studies of similar breeds and strains;
- encourage research institutions in their respective countries to include evaluation of the productivity and adaptability of the various indigenous breeds and strains in their research programmes.

to OAU/IBAR to:

- develop, with the asistance of the committee, an identification and documentation format to assist member countries in the collection of data on their indigenous breeds and strains;
- establish with the cooperation of FAO a data bank for the documentation of the various indigenous breeds and strains in Africa;
- encourage, support and coordinate the establishment of regional and subregional centres for comparative evaluation studies on similar breeds and strains in Africa;
- assign specific duties to members of the committee as the need arises in assisting member states.

At the FAO/UNEP technical consultation on Animal Genetic Resources Conservation and Management held in June 1980 in Rome, these two organizations were also called upon to assist member countries in the development of a data bank for livestock resources in member countries and in its coordination at regional level.

In the light of the two recommendations, a consultant was appointed to assist the Africa region to design a data bank system. The consultant visited a few selected African countries, the International Livestock Centre for Africa (ILCA) and the IBAR office in Nairobi. The consultant report has already been widely distributed. IBAR has been recommended by the consultant to be responsible for the future development and utilization of the data bank system.

The consultant was able to collect a lot of information from ILCA's computerized documentation centre which supplemented that already available in IBAR's library. The advantage of ILCA's computerized system was that the information is retrievable by breeds, ecozones and production systems. In view of this, ILCA will serve as the major source of information for the data bank.

The second OAU expert committee meeting to be held in Zimbabwe in November 1983 will discuss reviews on different breeds, using references retrieved from ILCA's computerized information system which is now available in IBAR. Furthermore, the experts will also indicate which of the references should be retained in the Data Bank for the breeds and strains. This meeting at the regional level will be held every two or three years. In 1984, subregional workshops on specific breeds will be held as well, starting with the Eastern and Northern African states in Ethiopia. All the resulting information will be fed into the data bank which in turn will be disseminated to member states and all other interested parties all over the world.

The expert committee is presently composed of 10 members from the five subregions of Africa. It is hoped that at the second meeting in Zimbabwe, there will be 13 members. As and when experts on Animal Genetic Resources are known to us it is planned to increase the number to fifteen. This does not include ILCA and FAO staff who will be permanent members of the committee. Thus, the expert committee will advise on the documentation, operation and use of the data bank.

ANIMAL GENETIC RESOURCES DATA BANKS

J.C.M. Trail1

There are two main areas in which ILCA is active that are of relevance to this subject.

1. Information and documentation,
2. Analysis and interpretation of livestock production data at the request of national research organizations.

1. INFORMATION AND DOCUMENTATION

ILCA has placed considerable emphasis on its documentation and information services at its headquarters in Addis Ababa. A great deal of livestock research has taken place in Africa, particularly during the last 40 years, that very little is known about. National programme annual reports lie unread for want of being printed, consultants' reports get no further than the institute that commissioned them, and information on location specific research tends to remain very location specific. Successful livestock research relies heavily on data generated by earlier work. If these are not available then research gets duplicated. ILCA was aware of this state of affairs when it began its operations in 1976. Not only did the centre want to help African researchers in their need for more information, but ILCA's own staff had to be well informed about previous work in the continent if research projects were to make an impact.

ILCA therefore began by sending documentation staff to countries throughout sub-Saharan Africa to seek out those documents on livestock research and production that might otherwise become lost or go unnoticed. Growing awareness of the value of the information collected in this way led ILCA to seek additional funding for its documentation activities. The International Development Research Centre (IDRC) in Ottawa has generously financed a significant portion of ILCA's expanded documenta-tion programme since 1978. Documents selected are microfiched on site in the countries visited. Having visited 17 countries in sub-Saharan Africa over the past 5 years and microfiched more than 10 000 documents, ILCA now has a unique collection of information on livestock research across the continent. Titles, descriptors and abstracts of the entire collection have been entered into a computerized data base and are accessible online. Any researcher in Africa wanting information on a particular subject can simply send a request to the Documentation Centre, who will search the data base and send back a list of references. The researcher selects those references of most interest, and ILCA then sends him or her photocopies of the full documents free of charge.

In 1983 a further service unique in Africa was launched. This service provides personalized information on world agriculture on a monthly basis to any African livestock researcher who requests it. ILCA has formed close links with two of the world's leading agricultural data bases, the Commonwealth Agricultural Bureaux (CAB) and FAO's AGRIS service. Each month CAB and AGRIS send the new additions to their abstract collections on magnetic tape. These tapes are loaded onto ILCA's computer, and the Documentation Centre makes searches of the tapes based on the individual search profiles drawn up for each scientist receiving the service. Titles, abstracts and key words of any relevant articles are then printed and sent free of charge to the scientist. In this way any African researcher who wishes can be kept up to date with the world literature by simply sending details of his or her research interests to ILCA's Documentation Centre. This selective dissemination of information (SD1) service is appealing to growing numbers of scientists in African national programmes.

2. ANALYSES AND INTERPRETATION OF LIVESTOCK PRODUCTION DATA AT THE REQUEST OF NATIONAL RESEARCH ORGANIZATIONS

As was reported in the first issue of "Animal Genetic Resources Information", ILCA has been, and is, involved in a considerable number of comparative breed studies, invariably in cooperation with national organizations or private producers, and sometimes with other international organizations. The initial aim is to build up comparative production information on important livestock groups in Africa so that decisions can more easily be made when breed has been shown to be a bottleneck in a particular production system; and so that the many questions directed to ILCA on the value of alternative genotypes for specific production sytems in various ecological zones can be better answered.

Examples of important breed groups are as follows:

i. Trypanotolerant indigenous *Bos taurus* cattle and trypanotolerant sheep and goats

   a. Considerable general information has been pulled together in the ILCA/FAO/UNEP report on trypanotolerant livestock in West and Central Africa (Report 1 in Appendix). In the network oftrypanotolerant livestock situations, quantitative data are currently being built up especially in Gabon, Ivory Coast, Nigeria and Zaire.
   b. Two Senegalese research scientists completed fellowships of 5 months each. One analysed the productivity of N'Dama cattle and the other the productivity of Djallonke sheep from records collected at the Centre de Recherches Zootechniques, Kolda, Senegal, between 1973 and 1981 (Report 2 in Appendix).
   c. A research scientist from Sierra Leone completed a 5-month fellowship on analysis of the productivity of N'Dama cattle at Teko Station, Sierra Leone, and the initial effect of introduction of Sahiwal genes (Report 3 in Appendix).

ii. *Bos indicus* cattle

   d. In Mali, joint analyses were carried out on ten years' data on the Maure and Peul breeds at the Sahelian Station, Niono (Report 4 in Appendix).
   e. In Ethiopia results of dairy crossbreeding work at the Arsi Rural Development Unit have been analysed by a visiting scientist *in* cooperation with ILCA's Highlands Programme (Report 5 in Appendix).
   f. In Kenya analyses are continuing of data on the Boran and its crosses with several different breeds under a range of management systems and ecological zones. These data were collected on 11 commercial herds, over a considerable number of years (Report 6 in Appendix).
   g. In Kenya, the Sahiwal and Ayrshire x Sahiwal crosses were studied under a range of production systems, the Sahiwal being the outstanding source of *Bos indicus* genes for milk production and let-down capacity available in Africa (Report 7 in Appendix).

iii. Sanga cattle

   h. A research scientist from Zimbabwe is currently on a 4-month fellowship, analysing data from Matopos Station of Africander, Mashona, Nkone and Tuli and their croses within several different breeds (Report 8 in Appendix).

APPENDIX

MAJOR RESERACH REPORTS ON BREED PRODUCTIVITY1

	Title	Reference	Language	Availability
1.	Trypanotolerant livestock in West and Central Africa: Vol. 1, General study; Vol. 2, Country studies, by J.C.M. Trail, C.H. Hoste, Y.J, Wi.ssocq and Ph. Lhoste in collaboration with T.L. Mason	Monograph 2	English/ French	Now
2.	Evaluation of the productivities of Djallonke sheep and N'Dama cattle at the. Centre de Recherches Zootechniques, Kolda, Senegal, by A. Fall, M. Diop, J. Sandford, Y.J. Wi.ssocq, J, Durkin and J.C.M. Trail	Research Report 3	English/ French	Now
3.	N'Dama cattle productivity at Teko Livestock Station, Sierra Leone, and initial results from crossbreeding with Sahiwal, by S.F. Carew, J. Sandford, Y.J. Wissocq, J. Durkin and J.C.M. Trail	Research Report	English	In press
4.	Evaluation of productivity of Maure and Peul cattle breeds at the Sahelian station, Niono, Mali, undertaken by the International Livestock Centre for Africa and the Institut d'Economie Rurale du Mali	Monograph 1	English/ French	Now
5.	Crossbred dairy cattle productivity in Arsi region, Ethiopia, by G.H. Kiwuwa, J.C.M. Trail, M.Y. Kurtu, F.M. Anderson and J. Durkin	Research Report 11	English	Now
6.	Productivity of Boran and crossbred cattle, by J.C.M. Trail, K.E. Gregory, J. Sandford and J. Durkin	Research Report	English	1984
7.	Sahiwal cattle: An evaluation of their potential contribution to milk and beef production in Africa, by J.C.M. Trail and K.E. Gregory	Monograph 3	English/ French	Now
8.	Breed and heterosis effects on beef cattle production parameters in Zimbabwe, by P. Tawonezvi and ILCA authors	Research Report	English	1984

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*S*OME ASPECTS OF ANIMAL GENETIC RESOURCES AND DEVELOPMENT OF DATA BANKS IN LATIN AMERICA

Dieter Plasse1 2

1. INTRODUCTION

Animal genetic resources conservation and management is a subject of considerable concern among people related to animal production in Latin America. Although, to a certain degree, it refers to all species used in animal production, at present interest is mainly focused on Criollo cattle, sheep and camelidae.

In 1978 an FAO/UNEP Expert Consultation was held in Bogota, Colombia, where the present status of genetic resources of Criollo cattle, sheep, goats, camelidae and guinea pigs was discussed and an inventory was presented of countries and experiment stations, which are carrying out research with each of them (Müller Haye and Gelman 1981).

In the following paper, a brief summary of the present situation is given by species, together with a discussion of the work which has been started on the formation of data banks.

2. PRESENT STATUS OF ANIMAL GENETIC RESOURCES AND THEIR CONSERVATION IN LATIN AMERICA

2.1 Camelidae

In the Andes of South America, four populations of camelidae exist: Llama, alpaca, vicuña and guanaco. The former two are domesticated, the latter two are not.

Of the 9.8 million head existing today (Novoa 1980), the great majority are found in Bolivia and Peru and only a small number in Argentina and Chile.

