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ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

Report of the FAO/UNEP
Technical Consultation
held in Rome, 2-6 June 1980

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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REPORT OF THE

FAO/UNEP TECHNICAL CONSULTATION ON ANIMAL GENETIC RESOURCES CONSERVATION AND MANAGEMENT

held at
FAO Headquarters
Rome, Italy

2 - 6 June 1980

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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I. RECOMMENDATIONS

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 rationalisation 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.

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

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 standardised 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 organisations in maintaining documentation systems;

(iii) the development of a two-stage data bank system

(a) initially emphasising enumeration of breed populations, population structure and minimum information on productive and adaptive characters;

(b) 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 industries in particular, it is recommended that FAO should encourage Member Governments and/or participating organisations 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-infested 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.

II. INTRODUCTION

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 in practical animal breeding improvement programmes has made possible an unprecedented rate of increase in the production of milk, meat and fibre per animal. As a result a few high performance breeds have emerged which are gradually displacing the local breeds in temperate regions. These changes have been particularly evident in the industrialised countries. Very little, if any, investment has been made for improvement of the local or indigenous breeds. As a result many developing countries are increasingly concerned about their livestock resources especially after large introductions of high-yielding breeds from the temperate zones which often cause a decline in the number of local livestock types. The latter have, through natural and man-made selection, developed characteristics which make them well adapted to the often harsh environmental conditions under which livestock will have to continue to live and produce in these areas (periodic droughts, high temperature and humidity, coarse feed, diseases, parasites, etc.). It is, therefore, important that this valuable genetic material be maintained and improved as the basis of national livestock breeding programmes and policies. Ways and means must be found by which rapid genetic progress can be made, through intensive selection and/or the introduction of breeding material, without jeopardizing the possibilities for genetic adaptation to the present or unforeseen future conditions. Greater attention to the management of animal genetic resources is needed as is evident from the fact that many well-known national breeds have declined seriously in numbers over the past few decades.

FAO has a longstanding interest in the utilisation and conservation of animal genetic resources and has arranged, as part of its Regular Programme, a number of meetings and studies through which governments have been advised on suitable breeding and development policies. Through its Field Programme, FAO has assisted many member countries in the evaluation of these livestock resources and their improvement through concrete breeding programmes. Genetic resources conservation in general (crop plants, forests, animals and microbes) was considered of such importance that it was highlighted at the United Nations Conference on the Human Environment held in Stockholm in 1972 and a number of recommendations on studies and action to be undertaken to safeguard the world's genetic resources were made.

As a result of this Conference, the United Nations Environment Programme (UNEP) was established and, since 1974, FAO and UNEP have been involved in a number of joint surveys and studies on genetic resources. At the same time interest in the conservation of animal genetic resources has been increasing particularly in the scientific community, but also at government policymaking levels. Work related to the conservation and management of animal genetic resources is now carried out in many countries, both by governmental organisations and by private or semi-governmental institutions. This involves breed development of adapted breeds which requires special breeding programmes to support local agricultural endeavours and to improve the quality of life.

The time has now come to review the wealth of information which has been collected on the subject during the last decade in many different places of the world and to prepare strategies and action programmes for the future. Accordingly FAO and UNEP organised this Consultation on Animal Genetic Resources Conservation and Management with the following objectives:

1. To discuss and analyse the current state of the world's farm animal genetic resources with a view to proposing methods and action for improved management of this biological resource to minimise genetic losses.

2. To discuss reasons for the decline in genetic variability, including the decrease in the number of specific strains and breeds of farm animals.

3. To review international, regional and national activities on the management and conservation of animal genetic resources.

4. To recommend national and international action and coordination required in the field of farm animal genetic resources conservation.

The Consultation was held at FAO Headquarters, Rome, during 2 - 6 June 1980.

Dr. Helen Newton Turner of Australia was unanimously elected Chairman and Dr. Guillermo Joandet of Argentina Vice-Chairman.

III. SESSION 1 - OPENING ADDRESSES

The Inaugural Address was given by Dr. Ralph W. Phillips, Deputy Director-General of FAO [1/]. Dr. Phillips pointed out that, although arguments against the continuing use of livestock have been advanced, the arguments for their retention are even stronger. Much of the world's surface is grazing land from which only feed suitable for animals can be harvested, frequently by the animals themselves. With rising living standards, more of the world's population is demanding animal products as part of its diet.

Between the time of domestication of livestock thousands of years ago and the development of modern techniques of animal breeding this century, many genetic changes took place in the animals but at a much slower rate than those which have occurred since. Rapid genetic improvement in recent years has led to greatly increased output, particularly in the developed temperate zones but at the expense of loss of genetic variability through discard of breeds and concentration on individuals within a breed.

In the environmentally less-favoured areas, genetic improvement programmes have received less attention until recently and increased production in the past has frequently been sought by importing genetic material from other areas. It is encouraging to see a reversal of this trend and to witness the emergence of organizations for the conservation of disappearing breeds.

One of the tasks of such organizations is to monitor the local breed population structures by collecting data on their numbers, distribution, main characteristics and productivity. The next step is to ensure that they are fairly evaluated under conditions where they are to be used and thus to save at least the profitable breeds. The work involved is world-wide in scope, and FAO has been deeply involved in the subject for some time. Its interest continues.

The Keynote Address was given by Dr. Swaminathan, Deputy Chairman of the Indian Planning Commission. Dr. Swaminathan took India as an example and stressed the importance of the livestock sector as an integral part of Indian life, through its role in increasing income and providing gainful employment, not only directly but through ancillary activities such as feed manufacture and fabrication of equipment. The economically weaker sections of the population prefer to supplement their income through livestock activities. He highlighted the maintenance of suitable plant ecology in marginal grazing areas to ensure their continued use. Well-conceived farming systems based on animal husbandry can make valuable contributions to achieving higher and more stable incomes. Production systems which combine different plant and animal species and the recycling of animal wastes give new levels of production and efficiency.

India has a wide range of environments, and in these many breeds and types of livestock have developed, which have considerable adaptation to local climatic conditions, as well as to the stresses of feed constraints and exposure to diseases. Efforts to improve productivity have included the introduction of exotic breeds and this could lead to the ultimate disappearance of some local breeds. No systematic attempt has been made in the past to halt this trend but efforts are now being made through the establishment of the National Bureau of Animal Genetic Resources.

The broad aims of this Bureau are:

(i) To identify, evaluate and catalogue herds or flocks valuable for conservation.

(ii) To formulate criteria for identifying genetically superior animals.

(iii) To document this information, using a computer system.

1/ The full text of Dr. Phillips' address is printed as an Appendix to this report

(iv) To process and disseminate information gathered in surveys.

(v) To maintain liaison with similar institutions elsewhere.

(vi) To render financial assistance where needed for the maintenance of conserved flocks.

(vii) To monitor the whole programme of maintenance.

Dr. Swaminathan went on to describe some of the wide range of livestock found in India, and concluded by stressing that scientific effort must be supported by social and political consciousness and action. He quoted the maintenance of conserved plant seed stock through the siege of Leningrad as an example of such consciousness.

He ended by suggesting a three-tiered organisational framework to help national governments/organizations to develop their own framework for classification, conservation and utilization of animal genetic resources, to promote regional gene banks, and to organize for each major animal species an International Working Group to support and stimulate scientific and sustained conservation work.

IV. SESSION 2 - WORK ALREADY DONE ON THE CONSERVATION OF ANIMAL GENETIC RESOURCES

The Session was introduced by Mason's account of the joint FAO/UNEP work since 1974. This has been published in the following reports:

(i) A Pilot Study on Conservation of Animal Genetic Resources which gave an account of the decline in the indigenous cattle breeds of the Mediterranean region and a brief survey of the threatened breeds of all species elsewhere.

(ii) Declining Breeds of Mediterranean Sheep by Brooke and Ryder.

(iii) FAO Consultation on Mediterranean Cattle and Sheep in Crossbreeding.

