

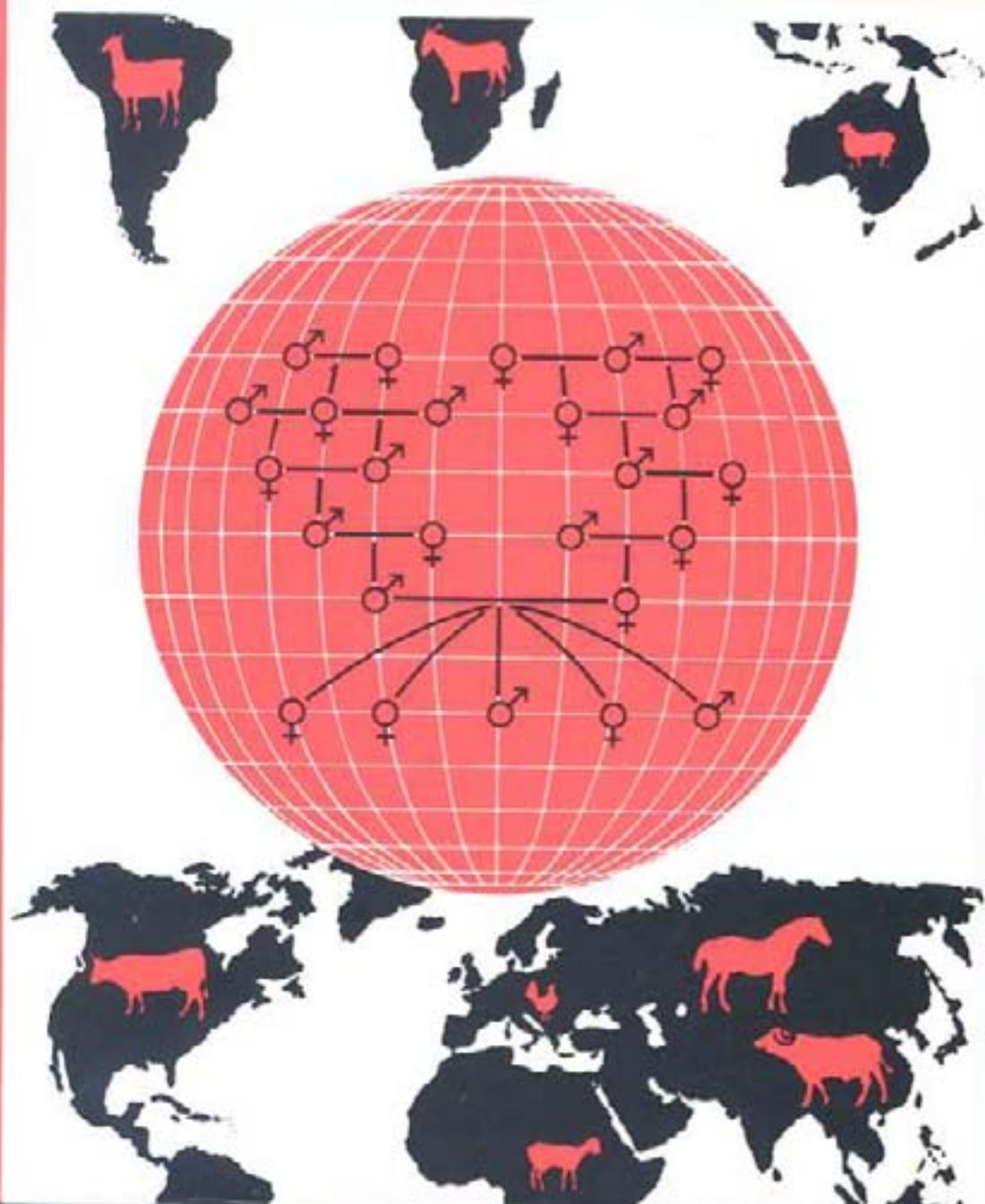
# Animal genetic resources

## Strategies for improved use and conservation

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PAPER

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## INTRODUCTION

The joint activities of FAO and UNEP in the field of animal genetic resources conservation and management in recent years have been most fruitful. The indigenous species and breeds of domestic livestock and poultry in the tropics are undoubtedly being threatened by the need for higher animal production, which often involves breed substitution or crossbreeding. There is an urgent need in this changing situation for rational planning and action to ensure both improved production and the preservation of the unique animal genetic resources of the tropics. Initiatives have been taken by FAO and UNEP to achieve these objectives in Africa, Asia and Latin America both by support of national government activities and by the creation of regional infrastructures. It is expected that these joint FAO/UNEP activities will continue to serve the interests of developing countries. The Joint Expert Panel is one of these ongoing fields of cooperation.