These animals which live between 3000 and 5000 m altitude guarantee the subsistence of man in these areas, serving him with meat, fibre and skin. Even their excrements are used and the llama is also an important means of transportation. Llamas and alpacas were very important in the Inca empire, where their numbers reached maximum values. After the Spanish invasion in 1532, however, their number decreased considerably (Flores Ochoa 1977) and, especially the guanaco and vicuña were in danger of extinction during the 1960s (Cardozo 198la). However, after the treaty of La Paz was signed in 1969 by Peru and Bolivia and later by Argentina and Chile, the population increased considerably as consequence of policies which protected these groups and guaranteed increase of their numbers. This treaty has recently been renewed for another 10 years.

Bolivia and Peru have been especially successful in protecting the remaining camelidae populations and stimulating their increase by adequate legislation and policies (Cardozo 1981a; 1981b; Novoa 1981). This constitutes a good example of what can be done in genetic conservation.

2.2 Cattle

The rapid decrease in the number of Criollo cattle in Latin America has been of general concern. These *Bos taurus* cattle were brought to the region by the invading Spaniards and Portuguese during the 16th century and during the last 60 years they have been increasingly crossed with bulls of different *Bos indicus* populations.

In 1977 FAO published a bibliography on Criollo cattle (Müller Haye 1977) giving evidence of a large volume of existing literature on these populations including valuable research reports. During the 1978 FAO/UNEP conference, reviews of research with Criollo cattle were given for milk production (Bodisco and Abreu 1981; Muñoz and Deaton 1981; De Alba 1981a), meat production (Hernandez 1981; Plasse 1981) and other aspects (Salazar and Cardozo 1981; De Alba 1981b; De la Torre 1981). Recommendations were made on how to conserve the small remaining populations (Müller Haye 1981). A recent review on crossbreeding for beef production in tropical Latin America includes all work done with Criollo cattle in this area (Plasse 1983).

Research on Criollo cattle is being carried out in Argentina, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador and Mexico (Müller and Gelman 1981).

In several countries, official, semi-official or private efforts exist to conserve Criollo cattle. Results mainly from crossbreeding have recently encouraged certain scientists and producers to assume a positive attitude towards the necessity for conservation programmes in Criollo cattle.

Other cattle populations of presently local importance such as the Dominican Romana Red, Cuban Siboney, Jamaica Hope, Jamaica Red, Brazilian Pitangueira, Colombian Licerna, Venezuelan Carora and others, which have been selected under tropical conditions and seem to have certain adaptive and production traits which give them an advantage in certain production systems, should be looked upon when cattle genetic resources are evaluated in the future.

2.3 Sheep

There are native sheep populations in Latin America, which certainly deserve conservation programmes. They are adapted to a particular and difficult environment where imported improved breeds often cannot even survive. They are especially important for small producers.

Research with native sheep is being carried out in Argentina, Barbados, Cuba, Jamaica, Mexico, Peru and Venezuela (Müller Haye and Gelman 1981). Mason (1980; 1981) has given a summary of the present knowledge of these populations in the tropical areas of Latin America, where they are used for meat, wool and natural fertilizer.

2.4 Goats

There are many areas in Latin America where man can only live because goats provide him with a base for subsistence. About 75 percent of all goats in Latin America are found in Argentina, Brazil and Mexico. The present situation of native goats as a genetic resource in Latin America was reviewed by Mason (1981). Research with goats is presently being carried out in Brazil, Jamaica, Mexico, Peru and Venezuela (Müller Haye 1981).

2.5 Swine

There is little known and published about native swine populations in Latin America, however, they do exist and should be evaluated. Such recommendation had also been included in the conclusion of the 1978 FAO/UNEP conference in Bogota (Müller Haye and Gelman 1981).

2.6 Poultry and Other Birds

Poultry are of increaing importance in Latin America and limited genetic work has been going on in a few countries. The conclusions of the 1978 FAO/UNEP conference in Bogota included a recommendation to FAO to organize a seminar on swine and poultry genetic resources in Latin America (Müller-Haye and Gelman 1981).

3. PRESENT AND FUTURE WORK ON ANIMAL GENETIC RESOURCES AND DATA BANKS IN LATIN AMERICA

Two important recommendations, which resulted from the 1978 FAO/UNEP Expert Consultation on the Evaluation and Conservation of Animal Genetic Resources were that (i) FAO should promote and support respective activities in Latin America and (ii) the Latin American Association of Animal Production (ALPA) should set up a commission on Evaluation and Conservation of Animal Genetic Resources in Latin America (Müller Haye and Gelman 1981).

In October 1981, the Board of Directors of ALPA approved the establishment of such a committee and its members are expected to be formally nominated this year. Meanwhile, in April 1983, the author was designated coordinator ad honorem for FAO of the pilot project to establish data banks for animal genetic resources in Latin America. The intention remains to combine efforts of FAO and ALPA to work in this field on a cooperative basis starting in 1983.

The necessary contacts for the establishment of data banks have been made and it is intended to start the following pilot projects during 1983/84: for cattle in Venezuela, for swine and sheep in Mexico and for camelidae in Peru. The Mexican and Venezuelan groups have started to work and are presently awaiting the letters of agreement between FAO and their institutions to be signed during October 1983. It is hoped that work in Peru can start in 1984. FAO/UNEP are giving financial support for these pilot programmes.

The following preliminary objectives for the establishment of data banks in Latin America have been proposed:

i. Assemble all existing literature on species of importance in animal production in Latin America, classifying it according to the traits included and their parameters, to environmental conditions and production systems, as well as to the scientific reliability of the source of information.
ii. Characterize species of importance in animal production in Latin America, with emphasis on those in danger of extinction, according to genotype, geographical distribution, objectives and type of production system, and priority for conservation. Provide quantitative information, derived from specific references, on important traits and their parameters together with information on the environmental conditions under which the data were obtained. Present a summary of the information included for each of the traits considered.
iii. Offer the user various options for the retrieval of the information, according to the classification criteria described.

The information output will contain two options:

1. Programme A describes the publication in general terms and by trait included.
2. Programme B provides general information as well as specific data by trait for the population under consideration.

Programme A is for the classification of literature referring to the species in question in Latin America and will include:

- general information
- specific information by trait:
  - . list of traits included
  - . parameters and additional information given for each trait.

Programme B gives the description of the species in question in Latin America and includes for each population:

- general information
- specific information by trait
- summary of information by trait.

It is felt that a classifiable bank of references is necessary since existing abstract services do not cover a large part of the Latin American literature. However, the central part of the data bank will be concerned with a description of the populations classifying and reporting the sources of information in each case.

For cattle, sheep and swine, the formats of these programmes are presently being finished and programming and data assembling will start when the letters of agreement are signed. The working programme of this first phase will include:

- development of the respective computer programmes;
- compilation, coding and processing of all data on Criollo cattle in Venezuela, Tabasco sheep in Mexico and a yet to be defined swine population in Mexico, all with the respective references.

This work will serve to test the computer programmes and make the necessary adjustments.

Future work will include:

- establishment of the data banks on camelidae, goats and birds;

- extension of the work started in each data bank to all existing populations of the respective species in Latin America.

The realization of this plan will depend on the availability of financial support during the next years.

It is hoped that FAO and ALPA will work out the objectives and strategies of a long term cooperative programme for the evaluation, conservation and management of animal genetic resources in Latin America, which, apart from the establishment of data banks, must also include the following aspects:

i. publication of population descriptions with relation to environment and
ii. production systems;
iii. identification of populations which need to be protected by conservation programmes;
iv. encouragement of governments and institutions to establish such conservation programmes and advice on their design and execution;
v. encouragement of research on genetic resources, identification of priorities and suggestions on national and international research programmes.

It is hoped that work will meet with the necessary intellectual and financial support, so that it may be carried out along these lines during the years to come and contribute to a more rational use of animal genetic resources in Latin America.

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ANIMAL GENETIC RESOURCES DATA BANK PROGRESS IN ASIA WITH SABRAO

P.N. Bhat1

SUMMARY

This paper discusses the history, origin and the progress so far of the Animal Genetic Resources Data Bank of SABRAO. The concept of a data bank was approved by SABRAO in 1979 and an inventory of personnel/institutions organizations connected with or interested in animal genetic resources was completed in 1981. This is being updated every year. The computer readable formats for collection of information on various species and breeds within species have been distributed for collection of the data. These are being sent to the Computer Centre of the National Institute of Animal Husbandry, Tsukuba, Japan, for processing and storage.

At the 3rd Congress of Society for Advancement of Breeding Researches in Asia and Oceania (SABRAO) held in Canberra, Australia, in February 1977. the Farm Animals Section recommended that the SABRAO Board should set up an Expert Committee on Animal Genetic Resources to investigate the problems connected with the collection and collation of data on breeds, strains and varieties of economically important /?/mestic animals of the SABRAO region. The SABRAO Board accepted this recommendation and constituted an Expert Committee on Animal Genetic Resources for this purpose and for evaluation, conservation and utilization of animal genetic resources of the SABRAO region. As a result, the first workshop on animal genetic resources in Asia and Oceania was organized at the University of Tsukuba in September 1979. The objectives of the workshop were to examine (i) what were the animal genetic resources available in the SABRAO region; (ii) the status of information regarding these resources.

This workshop was primarily devoted to finding out the status of information about identification, documentation and evaluation of animal genetic resources in the SABRAO region and to identify the gaps in the knowledge which need to be filled, the actions which could be initiated by SABRAO in consultation with national governments of the region, or in association with international organizations with similar aims like FAO and UNEP. Major issues in regard to animal genetic resources in the region were discussed in detail and it was noted that already considerable information on livestock breeds, strains and varieties was available. It was, however, noted that in many cases data are inadequate, based on small numbers of animals. In many cases the definitions of traits were not clear. It was also realized that while the information on strain crosses with exotic breeds was available in great detail, the indigenous breeds and strains were often less well identified, documented or evaluated. The environments under which the indigenous strains reproduced, survived and produced were not defined properly. It was necessary that environments be standardized or at least defined.

The workshop was specially concerned about the position of buffaloes which was an important animal of the SABRAO region. Although there were several breeds, strains within breeds, little is known about their relative merits. It was also observed that some

Indian breeds were in danger of losing genes for high production because high producing animals are withdrawn from breeding populations for use in units of high production and are subsequently slaughtered. Such breeds were identified.

The workshop in consideration of the financial limitations and voluntary nature of the organization decided that any action programme taken up by SABRAO has to depend on the initiative of its own members. It was, therefore, decided that each of these members should initially help in preparation of a national list of people/institutions/organizations involved with research, management and development of animal genetic resources in each country. Such a directory would make inter country contact for exchange of information easy and meaningful. This information has been compiled.