(iv) Trypanotolerant Livestock of West and Central Africa.

(v) FAO/UNEP Consultation on Animal Genetic Resources in Latin America.

(vi) Prolific Tropical Sheep.

(vii) Sheep Breeds of Afghanistan, Iran and Turkey by Yalçin.

(viii) FAO Consultation on Dairy Cattle Breeding in the Humid Tropics.

Reference was also made to a draft Inventory of Special Herds which lists conservation herds, feral populations and domestic animals in zoos.

Trail's paper gave full details of the joint FAO/ILCA/UNEP study on trypanotolerant cattle of West and Central Africa which showed that, in terms of productivity per 100 kg of dam's body weight, trypanotolerant cattle were almost as good as other breeds in tsetse-free areas of Africa. The work of ILCA also includes an analysis of the performance of various grades of Sahiwal cross on to European cattle.

The work of the Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO) in this field was described by Barker. This organisation formed a committee of scientists in the region to review and collate information on indigenous breeds and list gaps which should be filled. He presented the conclusions and recommendations of a Workshop held in Japan in 1979 which drew up a set of forms for documenting the various species. The report of this Workshop has been published. Reference was also made to the work of APHCA which processed data available on goats in the FAO Region for Asia and the Pacific through a conference sponsored in India in 1979.

The work of the Rare Breeds Survival Trust in the United Kingdom was described by Alderson. This is a voluntary organisation which works with 44 of the 52 breeds identified as rare. In Bulgaria, by contrast, it is the Government which gives financial support for the conservation of 18 sheep breeds, 3 cattle breeds, 1 buffalo breed and 4 goat breeds (Alexiev). Bhat surveyed the major breeds in India and described the functions of the National Bureau of Animal Genetic Resources which is being set up. In France, 80 breeds are threatened with extinction and the policy is to try and maintain nuclei in their natural environment with the help of a Government subsidy (Devillard).

Reports were presented by 27 country delegates and by the Inter-African Bureau on Animal Resources (IBAR) on genetic resources and their conservation. It is clear that much has been done to document populations and, in some cases, to conserve them. The reports ranged between two extremes. Turkey has had few imports of exotic breeds and little loss of indigenous material. While at the other end of the scale Hungary has lost nearly all its indigenous breeds but is maintaining their remains in a series of State farms.

There was a general consensus of opinion that there is a need to conserve useful indigenous germ plasm. However, first priority must be given to securing more accurate data on indigenous livestock, particularly on their performance in the environments to which they are best suited. Current information is based mostly on census data, while performance data are only available from a few countries and on a limited number of breeds. Efforts should be directed to obtaining information from all available breeds based on institutional farms, and, to the extent possible, from field data.

There was difference of opinion as to what should be conserved. Should all available germ plasm be conserved or only that which is potentially useful, or only the rare breeds and strains? There is a clear need to specify the criteria for the conservation of breeds, including characteristics that ought to be preserved. This could then lead to a classification of livestock on the basis of characters to be preserved rather than on the basis of breeds. The delegates from developing countries considered that it would be difficult to finance conservation of all livestock types and that dynamic breeding programmes for useful breeds are the best form of conservation.

From the reports on work done many questions arose, some of which occurred again and again in later discussions, and some of which have been crystallized in the recommendations.

1. In documenting breeds, what characteristics are being recorded? Can recording techniques be standardised? Should a working party be established to bring about standardization?

2. What further steps can be taken to document breeds for which information is not yet available?

3. What form of collation is being used for recorded data? Is any help (financial or technical) needed in establishing computerisation to aid dissemination and/or updating of information?

4. Can regional collaboration be established for utilizing genotypes of animals widely used in one or more regions? This would be valuable in a number of cases of which examples are for the buffalo (Southeast Asia and the Indian sub-continent) for Zebu cattle types (Africa, Asia, Latin America) and for hill-type or high altitude species of livestock in the higher altitudes of Europe.

V. SESSION 3 - THE NEED FOR MAINTAINING ADEQUATE GENETIC VARIABILITY

Van Soest divided the adaptive responses of ruminants into two main strategies: grazing, which involves extraction of the maximum available energy at the cost of feed intake; and browsing, which involves selective feeding for dietary quality at the cost of eating time. Body size and gastro-intestinal capacity set limits for grazers, while mouth parts, learning ability, agility and/or gastro-intestinal adaptation are determinants for browsers. Small ruminants must be very selective to overcome the disadvantage of small size (i.e. a smaller digestive tract size relative to body size) and the rabbit-sized dik-dik is probably at the limit of size for a ruminant.

Osman spoke on the need for different genetic types for different environments and gave examples from cattle and sheep in the Near and Middle East.

The future is extremely difficult to predict. Therefore, Bowman advocated flexibility in breeding programmes and the maintenance of as many different genotypes as possible. It is probably also safe to advocate selection for improvement in efficiency of production, for twinning in cattle, for increased appetite in most species and for ability to cope with varied and low-quality diets.

The need to select for disease resistance and environmental adaptation (Rendel) gave rise to discussion on the relationship between productivity on the one hand and resistance to high temperature and disease on the other.

It is impossible to generalize about the comparative biological or economic efficiency of intensive and extensive livestock production systems. Different breeds are needed for each system and performance per lifetime must be the basis of evaluating breeds and breeding. Local breeds should be selected for increased productivity. In addition they form a reserve whose traits may be useful elsewhere in the future and they are a valuable resource for creating heterosis (Cartwright).

There was general consensus about the need for maintaining genetic variability.

Stress was frequently laid on the importance of characteristics such as adaptation (to climate and to management systems) and disease resistance. In this connection, the point was made strongly that exotic genetic material should be introduced with caution and should be based on thorough evaluation, taking into account future production conditions.

VI. SESSION 4 - CAUSES AND MEASUREMENT OF DECLINING VARIABILITY

Two papers (Deaton and King) dealt primarily with causes of declining genetic variability, and two (Braend and Yamada) with measurement of variability.

Deaton and King dealt respectively with loss of variability through selection between breeds (not necessarily directed by economic evaluation), and with loss through selection within breeds. However, it is important to note that their presentations confound an important issue facing this consultation, i.e. the need to distinguish problems of conservation and utilisation of resources in developing countries and in developed countries. The present status and hence future utilization are different in these two situations.

In considering the disappearance of local breeds, Deaton made specific reference to cattle in Central and South America but his discussion and conclusions undoubtedly apply to all species in the developing countries. Particular attention was drawn to confusion as to what constitutes a breed population and to the lack of data, i.e. the primary problems of <u>identification</u> and <u>documentation</u>.

Loss of local or native breeds occurs through breed replacement (primarily by imported or exotic breeds) or by dilution through crossbreeding (generally indiscriminate rather than planned). These losses in both cases generally occur for reasons unrelated to productivity, again emphasizing lack of data and the need for comparative evaluation in environments where the livestock will be used.

Given documentation and evaluation, the need for information flow to the farmers was emphasised - to allow rational decisions on breed use based on lifetime productivity in the appropriate environment.

In discussing the effect of selection in single-purpose breeds, King addressed the question of whether present selection programmes prejudice opportunities for future change.

Theoretical expectations, supported by experimental evidence from laboratory populations indicate that genetic variation in the character under selection will decrease as a direct result of the selection compounded by an inbreeding effect with more intensive selection leading to a more rapid increase in inbreeding. In addition, total genetic variation will decrease at a rate dependent on the effective size of the selected population, i.e. a direct inbreeding effect.

Thus, genetic variation available at any time in a selected population will depend on that in the initial foundation population (possible bottleneck effects), effective population size of the selected population and the selection intensity.

It was stated that demonstration of additive genetic variation is not sufficient; what is necessary is additive variation that is amenable to selection and will lead to response. While this may be true for some livestock populations in developed countries (e.g. poultry), it may not be so relevant for populations in the developing countries that have not yet been subjected to intensive selection for productivity.

Further points raised in the discussion emphasized that quantitative genetic theory on the effects of selection on additive genetic variations refers only to that variation that is expressed in the foundation population. Evidence from laboratory selection experiments, primarily with <u>Drosophila</u>, have shown that much of the variation in unselected populations is not expressed but is suppressed by developmental regulation. This variation, together with additional variation released by recombination, may become available as selection proceeds. Thus it is likely that progress from selection may continue for much longer than expected from measured variability in the foundation population.

Nevertheless, many laboratory selection experiments have shown limits to selection with genetic variations remaining for the selected trait and further utilisation of this variation - i.e. further progress may be made by selections from crosses among such populations. This thus emphasises the dangers of concentrating selection efforts on a single genetic base as exemplified by poultry and dairy cattle in the developed countries.

In reviewing the origins of livestock breeds and progress from selection in these breeds, again primarily in the developed countries, King suggests that there has probably not yet been significant loss of genetic variability, with the possible exception of egg-producing poultry.

However, in many of these breeding programmes, insufficient attention has been paid to possible changes in characters not under selection and to changes in the genetic variation underlying those traits.

In order to assess the real genetic effects of breed loss or of within-population selection, suitable measures of genetic variation must be available.

An extensive review of qualitative variants in livestock was given by Braend. These variants include blood groups (markers in the red blood cell membrane), markers in the white cell membrane (histo-compatibility loci), protein and enzyme variants in the blood plasma, markers within red blood cells and markers within white blood cells (mainly enzymes).

From information on the frequencies of these variants in any population, the degree of genetic variability can be estimated as the average heterozygosity per locus ($\bar{H}$). For a large number of loci investigated (say > 30), and assuming that these loci represent a random sample of the structural loci in the whole genome, $\bar{H}$ can be taken as an estimate of overall genetic variability in that population. Thus $\bar{H}$ may be used in comparisons of the magnitude of genetic variation in different breeds or populations. For most livestock populations, only few loci have been studied to date and other measures of within-population variability also should be used such as estimates of additive genetic variation for quantitative traits. These will provide comparable data on different populations provided the estimates are made on these populations at the same time and under the same environmental conditions. $\bar{H}$ (particularly when estimated from a small number of loci) and additive genetic variance estimates may give different results when comparing the magnitude of variability in different populations so that both should be used.

Interesting data suggesting higher levels of genetic variation in Nigerian and East African Zebu than in European and other African breeds were presented.

Yamada addressed the same question of measurement of variability within a population, and that of diversity or differences among populations. The latter can be estimated from genetic distance measures and, although these may lead to apparently incorrect estimates of divergence time, the magnitude in absolute units of the distance measure does provide an estimate of genetic differentiation between populations. Again, genetic distance estimates depend on knowledge of gene frequencies at enzyme and other marker (qualitative) loci, and like $\bar{H}$, should be based on a large number of loci.

Other measures of genetic differences among populations, including canonical and morphometric analyses using phenotypic data on quantitative traits, were referred to in the discussion. As for estimation of variability within populations, these different measures of between-population differences should be considered as complementary, i.e. not necessarily measuring the same thing. Therefore, caution is necessary in determining whether or not two or more populations are genetically different.

Methods of conserving small populations with minimum increase in inbreeding also were discussed by Yamada, referring to a computer simulation study. In discussion, the delegate from France referred to work on endangered breeds of cattle and goats with total populations of 200-300 but only 10-20 males. By organisation of the population into families, rotation of sires and accurate control of reproduction, the rate of increase in inbreeding has been held at about 1 percent per generation. Generation interval can be increased by special breeding methods, the most effective being the selection of replacement breeding stock from the oldest possible parents per generation.

Finally, the use of qualitative traits (blood groups, enzymes, etc.) as aids to selection for economic characters was discussed by Braend. This appears to be an area that is coming more into consideration, stimulated largely by findings on the human HLA complex and specific examples in livestock (e.g. the porcine stress syndrome in pigs). It may be most important in connection with specific disease resistance and fertility components.

In conclusion it should be emphasised that in considering the loss of variability, it is important to distinguish loss of breeds from loss of variability within breeds. The former is much more significant on the global scale, and the within-population picture is quite encouraging. Crossbreeding is a major cause of this breed loss but systematic crossbreeding can be a useful breeding policy. The procedure to be condemned is indiscriminate crossing, without comparison of the cross with existing breeds and without ensuring that the original breed can be most effectively maintained if it proves superior.

VII. SESSION 5 - HOW TO MAINTAIN GENETIC VARIABILITY

Cunningham mentioned the intensive husbandry and sophisticated techniques of evaluation and of data analysis which have made possible the rapid genetic improvement of livestock populations in the developed parts of the world. In contrast, livestock improvement programmes now being undertaken in developing countries are faced with two limitations, those imposed by the natural and managemental environment and those due to the deficiencies in the supporting infrastructure. Models for selection and crossbreeding programmes were presented which are applicable in these conditions. It was emphasised that any crossbreeding strategy also requires an indigenous selection operation. In the absence of infrastructure, such a selection programme can be based on intensive recording and selection in a central herd or flock combined with recruitment of superior individuals screened by simple procedures from the general population.

Polge described the present state of knowledge on the preservation of gametes and embryos. The spermatozoa of most livestock species can be successfully stored in liquid nitrogen (-196°C) but there is a great variation between species in the ease of freezing and of thawing. However, the revival of sperm motility after thawing is not necessarily a good guide to potential fertilizing capacity.

Embryo transplantation has been applied successfully in cattle, sheep, goats, pigs and horses. By superovulation many eggs can be obtained from one female. Long-term preservation of embryos in liquid nitrogen has been achieved in cattle, sheep and goats. Cattle embryos are collected and frozen at the blastocyst stage (7 days after ovulation). Unfertilized oocytes can now be collected and transferred to recipient animals. The possibility thus exists of freezing and storing oocytes (instead of embryos) which may then be fertilized after thawing. Such experiments have so far been carried out only in laboratory animals.

Deep-frozen storage of gametes and embryos is a practical possibility and should protect against genetic drift. The main hazard is exposure to natural radiation but experiments with mouse embryos suggest that genetic damage would not be expected during a period of at least 200 years. So far spermatozoa and embryos have been kept frozen for maxima of only 30 years and 7 years respectively.

In attempting to establish cooperation between countries to maintain related breeds, Joandet pointed out that the first difficulty is one of definition. In many cases, the same breeds occur in different countries under diverse names. Conversely, of course, the same name may be used for markedly different breeds. The first step in cooperation between countries should be the establishment of a standardised system of evaluating populations. If the environmental conditions are also standardized, it should be possible to establish the degree of similarity of populations in different countries. The production system should also be carefully described before introducing new genetic material. If such an exchange is decided on, care should be taken that there is not a parallel exchange of diseases.

Hickman returned to the question of breeding programmes for indigenous breeds. He quoted simulation results from Malawi which showed that in terms of an overall index termed Net Present Worth, a breed improvement programme for the local Malawi Zebu was more profitable, in terms of beef production, than upgrading or rotational crossing with the Charolais.

Results from Australia gave a partial answer to a question raised in Session 3, namely the genetic relationship between production and adaptability. Cattle selected for rate of gain under range conditions in Queensland showed a higher level of adaptation to environmental stress than a random-bred control population under the same conditions. The adaptation was exhibited as greater disease and parasite resistance, greater water evaporation ability and lower mortality.

Hickman also discussed the relative advantages of various systematic crossbreeding systems and the use of standard testing procedures for identifying superior breeding stock.

He recommended the use of testing stations (for performance testing) where lack of infrastructure precludes field recording. Home testing (field recording) is difficult but not impossible. It is more difficult among nomadic pastoralists than among sedentary breeders but the nomads have the advantage of possessing large herds or flocks.

He does not favour the use of institutional herds or flocks for a selection programme unless such operations use breeding methods which allow close cooperation with the farmers or practical livestock breeding operations.