The second major decision was to establish an animal genetic resources data bank. This would have two parts. Part one would comprise of storing already available data on identification, evaluation, conservation and utilization of the animal genetic resources. A computer readable format for this has been developed for each species and breeds within each species. Part two involved actual collection of data in the data collection forms distributed to the scientists. Wherever information is already available this would be filled in and wherever information was not available this would be collected and recorded. So far the data collection forms have been standardized and distributed some of these are being received back by the National Institute for Animal Industry, Tsukuba, to be stored in the retrieval system with the objective of making this available to the cooperating members, and as soon as a breed, strain had reached a satisfactory information level the documentation would be undertaken. This is in process at their computer centre. The system has been so organized that the information pertaining to species and breeds within the species is being prepared in computer readable format which is directly fed to the process controller and the necessary information is stored in the system and is available to any member of SABRAO or other societies, organizations or individuals interested in animal genetic resources.

The Expert Committee on Animal Genetic Resources took stock of the progress made, in May 1981 in Kuala Lumpur, Malaysia. The urgent need for appropriate comparative evaluation studies was recognized at the first workshop, the second workshop considered the requirements for the second phase of evaluation studies. The evaluation of the breeds and collection of the data from evaluation studies has also been initiated. A committee has been set up which would develop designs and guidelines for the conduct of evaluation studies in field (village) populations. The committee has formulated various strategies for evaluation under village conditions and defined the environment and methods of monitoring the same.

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THE ANIMAL GENETIC RESOURCES OF CHINA AND THE POSSIBILITY OF ESTABLISHING DATA BANKS

Peilieu Cheng1

1. ANIMAL GENETIC RESOURCES OF CHINA

China is rich in animal genetic resources, and may be considered as one of the huge "gene banks" in the world.

i. Swine breeds

   a. Taihu (Great Lake) pigs are noted for their early sexual maturity and prolificacy; producing 15-16 piglets per litter; and possessing a very good mothering ability.
   b. Jinhua pigs are famous for their fine bones and excellent meat quality; especially good in making Jinhua ham; a favourite in China.
   c. "Fragrant" pigs are a miniature breed, especially good for roasting (barbecue pig). They have also been considered as experimental animals for biological and medical research.

ii. Herbivores

   a. Yaks are well adapted to the high, cold ecological zone in the Qinghai-Tibet Plateau.
   b. Bihumped camels are especially adapted to the arid desert in the North and Northwest.
   c. Tibetan sheep are noted for their production of carpet wool.
   d. Hu and Tan sheep, and Zhongwei goats are all famous for producing lamb pelts with attractive curls.

e. The famous yellow cattle breeds, Qinchuan, Nangyang, Jinnan and Luxi in North China, are noted for their large body size and fine beef quality.
f. Dulong, semi-wild cattle with four white feet have been discovered in West Yunnan Province recently; they are quite different from the indigenous yellow cattle.

iii. Horse breeds

A dwarf (or miniature) breed, 85-100 cm high, was recently discovered in the northwest of Guangxi Province.

iv. Poultry

a. Peking ducks are noted for their elegant conformation and fast growing rate. They are now raised in almost every part of the world. This is the breed famous for "roast duck".
b. Longshan fowls, with black plumage, are noted for their meat quality.
c. The silky fowl, with white feathers and black skin and bone, is a most important ingredient in making a well-known tonic bolus in Chinese medicine.
d. Shao ducks have a yearly egg production of over 280 eggs.
e. Jianchang ducks produce an extremely large liver (about 340 g) after 21 day forced feeding.

All these breeds, and others, are not only a wealth of China, but also of the world. For example:

- Chinese pigs have been introduced to different parts of the world and have exerted an influence in developing the Berkshire and Yorkshire in England, and the Poland-China in the United States.

- Longshan fowls were first introduced to England, and then to Germany, France, Japan and the United States, and were used in crossing with local breeds, Orpington and Australop were then developed.

2. POSSIBILITIES FOR DEVELOPING A DATA BANK OF ANIMAL GENETIC RESOURCES

A nationwide survey on animal genetic resources has been carried out by a combined effort of personnel in research, education, production and administration of 29 provinces and autonomous regions during the past four years (1979-83). A uniform procedure has been worked out, and data have been collected on the history of breed formation, number and distribution, body measurements and biological and ecological characteristics of the breeds investigated.

Two hundred and forty-one livestock and poultry breeds or types were recorded in the inventory, mainly:

horse (and ass)	43 breeds
cattle (including yellow cattle, water buffalo and yak)	30 breeds
camel	2 breeds
sheep and goats	42 breeds
swine	66 breeds
poultry	56 breeds

with a few minor breeds of other animals.

The preliminary survey gives a background for better understanding of animal genetic resources in China.

The urgent need for efficient management of the data of animal genetic resources has called for immediate attention in China. Although we have plenty of materials and data, we lack modern means for data handling, programming, registration, analysis and information retrieval. Electronic computing techniques are the best way for data processing, so that every recorded item in the data base can be retrieved and utilized most accurately and rapidly; the stored data can include all available information, and all the breed traits can be efficiently used in breeding and selection, crossbreeding and hybrid vigour utilization, to increase reproductivity and productivity, or even to develop a new breed. The importance and necessity of establishing a data bank for animal genetic resources are very evident in China.

China now has a solid foundation for establishing a data bank through the combined efforts of the two institutes of the Chinese Academy of Agricultural Sciences (CAAS):

i. The Institute of Animal Sciences (CAAS)

The Institute has a research laboratory on animal genetic resources, which will provide a technical basis for taking up the responsibility for organizing investigations in animal genetic resources.

The Institute will decide how many breed characteristics will be involved in the inventory.

The Institute will be responsible for aggregating data from the provincial or regional institutes of animal husbandry, for data evaluation and for data recording.

ii. The Electronic Computing Centre (CAAS)

The newly established Electronic Computing Centre will be responsible for establishing a separate section for animal genetic resources.

The Centre will be responsible for all technical measures such as hardware and software systems, magnetic tape storage, information retrieval, data interpretation, etc.

The Centre will supply necessary information for research, education and extension units, as well as for production and administrative units.

Studies on breed evaluation including genetics, reproduction, breeding and ecology have been carried out recently.

In addition, frozen semen, conservation of embryos (in sheep and cattle) and long-distance transportation of embryos (from Bremen, West Germany, to Beijing, China, on 29 September 1980, one calf being born on 27 June 1981) were carried out, and some successes have been achieved.

Some stud farms have been established for conserving and improving different breeds, such as:

pigs	:	Taihu, Large Black-White
sheep	:	Hu
cattle	:	Qinchuan, Nanyang

However, as it is impossible to conserve all the breeds of each species, there is a problem to secure sufficient financial support. Modern biological techniques seem to be one of the ways for conserving animal genetic resources.

3. RESEARCH PROJECTS ON ANIMAL GENETIC RESOURCES

- Establishment of animal genetic resources data bank (detailed in previous section)
- Establishment of "gene bank" (or "germplasm bank") for the conservation of germ cells, semen and embryos from the superior breeds.
- The Institute of Animal Science (CAAS), in cooperation with other units, will take up the responsibility for establishing such a "gene bank". We hope it could be accomplished in the very near future if sufficient financial support is available.
- Establishing more stud farms for preserving live animals of some superior or rare breeds, such as "fragrant" pigs, dwarf horses, white yaks, Altay fat-rump sheep. A practical plan should be worked out and submitted to the government for approval.
- Pushing forward research on breed evaluation and assessment of genetic value in crossbreeding or hybrid vigour utilization.

4. PROBLEMS TO BE SOLVED

Items necessary to carry on the above mentioned four important researches are:

- training more technical personnel
- improving necessary equipment and other facilities
- sufficient financial support.

It is hoped that these prerequisites for the advancement of animal genetic resources research could be considered and solved by FAO/UNEP. We are all aware of the importance of conservation and management of precious animal genetic resources, especially in China, and personally, I am expecting to obtain some assistance from FAO/UNEP.

I should admit that the proposed project is just a supposition or an opinion at the present time; it will take us much time and untiring efforts to become a reality. However, I have full confidence in future success.

I come here to learn.

Since this is the first time I have taken part in the FAO/UNEP Expert Panel, I have very little knowledge on what you have done and what you are going to do for the next step. I am very happy to have such an opportunity to learn from you, your views, methodology and also the results obtained.

If FAO/UNEP have any suggestions, I shall be very glad to ask our Government for further consideration. I am sure I would do my best to promote our work on animal genetic resources in China.

APPENDIX ON CHINA DATA BANK

A. Animal Species to be included: horse, cattle, buffalo, yak, camel, sheep, goat, swine, poultry.

B. Main items to be recorded:

   a. Distribution

   b. Conformation (including hair colour and measurements)

   c. Performance

      - growth and development
      - milking ability (and composition of milk)
      - meat production (and carcass quality)
      - draught ability
      - wool production (including wool quality)
      - egg production

   d. Reproductive traits

   e. Adaptability (including resistance to diseases)

   f. Anatomical, physiological, histological parameters (if available)

THE COMMONWEALTH BUREAU OF ANIMAL BRREDING AND GENETICS AND THE PROVISION OF INFORMATION FOR DATA BANKS ON ANIMAL GENETIC RESOURCES

J.D. Turton1

1. INTRODUCTION

The Bureau has been in existence since 1929. It is one of ten Bureaux and four Institutes owned, administered and financed by member governments of the British Commonwealth. The units, which collectively constitute what is now generally referred to as the Information Service part of CAB (the Bureaux and the information sections of the three UK-based Institutes), are almost financially self-supporting, as they derive revenue from the sales of their abstract journals, books and on-line retrieval service. Some Bureaux make a profit, but others do not, and the financial position is complex, as publications are sold within Commonwealth countries at a lower price than elsewhere, and this 'subsidy' element is taken into consideration in the overall profit/loss account for the Information Service. The main agent by which the Bureau of Animal Breeding and Genetics (hereafter called the Bureau) disseminates information is Animal Breeding Abstracts (ABA), which is now in its 51st year. In addition, the Bureau carries out retrieval of information from its card indexes and from CAB's on-line database, which is known as "CAB Abstracts", produces Annotated Bibliographies (collections of abstracts on different topics), answers enquiries, and supplies photocopies of original papers.