Turner raised a question relating to mating programmes which requires further study, namely the possible interaction between environment and the amount of heterosis displayed. If the heterotic effect is larger in harsh environments, then heterosis will need to be estimated when comparing indigenous breeds and their first crosses with exotics; otherwise a false conclusion could be drawn about the ultimate value of the cross. Hickman indicated that the relative magnitude of heterosis between breeds can be used to measure the genetic distance between breeds for particular environments.

Several interesting points on methods of conservation were raised in the discussion, for instance:

1. Should genes be conserved in the form of breeds or in gene pools wherein several breeds could be merged? The latter method is clearly cheaper but it lacks the flexibility which Bowman had called for. Furthermore if there are historically documented and genetically distinct breeds then they should be maintained for the sake of their gene combinations.

2. Should genetic variability be conserved in special breed conservation herds or in the ordinary commercial operations? The former method might be satisfactory as a source of special genes, as used by plant breeders for genes giving resistance to specific diseases, but few such genes have been identified among animals. The commercial population can be larger so loss of variation by inbreeding is less likely but loss of variation by selection is inevitable. There appears to be a case for both types of conservation.

Some of the discussion on methods of conservation was recapitulated by Devillard as follows:

Methods of conservation - advantages and disadvantages

Method	Advantages	Disadvantages
1. Gene pool (combination of several breeds)	+ Possible with small animals (short reproductive cycle)	- Lack of flexibility (especially with large animals)
	+ Needs fewer resources than 3	- Special farms needed
2. Breeds in commercial herds 3. Breeds in special herds	+ Evaluation can go on + Breed is visible	- Organization of breeders required
		- Higher cost than 4 or 5
		- 3 risks loss of adaptation
4. Frozen semen	+ Very low cost, rapid method preventing gene loss	- Only half genotype
5. Frozen embryos	+ Comparatively low cost	- Method not proved for all species

VIII. SESSION 6 - MANAGEMENT OF ANIMAL GENETIC RESOURCES

From the papers presented to the Session, the following points emerged. Lauvergne indicated that our present understanding of the history of domestication and of the migration of animal populations since domestication does not give us any clear guidance on the relationship between herds in the world today. Certainly our understanding is inadquate to make judgments about which populations to conserve and which to allow to disappear. He asked that an inventory of world breed resources be prepared at frequent intervals (2-3 years) in order that we know what animal genetic resources are available.

Crawford stressed the need to reach some understanding of the world's poultry genetic resources and how they should be classified. He indicated that the words duck, goose and quail are used in each case to cover two or sometimes more species which is at least confusing and probably highly deleterious to the conservation of these species. He outlined the history of poultry breed and population conservation in Canada and concluded that conservation has to be the responsibility of a public agency and cannot be left to commercial breeding organizations and hobbyists. He thought that this conclusion might be equally applicable in other countries. An interesting and relevant detail concerns the dwarfing gene in bantams. This is a gene which had been left to hobby stocks for many years and which had recently become of interest to commercial breeders who are trying to produce smaller chickens which require less food. Here is an example of a gene once considered undesirable in "improved" populations which is now becoming desirable. This stresses the need for conservation of genetic rescurces without regard to contemporary commercial needs.

Novoa portrayed, with excellent illustrations, the use for animal production of several species of considerable local significance in South America, namely, llama, alpaca, vicuña, guinea-pig and capibara. It was quite clear from his presentation that an understanding of the biology of these species is inadequate for the design of improved management production systems. Novoa also made it clear that the transfer of management and husbandry techniques from farm animals in the developed world to species of importance in South America may produce disappointing, even disastrous results.

In describing our knowledge of the numbers, biology and significance of eight other "minor species" in the Old World, Mason made it obvious that several species, including the donkey, the camel, the yak and the reindeer, are by no means of minor significance. He appealed for greater efforts to conserve the wild elephant, which, to judge from the marked variation in the census estimates, is probably in considerable danger of extinction. Mason also appealed for the production of a major text on the donkey which is numerically more important than the horse in developing countries. It was clear that obtaining information on the species considered by Mason often proves very difficult. In particular he referred to China and the U.S.S.R.; these countries are very important livestock areas and for all species there, including the yak and the camel, we have very little understanding of the animal genetic resources, their improvement and conservation. Mason also referred to the possibility of domesticating the new species mentioned particularly the eland and the oryx in Africa and deer in Scotland, New Zealand and Australia.

The final paper in the Session gave a full review of FAO activities on animal genetic resources, conservation and management at the international level.

In opening the discussion, Sundaresan emphasized the conflict between improvement in production and conservation. In India, it is estimated that milk production will have to rise by 10 percent per year to the end of the century if the present level of milk consumption is to be maintained by an increasing population. This implies, amongst other things, a considerable increase in the performance of dairy cattle. Sundaresan thought that difficult decisions are having to be taken, of which he had personal experience, in reaching an appropriate balance between the need to improve livestock, particularly in the developing countries, and the need to conserve animal genetic resources. He thought that there is some danger that conservation may be pursued to an extent that any possibility for genetic and management improvement is almost completely suppressed. Arising from discussion in previous sessions, Sundaresan also asked why we are conserving so many breeds and varieties, whether there is any conflict between improvement for production and improvement for adaptation, and whether we had a clear impression of <u>why</u> we wish to conserve material for future use.

King produced the following outline for the conflict, which he thinks is real, between improvement and conservation.

	<u>Involves preservation of:</u>	<u>Provides insurance against:</u>	<u>Methods</u>	<u>Population size</u>
Total conservation	All populations or all distinct populations	Known and unknown hazards	1. Freezing 2. Control populations with no selection	Small size may suffice
Conservation with genetic improvement	Only populations that are: a) distinct b) show evidence of adaptation c) reasonable prospects for a production system	Loss of adaptation to: disease climate nutritional deficiencies	Live animals with selection	Large enough to carry out useful improvement programme

In discussing this outline King thought that the second option would have to be adopted for reasons of pragmatism. He was supported in this view by several speakers including delegates from Kenya and Nigeria who thought that the pressing current needs of the developing world would make it essential for them to adopt the second option. Other speakers however thought the cost of the first option is often overestimated and that storage of genetic material, as outlined by Polge, would be possible even in developing countries. In conclusion, it is perhaps worth noting that it may be possible to take both options.

In relation to the identification of characters to be conserved, Cunningham thought that it was probably more important to ensure the survival of endangered domesticated species like the banteng and mithun than to conserve any single cattle breed. Other cattle breeds, no doubt, contain a high proportion of the genes of any breed in danger, but the banteng and mithun are genetically unique and stand alone.

IX. CHAIRPERSON'S SUMMING-UP

Dr. Turner began by giving a general summary of the papers which had been presented and of the discussion on them. She was pleased to be reminded in the reports of country delegates that there has been a great awakening of consciousness and that so much has been done to document populations and, in some cases, to conserve them. She continued:

"It is worth emphasizing that discussions here have made it clear that there is now a widespread realization that the value of indigenous breeds should be examined before embarking on programmes of indiscriminate crossing with exotic imports, and that the value of the crosses should be monitored.

Perhaps I should mention here that many Australian animal-breeders have been concerned at the indiscriminate crossing which occurred when frozen cattle semen was first permitted to enter our country. Some belated evaluations have been begun, but not before a great deal of crossing had taken place.

Australia is now building a quarantine station which will eventually permit the entry of many types of livestock, and a working party is in operation, drawing up guidelines for the evaluation of such imports and their crosses.

Australia has no indigenous livestock breeds, but has developed many new strains of Merino sheep and of cattle and poultry. We do not so far have to fear breed loss from two of the major sources frequently mentioned - crossing, and indiscriminate slaughter of breeding stock."

She concluded by referring to "the conflict" as follows:

"Although many speakers have stressed throughout that there is a conflict between the concept of conserving breeds or populations as they are now, and the need for improved productivity, the antagonism seems to me an artificial one. There is no doubt that it would be impossible to conserve all existing breeds, and equally no doubt that improved productivity is needed. Dr. King drew up the pros and cons of what seem to be opposing viewpoints. But surely the solution lies in a combination of the two. Keep some breeds while maintaining a programme of improvement; store others, either as animals or frozen parts, as a future insurance.

And it is impossible to stress too often the point which has been frequently raised by participants from developing countries - let there be no more indiscriminate crossing with exotic breeds. Crossing may raise production and the crossbred may be viable, but the exotic, or its crosses, should be evaluated against the indigenous breeds, in the environment in which the offspring must run, before swamping the indigenous breeds. Comparison on an experiment station is not enough if conditions there are likely to be better than, say, in the villages where the livestock are usually maintained. There may be difficulties about comparisons under village conditions but I do not believe for one moment that it is beyond the competence of our colleagues to solve them. And it has been an inspiration to hear the strongly voiced opinions of these colleagues that their own livestock are worth more consideration than they have had in the past.

For the question, what characters to conserve?, there can be no general answer, partly because we do not yet have sufficient documentation, partly because the answer will be different in different situations. But there is general consensus that productivity measures are not enough; characters like adaptation and disease resistance must also be considered. By all means, let us try to devise methods of measuring or assessing these characteristics - but let me make one point, which may be a comfort to those who pointed out that developing countries do not have the facilities for complex measurements. Most production measures are not difficult to make. And an animal which has above average production in a harsh environment must be adapted, as well as disease-resistant if there has been exposure.

On methods and techniques of conservation there have been differences of opinion, some favouring the conservation of whole populations, others gene pools. But again a solution to this apparent disagreement was offered in discussion - there is room for both. If breeds or populations are distinct, conserve them; if a breed or population is widespread, with only local minor variations, then a gene pool may be the answer. As to the different "parts" which might be frozen, my own opinion is that the embryo might be most useful.

I would like to look into the future and mention one kind of conservation which has only been touched on very briefly by, I think, Dr. Polge. Our colleagues working in molecular biology will eventually solve the problem of isolating, perhaps single genes, perhaps blocks of genes. This step may be a long way off, but I think it will come. We have some evidence in Australia that the prolificacy of our highly fecund Merino group may be the result of a single gene, while, if I understood him correctly, my colleague Dr. Lahlou has evidence that the long breeding season of the D'man in Morocco is also under single gene control. If individual genes like this could be stored, our horizons would be wide indeed.

We will be passing soon to a consideration of the recommendations which have come from the rapporteurs and from the floor. Before that, let me conclude by emphasizing once more two points which seem of outstanding importance.

First, there is the question of knowing more about our livestock - identification, documentation and evaluation - and of the need for some uniformity in our recording. When I read that a flock of sheep has a certain lambing percentage, let me not scratch my head wondering whether this means lambs born per 100 ewes put with the ram, per 100 ewes which conceived, or per 100 ewes which lambed.

There have been comments about the difficulties of recording in developing countries. But when I tried to put together Australian records for the SABRAO Workshop last year, I was staggered by the gaps and lack of uniformity in our own records. Sheep were not too bad - much effort has been devoted to them - but for other species I had a difficult task.

Second, there is the question of evaluation before discarding. I have mentioned it before, but stress it again - take care not to replace or swamp a breed before making sure you will be better off with the change. We cannot conserve everything, neither can we stand still. But we can try to be sure of what we are doing at every step."

APPENDIX A

INAUGURAL ADDRESS

THE IDENTIFICATION, CONSERVATION AND EFFECTIVE USE OF VALUABLE ANIMAL GENETIC RESOURCES

by

Dr. Ralph W. Phillips
Deputy Director-General
Food and Agriculture Organization

I am pleased to bid you welcome here, on behalf of the Director-General. It is indeed heartening to see such a distinguished group of animal geneticists assembled to consider the problems of identification, conservation and effective management of animal genetic resources. This is a matter critical to man's future, yet it has had little recognition and little real attention.

In fact there are those who might argue that it needs little attention, and that - in due season - we, as animal geneticists, will be an endangered species - since there will be no room for animals on this planet, and consequently no need for scientists who are concerned with their improvement

I do not wish to delve deeply into this argument, but let me cite four reasons why I believe there will be need for animals, and animal geneticists, not only at the turn of this century, but at the turnings of many centuries thereafter.

Much of the world's surface is grazing land, from which it is practicable to harvest a crop only through the use of livestock.

In the most densely populated areas - the developing countries, - it is estimated that the agricultural population will number over two billion by the turn of this century, and that within that population the agricultural labour force will number 823 million. These people will live and work mostly on very small farms, where the chief source of power will be bullocks and other draft animals.

Whatever the farming systems followed, much of the produce of the world's farms, whether they be in the developed or the developing countries, will continue to be roughage and by-products which only livestock can transform into products suitable for human consumption.

Given the economic level that people in the developed countries hope to maintain, and to which those in the developing countries aspire, a demand for livestock products seems certain to persist.

So, as the demands placed on this planet for food supplies for a rapidly growing population increase, and also when the human race learns to contain its own urge to expand and stabilises at some level - as it must - it is essential that man have at his disposal both the plant and the animal genetic resources with which to work to meet his needs.

As animal geneticists, I fear we must admit that this is an area in which the plant geneticists are well ahead. This is true in part because plant materials are easier and cheaper to manage. Also, the threats to plant genetic material became generally evident earlier, because of the rapid spread of improved types into centres of origin. In addition, the first major crop of plant geneticists emerged about a generation ahead of the pioneer generation of animal geneticists. So we have to run to catch up.

Our major species of farm animals were, for the most part, domesticated between six and eleven thousand years BP (before the present), and cattle, sheep, goats and hogs were domesticated mostly between eight and ten thousand years BP.

During the long period between domestication and the time when the science of genetics was developed and began to be applied in animal breeding, many genetic changes took place. Overall, those changes were probably much greater than the changes that have been achieved since man began to apply his knowledge of genetics. The rate of change was much slower, but there is evidence that some rather highly specialized animals evolved during that long pre-genetic period. Natural selection under unimproved conditions and the survival of the fittest over a long period of time were no doubt responsible for the genetic superiority in resistance to disease and harsh climatic conditions. It was possible for adaptation to natural environmental conditions to be maintained while man was making his selection for milk yield, wool production or other traits.

Our knowledge of animal genetics evolved during a period when rapid progress was being made in many fields of scientific endeavour. Thus, as genetics began to be applied, particularly in the developed countries of the temperate zones, many other improvements in agriculture were taking place. The rate of genetic change achieved was high, and high levels of specialisation were achieved in many breeds. The overall objective was to achieve not only a high output, in a high input situation (in terms of feed, management, health care, etc.,) but also to achieve increases in efficiency through more favourable input:output ratios. Production of milk, meat, eggs and wool was raised to levels that could not have been imagined at the beginning of this century. Maintenance requirements absorbed a smaller portion of feed intake, so less land was needed per unit of product. Although the overhead costs per high-producing animal tended to be high, the overhead cost per unit of output generally declined.

These rapid genetic improvements have not been achieved without paying a price. For example, improved breeds are rapidly displacing local breeds throughout Europe. A study by Lauvergne (1975) showed that only 30 out of 115 local breeds were holding their own. At the same time, owing to intensseive selection for a few production traits, the genetic base of the surviving breeds is becoming restricted. Thus, genetic variation both within and between breeds, is declining. The important character of adaptability to the natural environment is being lost, both by disappearance of locally adapted breeds and by further selecting the specialised breeds under favourable conditions of feeding, management and climate (including protection against climatic conditions through better housing, etc.). Unfortunately, the need for good breeding stock suitable for less sophisticated environments is, to a large extent, being ignored.

Conversely, it can be argued that the evidence for loss of variability in selected breeds is, in fact, scanty, and that new variations may have been exposed by intense selection for high levels of production. Concurrently, the formation of new breeds, for example those formed by crossing temperate and tropical breeds for use in warmer portions of the temperate zones, may maintain the overall genetic variability within the species, although that variability is threatened by the disappearance of other breeds.