2. CAB'S ON-LINE DATABASE

The on-line database of CAB dates back to the beginning of 1972 (veterinary material) or 1973. It is the computer-stored version of the main abstract journals. The "main" here distinguishes these journals from certain other CAB abstract journals, such as Poultry Abstracts and Pig News and Information, which draw material from several main journals, and republish it in a 'repackage' convenient to certain groups of reader. The database thus comprises subfiles which correspond to each main journal, such as ABA and Nutritional Abstracts and Reviews, and can be searched as a whole or by individual subfiles or groups of subfiles. It now contains about 1.6 million records, including 75 000 on animal breeding. The database is mounted in California, USA, by Lockheed, in Italy at Frascati, by the European Space Agency, and in the Federal Republic of Germany, at Cologne, by the Deutsches Institut fur Medizinische Dokumentation und Information (DIMDI). These databases are searchable by private individuals or the staff of institutions, over the public telephone lines, using some form of hard-copy terminal or visual display unit. The would-be searcher makes prior contact with the contractor mounting the database in order to obtain a password, and thereafter is billed for on-line time and the number of items of information retrieved. The addresses of the contractors are given in Appendix 1. The Bureau will carry out searches for those not wishing to do their own. CAB publishes an On-line Manual which gives details of the database and information and how to search it. All the contractors produce user manuals which explain how to access their systems and carry out a search.

The databases are updated every month from tapes sent to the contractors. Tapes corresponding to all CAB's main journals can be leased from CAB, and the lessee can process these to create special outputs matched to his needs. Details are given in Appendix 2.

Not only can one-off searches be carried out, but users of the system can have "profiles" automatically run against the database monthly updates to provide output on specific topics as each new tape is processed. A profile is an appropriately formatted collection of search terms which will retrieve material on a specific topic. The process is known as "selective dissemination of information" - SD1 for short.

3. COVERAGE OF ANIMAL BREEDING ABSTRACTS

3.1 Literature

The following types are covered:

i. Serials - journals, numbered bulletins and reports, irregularly issued numbered publications, and numbered conference proceedings.
ii. Non-serial publications - books, monographs, unnumbered bulletins, unnumbered conferences, theses, seminars, workshops, reports, etc.
iii. Audiovisual material.

In general, any paper or publication which can be regarded as being of scientific interest to readers of ABA is abstracted, provided it can be cited bibliographically, is available in multiple copies (i.e. at least a small print run), and can be purchased or borrowed by individuals and/or institutes.

3.2 Subject Scope

Broadly, ABA covers the reproduction and genetics (including immunogenetics) of farm livestock, poultry, farmed game, elephants, Camelidae, fur bearers, dogs, cats, laboratory mammals, and certain other mammals either of direct economic importance (e.g. reindeer) or closely related to farmed species of livestock (e.g. bison). Non-nutritional, environmental effects on traits of economic importance are covered, as are nutritional effects on reproduction. Breeds and their performance are a subject to which close attention is paid. Papers on theoretical genetics and evolutionary aspects of genetic theory are abstracted.

Thus, virtually everything of relevance to the conservation of genetic resources, and which is found in the categories of literature specified above, will appear in ABA, provided it comes to the notice of the Bureau.

4. RETRIEVAL OF INFORMATION ON GENETIC RESOURCES

Material which has appeared in ABA since the beginning of 1973. and that which will appear in future, is best retrieved from the on-line database. Most of the material required will be that on specific breeds or on certain species, for example South American Camelidae. Sometimes, the requirements will be for material on specific countries. To minimize retrieval problems arising from diverse breed nomenclature, the breed names used by the authors of papers appear in the abstracts, along with the names given in the Dictionary of Livestock Breeds, by I.L. Mason, published by CAB. The subject indexes of ABA use standardized terminology, which makes for accuracy of retrieval.

When the tapes corresponding to the various main abstract journals of CAB are received by the database contractors, they are processed into a form which makes them suitable for adding to the database. In doing so, several on-line indexes are produced, and it is these that the searcher interrogates. Every significant word in an ABA abstract entry, including names of authors, words in the abstract itself, the senior author's address, indexing terms, the title of the publication and year of publication are accessible to the searcher. The searcher is able to specify whether he wants to search the whole record or only certain fields, such as the index terms. Not only is the searcher able to specify terms, but he can also specify whether these terms should lie adjacent to each other in the original abstract (e.g. preweaning mortality) or in the same sentence or field. Another useful facility is the ability to search on codes corresponding to the broad section headings of ABA, such as "Cattle, genetics" or "Sheep, breeds".

Much of the interest in genetic resources relates to specific breeds in specific countries. The country name is generally given in the author's address *of* a paper, or if not, is mentioned somewhere else in the abstract record. The searcher, in formulating his search profile, is in essence looking for the co-existence in a record of certain terms or groups of terms. Thus, he might 'ask' the computer whether the word "Sahiwal (or Sahiwals)" co-occurred along with "India" in any records. The computer would respond to the effect that there were, say, 70 such records, and it is likely that the majority of these records would refer to the performance of Sahiwals in India. Of course, there is sometimes the "false drop", as might occur if there was a paper on Sahiwals in Pakistan written by an author resident in India. Nevertheless, our experience at the Bureau indicates that one can retrieve material on work done in specific countries with a high degree of accuracy using the country in the author's address.

For material abstracted prior to 1972/73, access can be obtained through the printed annual subject indexes, or through the Bureau's subject and author indexes on cards.

5. DATABASE OR DATA BANK

The Bureau produces a database comprising indexed abstracts. Subsets of this database, containing abstracts on breeds and species of relevance to a genetic resources programme, can easily be assembled, initially by carrying out retrospective searches on the Bureau's on-line or card indexes. These can then be kept "topped up" by the use of on-line SD1 profiles.

The information in these records can, if desired, be entered by searchers onto a standard form designed to meet the requirements of a genetic resources programme, and these forms can be the material on which a microcomputer-based information system on genetic resources is constructed. Record format and hardware would be standardized, so that tapes or disks could be exchanged physically between the computer installations in different continents, or, where the telecommunications facilities exist, records could be transmitted from one computer to another via a telephone or satellite link. The CAB database in California is accessed from Europe via a satellite and the local telephone lines.

An alternative way of reformatting the information would be to lease CAB tapes and write programmes to reformat the output of profiles to the requirements of the genetic resources programme.

The above options are more properly considered as databases rather than data banks, although the distinction between the two can become blurred. Data banks generally hold numerical, rather than a mixture of numerical and bibliographical data. If, for example, it was decided to store under each breed, the means, standard errors, genetic parameter values etc. derived from studies on the breeds, then that would constitute a data bank, as would information on chemical constants or the normal ranges of biochemical substances in different species. It is, however, always useful to be able to get back from a data value to the original source, and this of course means that bibliographical details must be stored, so that one would have a hybrid base or bank, with both bibliographical and reformatted or recalculated numerical data.

Comparative costings could be easily derived for a genetic resources data bank (or base) produced (a) by on-line retrieval from CAB Abstracts, followed by entry of information in a standardized form into the chosen microcomputer system, or (b) from leased tapes using a specially written programme. The on-line search and leasing costs are known, and the cost of keyboarding the data would be based on local rates of pay. The Bureau has information on the number of records or keystrokes that keyboarders can be expected to achieve. With either system, the facility would have to exist for inputting data additional to that derived from on-line databases.

For the genetic resources system, the records would be held on disk, and retrieval and editing software would be needed to allow updating of records for a particular breed or country, and immediate retrieval of any desired record, or records, containing particular keywords or combinations of keywords. For cheapness and speed of implementation, 'off the shelf software would be required, and so it would be necessary to find the best combination of hardware and software for the job, bearing in mind that rapid, reliable servicing of hardware is essential.

Finally, one should keep in the forefront of one's thinking during the design of a system the notion that an attribute of prime importance is the quality of information within the system, so that those responsible for selecting and entering material must have clear guidelines as to the criteria for inclusion.

APPENDIX 1

DIALOG Information Services Inc.
3460 Hillview Avenue
Palo Alto
California 94304
USA

ESA Information Retrieval Service
ESRIN
Via Galileo Galilei
00044 Frascati (Rome)
ITALY

Deutsche Institut fur Medizinische Dokumentation und Information
Postfach 42 05 80
5000 Köln 41
FEDERAL REPUBLIC OF GERMANY

APPENDIX 2

LEASING OF CAB TAPES - 1983

he lease fee covers the supply of the tapes by CAB and the running of up to 100 profiles per year by the user. If more than 100 profiles are run, usage charges become payable. These range from £10 to £15 per profile per year, depending on the number of profiles run.

Back volumes of Animal Breeding Abstracts are available on magnetic tape for 1973-82. The lease fee ranges from £290 for the 1973 volume to £485 for the 1982 volume. The fee for the current year's tapes for ABA is £500.

Further details can be obtained from:

Training Officer
Commonwealth Agricultural Bureaux
Farnham House
Farnham Royal
Slough SL23BN
UK

GENETIC CHARACTERIZATION OF THE SWAMP BUFFALO

Charan Chantalakhana1

1. INTRODUCTION

Very little is known about the genetics of the swamp buffalo, as compared to those in cattle or the river buffalo. Although the swamp buffalo is economically very important to most Asian countries they have been neglected by animal scientists around the world. These animals appear to be well adapted to climatic and farming conditions in Asia, especially in the tropical region. Their superiority in draught power and meat production utilizing low quality feeds, as well as longevity, has been well recognized by Asian farmers and animal scientists. It has been only during the past decade that animal scientists in Asia and other parts of the world have turned their attention to research investigation of the swamp buffalo. This paper is intended to present the present knowledge of swamp buffalo genetic characteristics.

2. CHARACTERISTICS OF SWAMP BUFFALO

Like other farm animals the swamp buffaloes, from genetic standpoints, possess two types of characteristics: (i) qualitative characteristics, and (ii) quantitative characteristics.

2.1 Qualitative Characteristics

The qualitative traits in the swamp buffaloes are numerous. Horns, skin and hair colours, body markings, and hair whirls are some of the more significant characteristics since these are related to certain cultural and traditional beliefs among farmers in some Asian countries.

2.1.1 Skin and coat colour markings

Most of the swamp buffaloes are dark grey in colour, only some of them are white. The frequencies of white buffaloes vary from country to country, as well as from province to province. According to Amano *et al.* (1982) the white colour gene frequencies in Indonesian buffaloes could be as high as 0.2 to 0.5. While the report by Nozawa and Ratanadilok NaPhuket (1974) showed that the frequencies of the white buffaloes in Thailand ranged from 0 to 15 percent based on provincial estimates, Rife and Buranamanas (1959) who examined field data on colours of buffalo cow-and-calf and tested the Mendelian ratios, employing the chi-square technique, inicated that the white gene could be dominant to the grey allele. However, there has been no breeding test so far to identify actual inheritance of the coat colour in swamp buffalo.