In the environmentally less-favoured portions of our globe, in particular the tropics and the marginal land areas with low rainfall or high elevations, programmes for genetic improvement of animals have received substantially less attention than in the generally favourable production areas of the temperate zones. An often used approach to the achievement of higher levels of production in these areas has been the importation of high-yielding breeding material from temperate regions. Such a breeding policy can be successful where the climate is not too severe, feed supply is adequate, and a level of management ability is available equal to the needs of the sensitive, high-producing animals involved.

There are also intermediate areas where carefully-managed temperate-zone stock, for example, highly specialised dairy cows, may produce more than local stock, although owing to lack of adaptation such stock may be slower to reproduce and have shorter life spans. Under such conditions, a new breed from a crossbred foundation, or carrying out systematic crossing between a temperate and an indigenous breed, will normally be the most economic. But, such approaches depend on the availability of an indigenous breed having adequate qualities.

There are other vast areas in the tropics, and in marginal semi-arid and high altitude regions, where only well-adapted indigenous breeds, or breeds that have evolved under comparable conditions, can survive and reproduce. These areas are primarily the home of sheep, goats, cattle raised for beef, camels, and in some high-altitude areas, the yak, alpaca, llama and vicuna. Clearly, stock is needed in such areas that is highly adapted to the prevailing conditions, and is productive. Attempts to use imported stock from the temperate zones has usually met with failure. So, instead of making further attempts to transplant non-adapted breeds, it would make more sense to transplant the technology of breed improvement. One cannot help but wonder how much progress might have been made in genetic improvement in those areas if, over the last half-century or so, efforts had been expended comparable to those in the temperate zones.

In the developed countries, most of the current attention continues to be on the further improvement of a few specialised breeds, or on the use of these breeds for cross-breeding programmes, although some efforts are being made to introduce and use lesser-known breeds, and to conserve remnants of breeds that are being displaced by the specialised breeds.

In developing countries - as I mentioned a moment ago - where much less attention has been given to the development of specialised breeds, and where in many cases programmes for improvement of local types have been overshadowed by programmes built around the use of often unadapted imported stock, there is urgent need to survey the situation and to build more constructive approaches to breeding, including ensuring that valuable local types are not diluted or lost. Unfortunately, breeding work in many developing countries is hampered by a shortage of animal geneticists, and by the lack of adequate organisational frameworks and financial resources.

It is most encouraging to witness the recent emergence of organisations for the conservation of disappearing breeds in a number of developed countries, and of organisations for the study of animal genetic resources in some developing countries and regions. You will be discussing these organisations under Part II of Item 4 of your Agenda.

One of the first tasks of such national and regional organisations is to document the local breeds. Inventories are needed of their numbers, distribution, main characteristics and productivity. A second step is to ensure that such unique genetic materials do not disappear before their true value is known. The work being undertaken by the Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO), could well be a model for other such conservation organisations to emulate.

The work involved is essentially world-wide in scope, and will involve action in many countries if the problem is to be coped with effectively. As the primary international organisation in the field of food and agriculture, FAO is in a position to provide assistance to its Member Countries, within the limits of its programmes and resources. It is also in a unique position to play a coordinating role. Among FAO's various functions, as set out in its Constitution, five are particularly pertinent to the matters you will be considering:

(i) To collect, analyse, interpret and disseminate information relating to nutrition, food and agriculture;

(ii) To promote scientific and technological research;

(iii) To improve education, administration and the spread of public knowledge or extension;

(iv) To conserve natural resources; and

(v) To furnish such technical assistance as governments may request;

all of these, of course, within the context of food and agriculture.

FAO has already carried out activities relating to animal genetic resources under all these categories, and the Organization's involvement in this work dates back to 1946. Perhaps it would be useful for many of you if I recount just a few bits of the history of that involvement. Here I will also inject a few personal notes, since there has been a certain linkage between my own and FAO's interest in the problem.

My own interest in the subject dates back just half a century, because it was in June 1930 that, as a graduate student, I began studying the adverse effects of hot summer temperatures on fertility in the ram. In fact, my Doctor's thesis carried the rather unusual title, "The Thermo-Regulatory Function and Mechanism of the Scrotum". In those days, when only a handful of Doctor's degrees was awarded at each commencement, it was customary at the University of Missouri for the title of each Doctor's thesis to be printed in the commencement programme. The title of mine no doubt caused quite a few eyebrows to be raised. Be that as it may, from this physiological base, my interests spread - over the next twelve years or so - into research on a number of the genetic and physiological aspects of adaptability to the environment.

During those years, I spent fourteen months in China and India, while on loan from the U.S. Department of Agriculture to the Department of State, serving as Adviser on Animal Breeding, to the Governments of China and India. It was during that period, in 1943, that President Roosevelt convened a Conference on Food and Agriculture, at Hot Springs, Virginia, which set up an Interim Commission, and led to the formal establishment of FAO at the First Session of the FAO Conference, in Quebec, in October 1945. Late in 1943, a friend in the American Embassy in Chungking showed me the report of the Hot Springs Conference, and it was this chance happening that first sparked my interest in FAO.

The work in China and India also further sparked my interest in the problems in animal breeding in relation to the environment so, back in Beltsville, I prepared a manuscript on <u>Breeding Livestock Adapted to Unfavourable Environments</u>. FAO, which was only beginning to evolve a programme of work, expressed a desire to publish it, and it eventually appeared as FAO's Agricultural Study No. 1.

Shortly after the Quebec Conference, Divisions were established in FAO to deal with Economics, Nutrition, Fisheries and Forestry. However, the then Director-General, Sir John Orr (later Lord Boyd Orr) was so preoccupied with his ideas for a World Food Board that he had not gotten round to setting up an Agricultural Division. Governments were getting restive about this and, to reassure them that action was being taken, Sir John convened a meeting of a Standing Advisory Committee on Agriculture, in Copenhagen, just in advance of the Second Session of the FAO Conference. That was in the late summer of 1946, and I was invited to serve on the Committee. One of my contributions to its work was the drafting of a recommendation - which the Committee adopted - that FAO should undertake work on the cataloguing of animal genetic stocks.

It was during that meeting that I was invited to join the FAO staff. So, on 2 December 1946, I left the research laboratory and began my first stint in FAO as Chief of the then Animal Production Branch, which later became the Animal Production and Health Division. But I also had a second assignment, that of creating the Agriculture Division, of which the Branch was to be a part. That Division, of which I later became Deputy Director, eventually evolved - with some modifications - into the present Agriculture Department. On that cold December morning in 1946 the agricultural staff of FAO consisted of myself, a soil scientist, and two secretaries.

Since those early beginnings, quite a few constructive steps have been taken relating to the identification, conservation and management of animal genetic resources. I will mention only three series of activities, as examples.

The first of these is a series of publications which has included, among others:

- Zebu Cattle of India and Pakistan (Joshi and Phillips, 1953)
- Types and Breeds of African Cattle, (Joshi, McLaughlin and Phillips, 1957)
- European Breeds of Cattle, Volumes I and II, (French, Johansson, Joshi and McLaughlin, 1966)
- Sheep Breeds of the Mediterranean, (Mason, 1967)
- The Husbandry and Health of the Domestic Buffalo, (Edited by Cockrill, 1974)

Such books not only constituted a solid contribution to the cataloguing of animal genetic stocks; they also served to focus considerable attention on the problems of conserving and effectively using such stocks.

The second was a series of consultations on animal genetic resources. The first, in 1966, undertook an overall examination of the problem. The three subsequent consultations dealt, respectively, with cattle (in 1968), with pigs (in 1970), and with poultry (in 1973). I had the honour of chairing those consultations, which, although the participants were present in their personal capacities, were precursors to the present meeting.

The third is a project which got under way early in 1975, with financing and other support from UNEP. The activities carried out under that project have included reports on declining breeds of Mediterranean sheep and on sheep breeds in Afghanistan, Iran and Turkey, surveys of trypanotolerant livestock in West and Central Africa and of prolific tropical sheep, expert consultations on animal genetic resources in Latin America and on dairy cattle breeding in the humid tropics, an inventory of special conservation herds, and this Consultation, which is the final activity in the project. We are grateful to UNEP for its foresight and concern with these problems, and for its support, including a large share of the financing of the present Consultation. We are also grateful to the International Livestock Centre for Africa (ILCA) for its cooperation in the survey of trypanotolerant livestock that I just mentioned.

You will hear of other activities which have been or are being carried out under our Regular and Field Programmes, as the Consultation progresses.

At this point I might have injected some ideas as to how FAO's cooperation with its Member Countries, and with the various national and regional organizations that are developing programmes relating to animal genetic resources, might be strengthened. However, these are matters which may, more logically, arise in the course of your discussions.

Because of my personal interest in the subject, I am also tempted to comment further on a number of the technical matters included in your Agenda. But I shall leave that to you who are now much closer to the science of animal breeding. I will only mention that you may wish to consider if the approaches to breed improvement needed under harsh conditions are different from those that have proved successful under favourable climatic conditions and sophisticated agricultural and economic environments. Also, you should keep in mind the need under such conditions, for innovative and less expensive methods of measuring performance. There might also be merit in re-studying the methods whereby progress was achieved prior to the days of modern genetics, sophisticated recording systems and electronic computers.

Let me inject a final personal note. When I left the research laboratory late in 1946, I made myself a promise that, when I lost contact with my chosen subject-matter field, I would retire.

I have managed to maintain that contact although at times the connecting thread has worn quite thin. But my presence here today is evidence that it hasn't yet broken. So I am indeed pleased to have this small part in your proceedings, and to wish you a most successful Consultation.

APPENDIX B

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APPENDIX C

LIST OF WORKING PAPERS

Session 2. Work already done on conservation of animal genetic resources

(i) Cooperative work by FAO and UNEP on the conservation of animal genetic resources (I.L. Mason)

(ii) Work done on conservation of animal genetic resources by the International Livestock Centre for Africa (J.C.M. Trail)

(iii) Work done on conservation of animal genetic resources by the Society for the Advancement of Breeding Researches in Asia and Oceania (J.S.F. Barker)

(iv) Work done on the conservation of animal genetic resources in the United Kingdom (G.L.H. Alderson)

(v) Conservation of animal genetic resources in Bulgaria (Tz. Hinkovski and A. Alexiev)

(vi) Conservation of animal genetic resources in India (P.N. Bhat)

(vii) French policy on the conservation of threatened livestock breeds (J.M. Devillard, J. Bougler and J.M. Duplan)

Session 3. The need for maintaining adequate genetic variability

(viii) Impact of feeding behaviour and digestive capacity on nutritional response (P.J. Van Soest)

(ix) Genetic types for different environments (A.H. Osman)

(x) Breeding livestock for the future (J.C. Bowman)

(xi) Adaptation of livestock to their environment (J.M. Rendel)

(xii) Efficiency of intensive and extensive systems of livestock production (T.C. Cartwright)

Session 4. Causes and measurement of declining variability

(xiii) The disappearance of local breeds (O.W. Deaton)

(xiv) Genetic exhaustion in single-purpose breeds (J.W.B. King)

(xv) Measures of genetic variability and aids to selection using blood types (M. Braend)

(xvi) Measures of genetic diversity and the importance of mating systems in the conservation of small populations (Y. Yamada)

Session 5. How to maintain genetic variability

(xvii) Methods for recording, evaluation, selection and crossbreeding in adverse environments (E.P. Cunningham)

(xviii) New biological techniques for the conservation of animal resources (C. Polge)

(xix) Cooperation between countries to maintain related breeds (G.E. Joandet)

(xx) Breeding programmes for indigenous breeds (C.G. Hickman)

Session 6. Management of animal genetic resources

(xxi) Organization of the conservation and management of genetic stocks of large farm animals (J.J. Lauvergne)

(xxii) Management of poultry genetic resources (R.D. Crawford)

(xxiii) Conservation of native species in Latin America (C. Novoa)

(xxiv) The agricultural potential of minor species of farm livestock in the Old World (I.L. Mason)

(xxv) Organizational aspects of animal genetic resources: conservation and management at the international level (FAO Secretariat)

N.B. At the Consultation, summaries of the above papers were distributed in English, French and Spanish. The full papers will appear in the language in which they were written, and with summaries in the other two languages, in an FAO publication which will be published in the near future.

APPENDIX D

FOLLOW-UP MEETING TO THE TECHNICAL CONSULTATION

Working Group on Animal Genetic Resources Conservation and Management - 9 - 10 June 1980

Following the Technical Consultation, a Working Group was established consisting of the following:

H. Newton Turner (Chairperson)
K.O. Adeniji
J.S.F. Barker
J.C. Bowman
T.C. Cartwright
G.E. Joandet
R. Olembo (UNEP)
D. Sundaresan
J.C.M. Trail
Y. Yamada
G.S. Child (FAO)
C.G. Hickman (FAO)
P. Mahadevan (FAO)
I.L. Mason (FAO)
J. Hendel (FAO)

The Working Group met to consider the recommendation from the Technical Consultation and to make suggestions for the implementation and further action on the recommendations. The terms of reference of the Group were:

(a) to identify specific topics and programmes for extending research and development action on animal genetic resource management in the developing countries; and

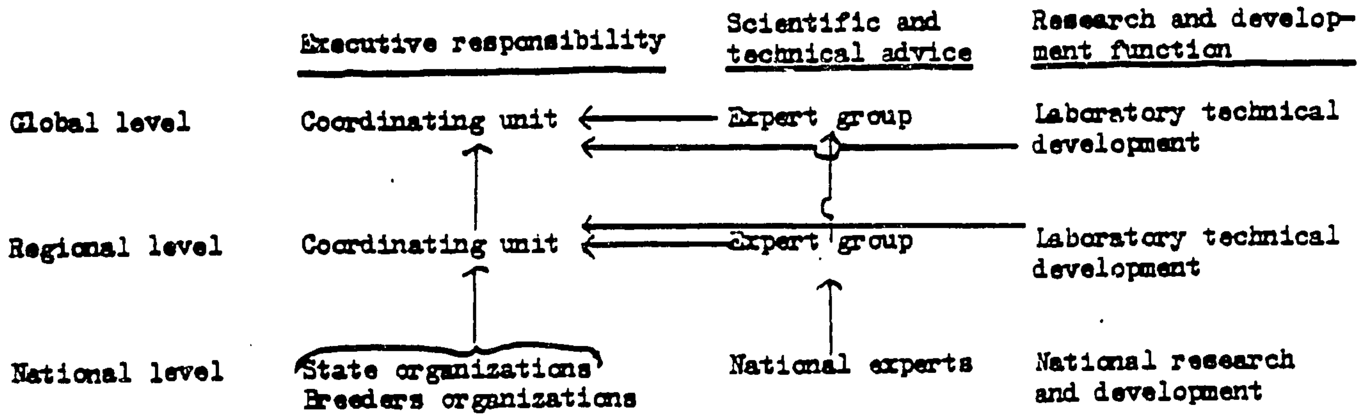
(b) to suggest alternative ways and means for translating the recommendations of the Consultation into concrete action plans.

The following conclusions emerged from the deliberations of the Working Group. Reference is made to the recommendations by number.

Recommendations to FAO/UNEP

1. (including subclasses i-vi inclusive)

It was agreed that the sort of mechanism which could undertake the tasks outlined should have the following structure.



The coordinating units at each level would have the terms of reference indicated in recommendation 1 and would have executive responsibility with scientific and technical guidance from an expert group in each case. The expert groups would be made up of specialists in science and technology of relevance to conservation and management of animal genetic resources. They would be selected and appointed for their individual qualities and not for their representation of national or organizational interests.