Black and white buffaloes (piebald) can be found in South Sulawesi, Sumba and Sumbawa Islands of Indonesia, but their frequencies are lower as compared to that of the grey or the white buffaloes. Inheritance of piebald in buffalo is also unknown. Amano *et al.* (1981) reported that the most frequent occurrence of spotted buffaloes (19.4 percent) were found in Tana Toraja, South Sulawesi.

As far as colour markings are concerned, white chevron, one or two, below the neck of the grey buffaloes is commonly found. White stockings on the feet of buffalo can be found, but this trait is not too common. Traditionally, the Thai farmers regard the animal with white stockings en four feet as good luck. No study has been conducted on the inheritance of these traits.

2.2.2 Horns

In general, the swamp buffaloes have much bigger and longer horn that cattle. However, a few polled buffaloes were also reported in Thailand (Tungtrakarnpong 1980). Variation in horn size and setting is often observed. Most of the swamp buffaloes are with horns which extend outward and then curl backward into semi-circles, but remain on the same plane as the forehead. A few buffaloes have loose horns or drooping horns. Buffalo horns are usually long, flat but thick; however, in some cases they may be short and thick. The nature of inheritance of buffalo horns is not known at present.

2.1.3 Hair whirls

Hair whirls are commonly found on various parts of the buffalo's body. They usually appear on both sides of the shoulder, both sides of the hip, the face and the forehead. The number of hair whirls and a combination of their positions seem to be unique for each animal. In certain countries such as Thailand hair whirls have been used as a means of animal registration identification. The exact knowledge of the inheritance of this trait in the buffalo, however, is not available.

2.1.4 Blood groups and blood protein polymorphisms

Amano *et al.* (1981) found 6 blood antigenic factors in the swamp buffaloes in Indonesia. These are Wh_1 , Wh_2 , Wh_3, Wh_4, W_5 and Wbj at the frequencies of 1.5, 13.0, 23.2, 21.7, 0.0 and 15.9 percent, respectively. In this study, they also detected some of these blood groups in the crossbred (swamp x river) buffaloes, but none in the river or Indian buffaloes. This evidence suggested that the swamp and the river buffaloes are immunogenetically different.

Amano *et al*.(198l) also examined 22 electrophoretic loci and found only 6 loci showed polymorphism; these are Alb (albumin), Tf (transferrin), AmI (serum amylase I), Hb (haemoglobin a), CA (cell carbonic anhydrase), and PepB (cell peptidase B). From the analysis of genetic distance they also found a distinct biochemical genetic differences between the swamp and the river buffaloes. For example, at the Alb locus for which the Alb^A , Alb^B and Alb alleles were found, only the Alb and Alb alleles were detected with the frequencies of 0.57 and 0.43 respectively, and none of the Alb allele in the swamp buffaloes, while in the river buffaloes the Alb was 0.55, the Alb^A 0.05, and the Alb^A 0.40.

2.2 Quantitative Characteristics

The quantitative characteristics are influenced by genetic and environmental factors; it is therefore necessary to describe some salient aspects of environmental, management, and feeding conditions under which animal performance is generally measured.

Most of the swamp buffaloes are in China and Southeast Asian countries and they serve as an integral part of the integrated farming system, with rice as a common basic crop, by providing draught power, manure, and utilizing non-marketable crop wastes and other by-products. Buffaloes are most prevalent in paddy areas and they are managed according to seasonal conditions. In most of these countries, after rice and other crops have been harvested, buffaloes are herded on to croplands where they graze on rice stubbles, corn stovers, grases and indigenous weeds, plant regrowths, and other crop wastes as well as rice straw. During the summer and rainy seasons, rice straw becomes a basic feedstuff, supplemented with some green grases collected from nearby uncultivated areas or marginal land. Some grazing areas such as upland communal grazing areas, forest land, roadsides, fallow fields, etc. are also available for the animals. Buffaloes gain their prime condition during the post-harvest time until the early dry season, during which time breeding takes place most frequently and freely. Therefore, calving season in buffaloes in certain countries can be observed accordingly.

It is reemphasized that the quantitative traits recorded in the following section were mostly from the buffaloes which were raised primarily for draught purposes with a low level of feeding and management as compared to conventional beef production in some developed countries. Five major groups of quantitative traits in buffalo are presented: these are (i) size and growth; (ii) reproductive traits; (iii) carcass traits; (iv) milk and its constitutents; and (v) working ability.

2.2.1 Size and growth

The weight at birth in swamp buffaloes averaged from 26 to 38 kg and male calves averaged heavier than females in every report. The weight at 8-months of age ranged from an average of 125 to 150 kg. In general, weaning of calves in swamp buffaloes is not practised by farmers, and the calf stays with its dam until the age of one year or more, at which time the cow has ceased to produce milk. The weight at 8 months of age may be taken as equivalent to weaning weight. The pre-weaning average daily gain in swamp buffalo averaged 0.34 to 0.41 kg (Table 1).

Table 1 RANGES OF MEANS FOR SIZE AND GROWTH OF SWAMP BUFFALOES (Chantalakhana 1981)

Traits	Unit	Range of $\underline{X}$	Traits	Unit	Range of $\underline{X}$
Birth weight	kg	26-38	Mature weight		
8 month weight	kg	125-150	Male	kg	450-650
Preweaning gain	kg	0.34-0.41	Female	kg	350-450
Yearling weight	kg	135-205	Height	cm	120-137
Post-weaning gain	kg	0.34-0.75	Girth	cm	180-209
			Length	cm	121-157

The yearling weight in swamp buffaloes averaged 135 to 205 kg. Under rather poor feeding and management conditions the yearling weight was reported to be as low as 119 kg, as compared to the heavy breed (Pin hu) in China which averaged 250 kg at one year of age. The post-weaning average daily gain of the swamp buffalo was reported to range from 0.34 to 0.75. This variation, however, is expected to be due largely to feeding and management conditions.

Generally, swamp buffaloes reach mature weight at about 4-5 years of age. But most research reports on weight at maturity gave the weight of animals at slaughter. The mature weights of swamp buffaloes given in Table 1 vary from 450-650 in the male, and 350-450 in the female; males were heavier than females.

In Table 2, mature weight and body measurements of swamp buffaloes in some Asian countries are given. Considerable variation in mature weight of buffaloes within each country can be observed, but there are no distinctive differences in mature weight and size among countries. Some further comparative data on body weights and measurements are given in Table 3 and Table 4.

2.2.2 Reproductive traits

i. Age at puberty and at first calving and gestation period

Age at puberty is generally defined as the average age at which female animals show their first oestrus. However, most reports gave the average age of female buffaloes when successful matings were obtained for the first time (age at sexual maturity). This age was between 1.6 and 3 years (Table 5).

The gestation period as shown in Table 5 averages between 308 and 332 days. The gestation period of the swamp buffalo was found to average as low as 308-309 days in one report from Sri Lanka (Jalatge 1980), while a high estimate of 330-340 days was reported in Malaysia (Camoens 1976)). A gestation period of 320 days was recommended the standard estimate in the Philippines (Philippine Council for Agriculture and Resources Research 1978). The lengths of gestation period for buffaloes in Southeastern Asian countries are more or less similar to those reviewed by Pant and Roy (1972). It should be noted that the variation in this trait could be contributed to various factors such as sex of calves, age of dam, size of dam, parity number, etc.

Age at first calving generally was between 3.5 and 4.7 years of age (see Table 5). The swamp buffalo in Malaysia averaged 4.3 years, while those in Sri Lanka averaged 3.7 years. The age at first calving of the buffalo in Southeast Asia is considerably longer than those reviewed by Pant and Roy (1972) since this trait as well as the age at puberty depends very much on the level of feeding and management.

Comparative data for age at puberty, age at first service, and gestation period for local swamp buffalo, Murrah, and their crossbreds in China are given in Table 6.

ii. Oestrus cycle and heat period

It has been generally accepted that heat expression in swamp buffalo is not as obvious as that in cattle. Some farmers may be accurate in detecting heat in their own buffaloes since they tend their buffaloes personally. However, for extension workers and scientists in the Southeast Asian countries heat detection in swamp buffaloes is still a problem.

Table 2 MATURE WEIGHT AND SIZE OF SWAMP BUFFALOES1

Countries	Weight (kg)	Height (cm) M 2	F	Length (cm) M	F	Girth (cm) M	F
China*	450-600	136	126	157	151	204	202
China	400-450	129	124	143	132	188	179
Indonesia	450-500	130	125	-	-	-	-
Indonesia**	500-600	127	124	-	-	190	180
Malaysia	364-545	129	121	123	121	183	180
Philippines	520	-	125	-	-	-	193
Philippines	364-545	127	120	-	-	196	184
Taiwan***	400-450	129	124	141	135	196	190
Thailand****	404-600	121-137	121-126	141-148	132-137	186-209	181-183

[1]Modified from Camoens (1976) with additional references as noted:

* Liu (1978);

** Hardjosubroto and Astuti (1980);
*** Ma (1980);
**** NaPhuket (1980)

2 M - Male; F = Female

Table 3 WEIGHTS AND MEASUREMENTS OF CHINESE SWAMP BUFFALO ADULTS (Liu 1978)

	Province	Local Name of Buffalo	Sex	No. of Buffalo	Body weight (kg)	Height (cm)	Length (cm)	Girth (cm)	Cannon Girth (cm)
Heavy	Kiangsu	Haitzu	M	2	784.0	154	163.2	233.3	27.5
			F	105	559.8	133.5	150.0	204.2	23.0
Medium	Hupeh	Pin hu	M	6	617.5	135.9	156.7	203.5	25.0
			F	19	535.6	125.5	150.8	201.8	22.3
	Szechuan	Techang	M	10	506.0	132.7	141.7	196.2	23.7
			F	158	450.0	128.7	134.4	189.8	19.9
Light	Kwangsi	Shilin	M	88	453.0	126.7	141.1	189.0	23.1
			F	438	403.7	120.1	132.9	182.4	20.9

Table 4 WEIGHTS AND MEASUREMENTS OF THE THAI SWAMP BUFFALOES (Chantalakhana *et al.* 1978)

Age	Sex	Weight (kg)	Heart Girth (cm)	Length (cm)	Height (cm)
Birth	M	27.1 (120)1	71.1 (120)	55.5	67.7
	F	25.6 (99)	70.3 (99)	54.5	67.2
7 months	M	100.4 (70)	114.7 (69)	85.0	92.6
	F	96.3 (66)	113.5 (63)	83.2	91.7
Yearling	M	147.6 (43)	126.8 (33)	91.7	101.5
	F	140.1 (27)	125.2 (18)	91.0	98.9

1 Number of animals in parentheses

Reports on the length of oestrus cycle in swamp buffaloes ranged from 20 days to 34days, but part of this variation could be attributed to the problem of heat detection. Pant and Roy (1972) estimated the oestrus cycle in buffaloes at 21 days, and noted more variability than that in cattle.

The duration of oestrus or heat period in swamp buffaloes was reported to range from 12-36 hours up to 3-5 days. However, most reports indicated a period somewhere between 24 and 36 hours (Table 5 and Table 6).

Pant and Roy (1972) stated that the buffalo was more a nocturnal breeder than cattle, but from several studies reviewed in this paper no such evidence was reported. In some reports the belief was expressed that breeding activities in buffaloes were more or less random with regard to time of day. The author has obtained data on this question from a field station where a herd of swamp buffalo cows (about 150 head) was divided into two groups: one with bulls only in the day, another with bulls in both day and night; and the calf crops obtained from these two groups were not different.

iii. Calving rate, calving interval and twinning

Calving rates of 50 to 65 percent were common in swamp buffalo. Table 5 gives the range of estimates between 23 and 82 percent.

Calving intervals were widely different from one report to another (Table 5). Camoens (1976) examined this trait in the swamp buffalo of Malaysia and found the intervals ranging from 480 days up to 912 days. However, most estimates fall between 1.5 and 2 years.

The calving interval in the Murrahs is expected to be much shorter, since their feeding and management would be more intensive. It was found that the calving intervals for the Murrahs in Burma, Philippines and Thailand were 420, 435 and 503 days respectively. Considerable variation, however, was observed.

The rates of twinning in buffaloes were found to be very low, viz. 0.001 to 0.015.

2.2.3 Carcass traits

In Table 7 various carcass traits of swamp buffaloes from different studies are shown. The dressing percentage was found to be 43 to 51, for animals with slaughter weight ranging between 300 and 600 kg. Rib-eye area averaged 33 to 49 sq. cm. The dressing percentage and rib-eye areas reported are generally inferior to those of cattle.

The percent boneless meat from buffalo carcasses averaged around 75 (less than 25 percent bone). The weight of animal hide was around 11-13 percent of body weight. The carcass shrinkage due to cold storage was approximately 3 to 4-5 percent.

Table 5 RANGES OF MEANS FOR REPRODUCTIVE TRAITS IN SWAMP BUFFALOES (Chantalakhana 1981)

	Unit	Range of $\underline{X}$
Age at puberty	yr	1.6-3.0
Age at first calving	yr	3.5-4.7
Oestrus cycle	d	20-34
Oestrus period	hr	24-36
Gestation period	d	308-332
Calving rate	%	23-82
Calving interval	d	370-670
Twinning	%	0.001-0.015

Table 6 COMPARISONS OF THE REPRODUCTIVE CHARACTERISTICS OF LOCAL SWAMP BUFFALO BREEDS, MURRAH AND THEIR GRADES (Liu 1978)

Traits	Murrah	1/2 Murrah	3/4 Murrah	Local Breed
Age at puberty	431	674	751	1068
(days)	(314-634)1	(364-1203)	(493-983)	(658-1387)
Age at first service	738	1140	1123	1405
(days)	(463-1267)	(899-1542)	(915-1512)	(1065-1997)
Gestation period	304	308	—	312
(days)	(292-322)	(293-328)		(290-330)
Oestrus cycle (days)	24.9	24.5	25.6	24.2
Duration of oestrus (hours)	18.7	34.3	33.0	43.2
First post-partum oestrus	65	162	180	296

1 Range of estimates

Table 7 RANGES OF MEANS FOR CARCASS TRAITS IN SWAMP BUFFALOES (Chantalakhana 1981)

Traits	Unit	Range of X
Dressing percentage	%	43-51
Slaughter weight	kg	300-600
Loin-eye area	cm^2	33-50
Carcass length	cm	111-118
Boneless meat	% of carcass	73-75
Hide	% of body weight	11-13
Cold Shrinkage	%	3.1-4.5

2.2.4 Milk yield and constitutents

Table 8 shows milk yield and certain milk constituents in swamp buffaloes. As previously indicated, the swamp buffaloes are not good milkers, only a small quantity of milk is produced by a buffalo cow to suffice the requirement of the calf. From most studies reviewed, it was found that milk yield from one milking a day was only 1 to 2 kg, plus a certain amount of milk suckled by the calf for the rest of the day. In reports from Malaysia and Thailand, milk yield was shown to average 250 kg during 210 day lactation period, and 333 during 330 days lactation, respectively. A high milk yield of 828 kg per lactation was obtained in China.

Table 8 RANGES OF MEANS FOR MILK YIELD AND OTHER RELATED TRAITS IN SWAMP BUFFALOES (Chantalakhana 1981)

Traits	Unit	Range of X
Milk yield	kg/d	1-2
Length of lactation	d	121-330
Butterfat	%	8-10
Protein	%	4.2-5.3
Total solid	%	18.1-21.3

The butterfat percentage was reported to range from 8 to 10, with an average of 9 in the Philippines, while Murrah buffalo in Thailand showed a range of 4.9 to 12.3 with an average of 7.9.

The total solids in swamp buffalo averaged 18.1 and 20.4 percent and the percent protein 5.0 in the studies in Thailand and the Philippines.

2.2.5 Working ability

It is rather obvious that the pattern and type of work for buffaloes would vary from one country to the other, although the paddy field is certainly the common place to find buffaloes at work. Even in one country, the intensity of work for buffaloes varies from one location to the other. From a nationwide survey by Buranamanas (1963), it was found that buffaloes were used to work on average 66 to 146 days a year, with an overall average of 122 days. But in other studies the estimates were only 50-60 days in Central and 20-78 days in North Thailand, and 53 days in Taiwan.

The age at first work of swamp buffaloes in Thailand was estimated to be 4.2 years, and they would work for 12-20 years. The number of hours per day for buffaloes in the cropping season averaged around 5. The area which a buffalo could plough over per hour was estimated to be 0.05 and 0.06 acre in Thailand, and 0.08 acre in Taiwan (Table 9).

3. RECOMMENDATIONS FOR BREEDING IMPROVEMENT

It is clearly evident that in many countries where the swamp buffaloes are being raised, the number of animals has been decreasing at alarming rates due to increasing demand for meat of the fast-expanding human population. In certain countries such as Thailand, not only the buffalo population number that tended to go down but also the average body size of mature buffalo had decreased during the last two decades due to traditional castration of the larger buffaloes for draught. In order to maintain the quality and number of the swamp buffaloes, the following recommendations for breeding improvement are suggested:

Table 9 WORKING ABILITY OF SWAMP BUFFALOES (Chantalakhana 1981)

Traits	Unit	Estimates
Maximum burden capacity	kg	869 (Female)
Draught power	kg	287 (Female)
		370 (Maximum)
Cart speed	m/min	50-70
Plough	ac/hr	0.05-0.08
puddle	ac/pair	0.12-0.25
Work	d/yr	20-146

i. In the countries where the swamp buffaloes are of economic importance, a genetic evaluation scheme to identify superior breeding stocks under well-defined environments for further multiplication and improvement should be carried out as soon as possible.

ii. It is recommended that the national breeding herds and performance testing scheme for buffaloes in order to make breeding selection of superior genetic stock should be organized.
iii. Exchange of swamp buffalo germplasm resources for comparative evaluation among interested countries should be organized and supported by regional or international organizations.
iv. In the light of on-going interest in crossbreeding of the swamp buffalo to improve milk production, especially in the Southeast Asian countries, it is recommended that crossbreeding trials and testing of the crossbreds under various farm production systems for their suitability should be conducted and confirmed before carrying out any extensive scheme of swamp buffalo crossbreeding.

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TRAINING METHODS IN ANIMAL GENETIC RESOURCES

TRAINING METHODS IN ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

A.H. Osman[1]

1. INTRODUCTION

During several previous meetings concerning animal genetic resources conservation and management held by or under the auspices of FAO and other organizations the consensus of opinion was that although long-term objectives are the same, immediate goals differ between developed and developing countries. This paper deals with training methods in animal genetic resources in developing countries.

Information as well as experience in this subject is rather limited and therefore the views expressed herein are meant to stimulate discussion. An attempt will be made to answer the following relevant questions:

- Is there a need for such training?
- To whom should this training be given?
- Who should give this training?
- What are the facilities needed and the need for regional and international cooperation?

2. NEED FOR, AND BENEFITS OF, TRAINING IN ANIMAL GENETIC RESOURCES

Animal breeding in Europe and other developed countries has followed, for the last two centuries, a different path from that in developing countries. In developed countries intense selection for type as well as for production traits resulted in a relatively small number of well defined breeds. The establishment of breed societies, with the help of government and semi-government agencies promoted further pure breeding and development of distinguishable and specialized breeds.

On the other hand, in most developing countries animal breeding followed old traditional methods which emphasized "quantity" rather than "quality" breeding. Becaue of social outlook to livestock, livestock owners paid little attention to individual excellence, and stressed increases in the herd or flock which is to a large extent related to multiplication and survival under the prevailing adverse conditions. The security of the livestock owners is reflected in raising more animals rather than the production performance of individual animals.

Under this genetic situation (lack of selection) and social outlook, practically all breeds and strains are preserved, each adapted to a specific environment. Performance recording is virtually unknown. High producing and low producing breeds are in co-existence, sometimes physically not far from each other.

Due to the rising demands for animal products many governments of developing countries tried to rectify the situation by the introduction *of* exotic genetic resources from developed countries. These policies are based on the assumption that productivity of indigenous breeds is very low. However, in many instances the indigenous breeds have not been properly evaluated. The dangers of this policy of indiscriminate cross-breeding with exotic stock and the rationale behind preserving indigenous breeds must be pointed out to governments before further damage is done.

Therefore there is need for documentation, and evaluation of the present indigenous breeds in developing countries. Once this information is available then programmes of conservation and utilization of these indigenous breeds should be carefully planned to cater for the short-term and long-term requirements of animal production in developing countries.

Due to the present organization of animal production in developing countries, which is characterized by a large sector of small farmers and nomads, genetic improvement methods relying on performance recording as seen in developed countries must be altered in such a way to cope with the situation. Under these conditions the problems of conservation and selection are closely linked.

3. PARTICIPANTS AND LEVELS OF TRAINING

In developing countries there is a shortage of highly qualified technical staff. Therefore a large part of the work will be entrusted to technicians and medium-level staff.

Documentation

It will be adequate to train technicians in animal production and veterinary science to shoulder this responsibility, including training in laboratory techniques.

Evaluation

This requires university training in animal production preferably in animal breeding. Post-graduate diploma or MSc will be even more suitable.

Conservation, Management and Utilization

In order to draw an effective programme of conservation, genetic improvement and utilization of the animal genetic resources, PhD training in animal genetics and breeding possibly also in other related fields is essential. In many developing countries this calibre of technical staff is not available. This situation would then require regional and international cooperation.