The activities at the national, regional and global levels would be linked. It is not intended to imply by the scheme shown that the global coordinating unit should impose a plan of action from above but rather that the national activities should be coordinated regionally by cooperation between the regional coordinating units. Similarly the global coordinating unit would seek to stimulate cooperation between regions.

Much of this cooperation can be arranged by ensuring that the expert groups at each level are composed of persons involved in the level below it. Most of the activities concerning conservation and management of the world's farm animal genetic resources will have to be undertaken by national organizations and individuals. The regional and global coordinating units, however, will have to ensure that countries in which appropriate action is apparently lacking are encouraged to develop such action.

It was pointed out that a number of organizations exist which might be able to fulfil the roles of coordinating unit or expert group at the regional level. As coordinating units at the regional level, the Interafrican Bureau for Animal Resources (IBAR), Tropical Agricultural Research and Training Centre (CATIE) and the Animal Production and Health Commission for Asia, the Far East and South-West Pacific (APHCA) were mentioned and as expert groups, the Society for the Advancement of Breeding Researches in Asia and Oceania (SABRAO) and the Latin American Association for Animal Production (ALPA) were cited. These are only examples and other organizations may also be found in other regions which could perform similar responsibilities and functions. In some regions new organizations will have to be set up or existing national organizations may take on regional responsibilities. At the global level, the Working Group concluded that there were many advantages in finding a way of linking the mechanism to the existing activities of the Animal Production and Health Division of FAO. In particular the global coordinating unit function could, with considerable benefit particularly to the developing countries, be a part of the FAO Animal Production and Health Division. However, the Working Group were unanimous in emphasizing that a proper conservation and management of the world's animal genetic resources can only be developed, along the lines outlined, if at least one person (preferably two or three) can devote their full time to the work of the global coordinating unit.

The Working Group recognized the urgency of the situation and would like to see the appointment of one person to carry out the global coordinating unit function as soon as possible. FAO/UNEP should actively seek funds for the purpose and a sum of about US$100 000 per year is needed. However, the Working Group also realized that the development of the full mechanism outlined is likely to take several (5 - 7) years. This does not imply that nothing should happen in the near future but that full implementation will have to proceed as resources allow.

The eventual nature of the global level of the mechanism was envisaged in one of two ways by the Working Group. The first is the appointment of staff, responsible for the co-ordinating unit function, to the Animal Production and Health Division of FAO coupled with the appointment of an Expert Panel to fulfil the role of the expert group. This way has the merit that integration with other FAO activities could be very close. The second way is to follow the example of those concerned with plant genetic resources and to seek the organization of an International Board for Animal Genetic Resources (IBAGR) similar to IBPGR. This way has the advantage that experience gained from solving plant conservation problems could be transferred to animals. The possibility of developing an IBAGR could either take place by seeing if the terms of reference of the IBPGR could be extended to cover animals or by seeing if the CGIAR are interested in establishing a separate IBAGR.

2. The Working Group would like FAO/UNEP to prepare and distribute a newsletter, similar to that published by the IBPGR. The newsletter should contain material in one of three languages (English, Spanish or French) with summaries in the other two languages. The newsletter should be published as soon as editorial and financial resources are available, perhaps on a quarterly basis, in order to stimulate interest and activity at national and regional level. The importance of good quality articles, particularly in the early issues, was stressed.

3. The Working Group was informed that FAO and UNEP are already active in seeking to extend the range of the current FAO/UNEP project. No major new initiative seems to be required but existing consultations need to be maintained with at least the same momentum.

4. The Working Group considered and gave support to proposals for a feasibility study to set up one regional gene bank in a specific region in Latin America. The cost of the feasibility study is estimated at about US$ 54 000. The working party encouraged FAO to proceed with the feasibility study.

Recommendations to FAO/UNEP and Member Governments

5. The Working Group discussed at length the best means of reaching agreement on the preparation of standardized definitions, nomenclature and data collection and collation systems. It was concluded that the forms designed by SABRAO are a valuable starting point. The Animal Production and Health Division of FAO (AGA) agreed to act in a coordinating role in a scheme to obtain reaction by many countries to the use of the SABRAO forms for the purposes outlined in recommendation 5 (i). It was agreed in relation to recommendation 5 (iii) that the form prepared and presented to the Consultation by the Moroccan delegation would be circulated for comment in a manner similar to the SABRAO forms. The Animal Production and Health Division of FAO also agreed to consider the possibility of holding a small coordinating meeting when the views on the SABRAO forms had been obtained.

Members of the working party agreed to circulate the SABRAO and Moroccan forms in the following manner:

Joandet (translation into Spanish)	circulate to ALPA
Yamada	" " SABRAO
FAO (AGA) will contact IBAR to see if IBAR will circulate the forms to African countries. A translation into French will be arranged by FAO. The Moroccan forms are already available in Arabic and Chinese	
Cartwright	circulate to N. America
Turner	" " China
Bowman	" " EAAP
FAO (AGA)	" " Canada

6. The Working Group gave favourable support to FAO to pursue their existing efforts in encouraging Member Governments and participating organizations to include in their agricultu-ral development programmes a component for the development and conservation of local breeds. In this respect the working party have assumed that the use of the phrase "participating organizations" in the recommendations from the expert consultation is a reference to organi-zations such as the World Bank, charitable foundations and non-governmental national organizations.

7. The Working Group gave strong support to FAO to pursue their efforts to establish a limited number of pilot schemes for selection in local livestock populations pioneering methods of livestock improvement that make most efficient use of limited resources and infra structure. It was pointed out that the recording schemes referred to under recommendation 5 to FAO/UNEP and Member Governments should be used as the basis for designing improvement programmes. FAO is planning to hold a meeting on production recording in Botswana in 1981.

8. The Working Group discussed possible alternative breeds which may be included in the activities included under this recommendation. It was concluded that the following breeds should, as an early and high priority, be included in plans to stimulate intercountry pro-grammes for genetic improvement and conservation.

N'Dama cattle	Awassi sheep
Sahiwal cattle	Shami goats
Boran cattle	

9. FAO staff reported that, subject to funds being obtained, a comparison of buffalo breeds and strains (including River and Swamp buffalo in separate trials) had been planned and would be implemented as soon as possible. The initial phase is planned to last two years with planned extension for a further three to five years.

The Working Group drew attention to the information presented during the Consultatic that Morocco is keen to compare prolific breeds of sheep and provide an opportunity to study the behaviour and physiology of such breeds. The Working Group hoped that FAO would lend support to this initiative and stimulate other countries (particularly Greece, China and Indonesia) to take part.

It was also pointed out that comparisons of cattle and goat breeds in other parts of the world should be encouraged and planned.

10. In respect of this recommendation it was noted that FAO hopes to encourage certain countries to expand work on the camel. Reference was also made to work on the Andean Camelidae and Cavidae being started on a collaborative basis by the Inter-American Institute of Agricultural Sciences (IICA) and it was suggested that FAO explore the possibility of providing additional support.

11. The Working Group concluded that the phrase "international encouragement" implied moral rather than financial support. It was noted that such moral support (verbal en-couragement and recognition of activities by FAO) can be extremely helpful in bringing forth financial support for the activities in developed countries mentioned in this recommendation. Such activities have valuable "spin-offs" for similar work in developing countries.

12. The Working Group received advice about this recommendation from the FAO Forestry Department (FO). AGA agreed to prepare a list of those species which should be included under this recommendation (FAO, AGA), and FO a list of national parks where the wild species are being kept. It was agreed that comparison of these lists will provide an indication of the species and sites which should be brought to the attention of Member Governments. It will also indicate which wild species are not covered by specific conservation measures.

FAO, FO agreed that when this had been done, it would contact Member Governments to encourage them to maintain their conservation activity and if possible to provide them with advice and financial support.

The Working Group was pleased to learn that a meeting between Forestry, Fisheries and AGA was considered by FAO to be worthwhile not only to explore the way in which FAO can strengthen the value of national parks as a means of conserving wild animal species which are the ancestors or close relatives of domestic species, but also to discuss common ground in the conservation of animal genetic resources in general.