4. RECOMMENDED METHODS OF TRAINING

4.1 Theoretical Aspects

Topics	Technicians	Graduate	High qualifications MSc, PhD
Reasons for conservation of animal genetic resources	yes	yes	-
International work done	-	yes	yes
Breed documentation	yes	-	-
Breed evaluation	-	yes	yes
Conservation and management	-	yes	yes

Utilization of animal genetic resources	-	-	yes
Organization of data banks	yes	yes	yes

4.2 Practical Aspects

Topics	Technicians	Graduate	High qualifications MSc, PhD
Breed documentation	yes	yes	-
Data handling and organization	yes	yes	-
Genetic polymorphism			
Red cell antigens			
Haemoglobins			
Blood serum proteins			
Enzymes	yes	yes	yes
Conservation methods			
Live animals			
Frozen semen			
Frozen embryos	yes	yes	yes
Genetic improvement plans	-	-	yes

4.3 Country Reports and Case Studies

Each participant should present a country report for discussion. The report should include the work done in his (her) country and the problems related therewith.

Since most of these training courses will be regional because of language limitation, etc., then case studies of interesting work from outside the region can also be reported and discussed.

5. FACILITIES AND STAFF NEEDED FOR TRAINING

As far as possible training in animal genetic resources conservation and man agement should be shared between developed and developing countries. Lack of adequate training facilities should not be a limiting factor in organizing training courses in developing countries. Where there are nucleus facilities they should be augmented with the assistance of regional and international cooperation.

Technical staff from developing countries should be aware of the fact that even with limited facilities, some work can be accomplished.

Only high-level courses requiring elaborate facilities and complex equipment should be held in developed countries.

Also qualified personnel from developing countries should participate in these training courses.

6. NEED FOR REGIONAL AND INTERNATIONAL COOPERATION

Training in animal genetic resources conservation and management requires good and multidisciplinary facilities which are not present in any one single developing country. Therefore intercountry, regional and international cooperation *is of* paramount importance. This can best be accomplished by identifying potential training centres in developing and developed countries. These centres should be earmarked for certain levels of training. They should be augmented and improved in the best possible way through regional and international assistance, if need arises.

REPORT ON THE FAO/UNEP TRAINING COURSE ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

I. Bodó1

On the initiative of FAO/UNEP a two-week training course was organized on animal genetic resources conservation methodology for animal scientists from developing countries.

1. THE GOALS OF THE TRAINING COURSE

- To give the participants a survey on the present state of the theory and practice of the conservation and management of animal genetic resources.
- To gain experience for preparing such training courses in the future as the need arises from member countries of FAO.

2. HOST INSTITUTION

The host institution of the trailing course was the University of Veterinary Science, Budapest, Landler Jenó u. 2, Hungary.

3. PARTICIPANTS

Eighteen participants were selected by FAO from 15 developing countries. All of them were very well educated people and included university lecturers, research officers, extension workers, government administrators and livestock station superintendents. Some of them had the PhD degree from Europe or North America. For details see the list of participants (Annex II).

All the participants understood and spoke English. The course was conducted in English.

4. ACCOMMODATION, CLASSROOMS AND OTHER FACILITIES

Accommodation and breakfast was provided for the participants in the student hostel of the University in single or in some cases double rooms with bathrooms. Classroom lectures were organized in the same building. Slide and transparent projectors were available. Lunch and dinner were served nearby in a restaurant.

5. FINANCE

A fund of Hungarian Forints equivalent to US$ 20 000 deposited by FAO/UNEP was available to the University of Veterinary Science to cover the costs of the training course. The travelling of the participants was arranged separately by FAO. The cost of providing a Manual to be published soon is also included in the above mentioned sum.

6. SEQUENCE OF EVENTS IN THE TWO-WEEK TRAINING COURSE (see Annex I for full programme)

2	days arrival, registration
2	days classroom lectures
1	day field visit
2	days classroom lectures
1/2	day classroom lectures
1/2	day relaxation, sightseeing (Saturday)
1	day relaxation, excursion and field visit (Sunday)
2	days classroom lectures

1 day field visit
1 day classroom lectures
1/2 day closing of the training course, afternoon free
2 days departure of participants
16 days

Social Events:

a. Opening Reception, given by the Rector of the University
b. Farewell dinner

7. SUBJECTS OF THE TRAINING COURSE

7.1 Classroom Lectures

Theory of conservation and management

- genetics
- necessity and importance of the conservation programme
- the world situation and the work already done
- the possible role of immunogenetic and chromosome research
- importance of selection

Several approaches to the problem

- Hungarian
- British
- French
- Scandinavian
- the work organized by EAAP

Methods of conservation

- living animals (purebred and gene pool system)
- cryogenic methods

Organization of maintenance of rare breeds threatened by extinction

possibilities at government level
- mobilizing the forces of society
- problems at national
  regional
  worldwide level

Health and disease problems of conservation and the role of indigenous breeds in resistance against disease

- infectious diseases
- parasites

Special cases

- poultry
- Sahiwal
- Hungarian Grey Cattle

Other species

- variability in non-domestic species

- domestication and history of breeds.

Following each lecture numerous questions were put during the discussion periods.

7.2 Country Reports

Each of the participants gave a report (usually illustrated) on animal genetic resources in his own country, which were very interesting. These reports may be considered as case studies and were followed by active discussion, many questions and comments.

7.3 Field Visits

The participants of the course visited the Hortobágy State Farm and National Park which are responsible for the maintenance of genetic resources of some Hungarian endangered domestic species (sheep, cattle, swine).

Another visit was paid to an AI centre where the participants could study cryogenic methods and storage of semen.

An embryo transfer was demonstrated in practice with cattle.

The Saturday afternoon and Sunday excursions were for relaxation and to show the participants Budapest and some landscapes of Hungary as well as a visit to a Game Production Centre in the country.

8. CONCLUSIONS

Based on the experiences of this training course, I highlight the following items for future courses:

i. The scientific programme should include the small animals such as rabbit, pigeon and other backyard production breeds as well as fisheries (freshwater and sea) ; furthermore game meat production and consumption.
ii. It would be desirable that FAO provides the available data on each represented country on which the country reports should be based.
iii. The host country must be prepared for the duplication of the lectures as well as the country reports and possibly brief summaries. Also for the provision of the technical facilities such as projectors, tape recorders, etc.

I consider it desirable to reproduce also the illustrations of the lectures and country reports (use of video recorder?).

iv. Since discussion is a very important part of the course one should consider whether the oral part of the discussions should be taped and published in the form of brief minutes, or in the final report.
v. The scientific and the financial/organizational tasks of the training course should be separated.
vi. Because of the different financial systems of possible organizing countries provision should be made for the participants to have both convertible and local currencies.

ANNEX I

FAO/UNEP TRAINING COURSE ON ANIMAL GENETIC RESOURCES
CONSERVATION AND MANAGEMENT
Budapest, 5-16 September 1983

Director: Dr. I. Bodó
Co-Director: Dr. John Hodges

TIMETABLE

4-5 September

Arrival of participants

Registration

5 September

18.30 Reception given by the Rector of the University

6 September

08.10	Inaugural address	L. Zelkó
08.20	Keynote address	I. Bodó
08.30	The importance of conservation of genetic resources with special respect to the strategy of heterosis	A. Horn

	breeding	
10.30	General survey on the present situation for the maintenance of animal genetic resources and the work already done	J. Hodges
14.00	How to avoid total genetic loss of domestic animals: Hungarian approach	I. Biró
16.00	Country report, Brazil	A. Primo
17.00	Country report, Botswana	E. Senyatso

7 September

08.30	Scandinavian activities on the conservation of animal genetic resources	K. Marjala
10.30	The evolution of domestic animal breeds. The problem of variability in wild and feral populations	A. Reményi
14.00	Maintenance of animal genetic resources in Europe. The work already done by the EAAP	K. Maijala
16.00	Country report, Cyprus	A. Mavrogenis
17.00	Country report, Ethiopia	G. Yilma

8 September

07.00 Visit to the State Farm and National Park of Hortobágy. Herds of ancient Hungarian Grey Cattle, sheep and pig breeds. A whole day programme

9 September

08.30	Genetic problems in the maintenance of rare, non-commercial populations of domestic animals	J. Dohy
10.30	The role of genetic polymorphism research in the conservation of rare breeds threatened by extinction	L. Fésüs
14.00	Maintenance of living herds of farm animals (example: Hungarian Grey Cattle)	I. Bodó
16.00	Country report, Indonesia	A. Siregar
17.00	Country, report, Kenya	C. Gichohi

10 September

08.30	Improvement of Sahiwal cattle by intercountry cooperation	J. Hodges
10.30	How to avoid total genetic loss of domestic animals. French approach	J. Devillard
15.00	Free or sightseeing of Budapest	

11 September

10.00 Round tours in the country by coach

12 September

08.30	Organization of the maintenance of rare domestic animal breeds at Governmental level	J. Devillard
10.30	The role of control of infectious diseases in the maintenance of animal genetic resources	T. Szent-Iványi
14.00	Importance and possibilities of cryogenic systems on the maintenance of genetic variability of domestic animals	P. Soós
16.00	Country report, Nepal	N. Shrestha
17.00	Country report, Pakistan	N. Zafarullah

13 September

08.30	Problem of selection in indigenous breeds	V. Buvanendran
10.30	The problem of conservation of genetic variability in poultry populations	P. Horn
14.00	Genetic improvement of indigenous breeds	V. Buvanendran
16.00	Country report, Sudan	M. Ahmed

17.00	Country report, China	W. Huang

<u>14 September</u>

07.00 Visit to Al Centre at Gödölló. Laboratories in AI station. Blood group and chromosome control in practice

14.00 Visit to embryo transfer centre at U116. Methods and demonstration. A whole day programme

<u>15 September</u>

08.30	How to avoid total genetic loss of domestic animals. English approach	G.I. Alderson
10.00	Country report, Afghanistan	K. Janan
11.00	Country report, Bhutan	K. Wangdi
14.00	Mobilization of the forces of society for the conserva tion of animal genetic resources	G.L.H. Alderson
16.00	Country report, Thailand	S. Chantsavang
20.00	Dinner	

<u>16 September</u>

8.30	Country report, India	P. Thomas P. Dash
09.30	Country report, Nigeria	G. Nnadi
10.30	Summary of the main topics and closing of the training course	J. Hodges I. Bodó

<u>17-18 September</u>

Departure of participants

ANNEX II

LIST OF PARTICIPANTS

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RECOMMENDATIONS AND DEFINITIONS

RECOMMENDATIONS*

To FAO/UNEP

1. Since the benefits of conservation and management of domestic animal resources

are known to be great relative to costs and since many adapted indigenous populations in developing countries are threatened by loss, the Panel recommended that planned programmes for the conservation of animal genetic resources, especially those adapted to the production conditions of developing countries, should have three mutually supportive strategies for preservation and management.

i. Highest priority should be given to identification and characterization of genetic resources and their adaptation.
ii. Preservation programmes should aim to prevent the loss of those populations containing unusual genetic variations. The preferred techniques will usually be the cryogenic storage of sperm and/or embryos, because most developing countries would not be willing to preserve live animals without utilization, and for most species, satisfactory methods of cryopreservation are available. FAO/UNEP should set up an International Cryogenic Animal Gene Bank, at more than one location using a split sample technique. Particular attention should be paid to ensuring the dependability of the maintenance services.
iii. Resource management programmes with live animals should comprise continued genetic improvement of productivity of local livestock populations, so that wherever possible, they remain economically competitive with imported exotic breeds. To ensure this, development and provision of performance recording systems suited to management needs at the farmer level should be implemented.

2. The Panel recommended that FAO/UNEP should promote the establishment of a list of threatened breeds and populations, indicating their potential genetic value and possible utilization, and proposing priorities for urgent action for conservation.

3. The Panel agreed on the importance of establishing regional data banks on animal genetic resources as soon as possible. It recommended that these should continue to be built up systematically in close cooperation with existing regional bodies such as IBAR/OAU and ILCA for Africa, ALPA for Latin America and SABRAO in Asia and with the leading international information centre on this subject (Commonwealth Agricultural Bureau of Animal Breeding and Genetics) to avoid duplication of effort. The Panel commended FAO/UNEP for initiating its work with a thorough study on the methodology to be applied for the collection, interpretation/summarizing and dissemination of the available information so as to minimize cost, maximize efficiency and to ensure that a globally compatible system should be established.

4. The Panel supported the view that the end point of the methodological study should be (a) a common, worldwide data format for use in the various regions; (b) the creation of descriptors for each species; and (c) a uniform system of criteria on which information would be judged for inclusion in the data bank. It was therefore recommended that FAO/UNEP continue their work to achieve these objectives without break or delay, and urged them to embark upon the establishment of Regional data bank centres as soon as the methodological studies are complete.

5. The Panel also recommended that FAO/UNEP, when promoting the creation and use of data banks, insist upon the competent scientific screening and compilation of all data entering data banks and that FAO/UNEP ensures that priority be given to this need.

6. The Panel noted that the genetic principles for determining the numbers of parents required to reconstitute a breed are established. It recommended that when cryopreservation of sperm and embryos from a threatened breed is part of its conservation, these principles should serve as guidelines to the amount of material to be stored.

7. The Panel noted that in the long-term storage of sperm and embryos, there should be safeguards for the health of future generations of livestock that will be exposed to contact with animals bred using cryogenically stored cells. It recommended that sperm and embryos stored in gene banks for endangered breeds should have adequate records concerning the health status of the herd and area/country of origin, and of the diseases for which the donors were tested. Future users of these stored cells should have access to these records.

8. The Panel noted that many of the trypanotolerant livestock breeds of West and Central Africa occur as small and scattered populations in a number of countries; that there are inherent difficulties in establishing and maintaining separate conservation and management programmes for these small genetic groups in each of the several locations; and recognized the advantages that may be gained by collaborative programmes of selection, multiplication and conservation which transcend national boundaries; it therefore recommended to FAO/UNEP that they should:

i. continue to foster intercountry cooperation in the development and operation of breeding programmes for trypanotolerant livestock; and
ii. assist in investigations that would help determine the genetic distance between the trypanotolerant breeds in all traits of economic importance, so that rational decisions may be taken to treat populations as discrete or combined for more effective future use.

9. The Panel noted that many domestic animal species in addition to cattle make significant contributions to human welfare and are similarly threatened by loss of important genetic variation, and recommended that greater attention and action be given to the conservation and management of genetic resources in populations of:

i. sheep, goats, buffalo, camelidae, swine and all other domestic species;
ii. breeds kept for draught;
iii. species used only on a small scale but in special environments.

Parallel attention should also be given to ways and means of preserving, for possible future use, populations of wild animals which are related to domestic species.

10. The Panel noted that considerable resources, both intellectual and material have gone into the organization and conduct of the first course on animal genetic resources conservation and management; and that the Hungarian scientists responsible for this course are in a unique position to suggest modifications and improvements that could be incorporated in future courses. It also recognized that there are advantages in organizing future courses at locations in developing countries where the problems exist and using appropriate regional languages for the conduct of the courses. It therefore recommended a two-stage approach to future course locations:

i. Organize the second course in the same location as the first course viz. University of Veterinary Sciences of Hungary, inviting persons who might serve as future Course Directors in developing country locations to participate and benefit from the experience gained by the Hungarian scientists.

ii. Organize subsequent courses on a regional basis giving priority to the needs of developing countries in course organization and selection of teachers and students, and in close contact with the regional associations of animal production, as well as animal breeding and genetics.

11. The Panel recommended that FAO/UNEP encourage educational institutions in the developing countries to include in their animal science curriculum aspects of animal genetic resources conservation (including preservation of threatened genotypes, evaluation, improvement and management). The Manual prepared at the First International Course on Animal Genetic Resources Conservation and Management by FAO/UNEP and the University of Veterinary Sciences, Hungary, should be offered as a source of ideas for inclusion in such curriculum development.

12. The Panel noted that information on genetic distances between breeds of domestic animals would be of value in deciding priorities for action on breed conservation and management, and recommended that research on this topic be encouraged. In particular FAO/UNEP should assist investigations to this end.

13. The Panel recommended that the new techniques of molecular biology should be used to study the functioning of major genes known to be important for animal production, to the discovery of additional major genes, and to the production of gene maps for domestic species, and that FAO/UNEP should promote such studies.

To FAO/UNEP and Governments

1. The Panel agreed that in most developing countries genetic improvement of local

breeds would form integral and necessary parts of constructive programmes for their conservation and future use. It was pointed out, however, that such breeding programmes would require more information on production characteristics both under station and field conditions than was usually available. The Panel also noted that recent developments of AI services in developing countries have often been accompanied by massive importations of exotic bovine semen, without concurrent development in semen processing facilities for superior indigenous bulls. The Panel recommended:

i. that Member Governments should give higher priority than hitherto to production recording and breeding programmes adapted to their own conditions so as to ensure the conservation and development of their national livestock resources.
ii. that Member Governments should establish breeding and multiplication centres in countries where breeds are found which are in need of improved utilization;
iii. that FAO/UNEP should render assistance in the establishment of these breeding and multiplication centres and the necessary infrastuctures to support them.

2. The Panel noted that there is only a small number of indigenous cattle breeds suited to milk production under harsh conditions; that these breeds are threatened as a result of a progressive narrowing of their genetic base; that in order to widen their genetic base there must be an exchange of germplasm between countries where the breeds occur; and recommended that:

i. inter-country cooperation in the exchange of germplasm should be encouraged with due regard to quarantine precautions;
ii. FAQ should assist in the development of the requisite infrastructure for the exchange of genetic material between countries, for the genetic evaluation and comparison under different harsh conditions and for studies and action on their adaptation in both purebred and crossbred improvement programmes.

DEFINITIONS
pertaining to Animal Genetic Resources

1. CONSERVATION

The management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations. Thus conservation is positive, embracing preservation, maintenance, sustainable utilization, restoration and enhancement of the natural environment.

(This definition of CONSERVATION originates with the World Conservation Stra tegy, which was prepared by the International Union for the Conservation of Nature and Natural Resources (IUCN), and the following collaborative organizations: United Nations Educational, Scientific and Cultural Organization (Unesco), the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), and the World Wildlife Fund (WWF).)

2. PRESERVATION

That aspect of CONSERVATION by which a sample of an animal genetic resource population is designated to an isolated process of maintenance, by providing an environment free of the human forces which might bring about genetic change. The process may be in situ, whereby the sample consists of live animals in a natural environment, or it may be ex situ, whereby the sample is placed, for example, in cryogenic storage.

3. CONSERVATION BY MANAGEMENT

That aspect of CONSERVATION by which a sample, or the whole of an animal population is subjected to planned genetic change with the aim of Sustaining, Utilizing, Restoring or Enhancing the quality and/or quantity of the animal genetic resource and its products of food, fibre or draught animal power.

4. THREATENED (Species or breed)

A term used to describe an animal genetic resource population which is subject to some force of change, affecting the likelihood of it continuing indefinitely, either to exist, or to retain sufficient numbers to preserve the genetic characteristics which distinguish it from other populations. THREATENED is a generic term embracing more precise descriptions such as Endangered, or Vulnerable.

(It is also so used in the context of the World Conservation Strategy.)

5. GENE BANK

A physical repository, in one or more locations, where the samples of animal genetic resource populations which are being preserved are kept. These may include animals, embryos, oocytes, sperm, DNA, etc.

6. DATA BANK

The fund of knowledge comprising the CHARACTERIZATIONS which describe the genetic attributes of animal breeds or species and the various environments in which they occur; these CHARACTERIZATIONS being stored both as numerics and words in a data/word processing system which provides for the addition of further information, for amendment and for analytical use.

7. CHARACTERIZATION

The numeric/word decription of:

i. the genetic attributes of an animal species or breed which has a unique genetic identity; and
ii. the environments to which such species or breed populations are adapted or known to be only partially or not adapted.

The CHARACTERIZATION is a succinct statement, being the distillation of all available knowledge both previously published or unpublished, which contributes to the reliable prediction of genetic performance in defined environments. It is different from the mere accumulation of existing reports or individual findings on genetic performance on specific occasions.

8. DESCRIPTORS (of species or environments)

A series of items with defined meanings for a species and its environments, which are universally used to prepare data bank CHARACTERIZATIONS of:

i. breeds of a given species, covering the phenotypic and genetic parameters of the breed;
ii. environments in which breeds of a given species are found, covering the natural and artificial features relevant to genetic analysis, including such items as climate, topography, endemic disease risk, feed and water supply, and management systems.

The purpose of DESCRIPTORS is to facilitate valid comparison, classification or enumeration of breeds within a species in the context of the environments existing in different countries and regions of the world.

- These should be read in conjunction with the definitions which follow the recommendations.

THE FAO TECHNICAL PAPERS

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1. Animal breeding; selected articles from World Animal Review, 1977 (C* E* P S*)

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36. Ticks and tick-borne diseases; selected articles from World Animal Review, 1983 (E* F* S*}

37. African animal trypanosomiasis: selected articles from World Animal Review, 1983 (E* F*)

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