The FAO/UNEP Expert Panel on Animal Genetic Resources Conservation and Management held its second meeting in June 1986 in Warsaw, Poland. The first meeting of the Panel had been held in Rome, Italy in 1983. The Panel consists of 36 distinguished scientists whose expertise covers all the major disciplines within animal breeding and genetics, all the major species of domestic animals, and among them represents the major areas of the globe. The scientists are appointed in their individual capacities and not as representatives of governments or institutions. Funds did not permit all members of the Panel to attend. On this occasion 13 members of the Panel were assembled.

The meeting was convened by FAO and UNEP to take place in Warsaw at the same time as a scientific symposium organized on behalf of the European Association of Animal Production (EAAP) by the Polish Society of Animal Production (PSAP). This meeting addressed the issue of the use of small populations of

domestic animals in the European context. Thus there was a meeting of minds and interchange of ideas which was particularly valuable as it brought into focus the methods and resources of both developing and developed countries concerning animal genetic resources utilization and preservation. The papers presented at both the FAO/UNEP Expert Panel meeting and at the EAAP/PSAP symposium are given in full in this volume.

Dr. Helen Newton-Turner of Australia was unanimously elected Chairman of the FAO/UNEP Expert Panel and thus provided valuable continuity with the first meeting of the Panel in 1983 and with the FAO/UNEP Technical Consultation in 1980, both of which she chaired. Dr. J. de Alba of Mexico, who also served as Vice-Chairman in 1983 was unanimously elected again.

The recommendations of the FAO/UNEP Expert Panel are given first in this publication, followed by the papers presented at the Panel meeting, and the papers given at the Symposium; in the Appendices supporting information relating to the activities of the Expert Panel is provided.

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## **ABSTRACT**

This publication on animal breeding and genetic resources covers both improved utilization and preservation. It contains the papers presented on the occasion of the 2nd meeting of the FAO/UNEP Expert Panel on Animal Genetic Resources, held in Warsaw, Poland in June 1986, and the recommendations of that meeting. These relate primarily to the issues affecting developing countries. It also contains the papers of the EAAP/PSAP Symposium held at the same time on use of rare breeds in Europe, and thus brings into the same volume experiences in developed countries. The papers cover all species of domestic animals and relate to issues and principles in all types of environmental conditions in tropical and temperate climates and conditions.

### **KEY WORDS**

Cattle, Buffalo, Sheep, Goats, Camilidae, Pigs, Equines, genetics, breeding, conservation, cryogenic, education, training, small populations, environment, heterosis, crossbreeding, selection, embryo transfer, artificial insemination, gene bank, data bank, animal descriptors.

## **RECOMMENDATIONS OF FAO/UNEP EXPERT PANEL ON ANIMAL GENETIC RESOURCES**

### **SECTION A**

#### **PRINCIPLES FOR GENETIC IMPROVEMENT OF INDIGENOUS ANIMALS IN THE TROPICS**

**ALL LIVESTOCK****TO FAO/UNEP**1. The Panel recommends that:

- i. FAO/UNEP should initiate action to help establish Regional Data Banks for animal genetic resources now that the methodological studies are complete. National governments should be encouraged and guided in the preparation of national data for entry into the Regional Data Banks. It is essential to plan to use a fully compatible system from the beginning.
- ii. FAO/UNEP should examine and evaluate the invitation from the Government of India to develop a regional data bank for Asia at the newly-established National Data Bank located at the National Bureau of Animal Genetic Resources.
- iii. FAO/UNEP should initiate actions for the establishment of regional International Cryogenic Animal Gene Banks to serve all developing countries.
- iv. FAO/UNEP should continue to foster inter-country cooperation in the exchange of germplasm, with due regard to quarantine precautions.

2. The Panel recommends that FAO/UNEP should actively participate in the preparation of four publications:

- i. A manual concerned with the conservation (preservation and better utilization) of indigenous animal genetic resources for tropical areas. It should include information on assessing the potential economic value of less-known breeds.
- ii. Further publications on unknown or poorly documented animal genetic resources. The recent publications on Chinese livestock and on the Awassi sheep indicate the value of such comprehensive and competently researched works.
- iii. A manual addressing the methodologies for improved productivity and utilization of animal genetic resources in the tropics. Farmer participation is highly desirable, but ways and means of achieving it have rarely been formulated.

The manual should include discussion of:

- monitoring animal performances;
- selection of outstanding individuals by population screening;
- interactions between experiment station and farmer herds;
- use of nucleus herds;
- establishment of societies for recording pedigree and performance;
- assignment of valid genetic values to bulls and cows;
- use of artificial insemination and embryo transfer;
- avoidance of inbreeding.

The manual should be aimed at administrators, extension officers and researchers and be in appropriate local languages.

- iv. A manual dealing with the design of breeding plans for the genetic evaluation of small populations.
- 3. The Panel recommends that FAO/UNEP should develop guidelines for national governments to use when deciding priorities to derive maximum benefits from the application of new technologies such as embryo transfer, artificial insemination, etc. to the improvement of a livestock species.
- 4. The Panel recommends that FAO/UNEP encourage the application of biotechnology to animal production and health. Priorities for the rapid application of biotechnology to livestock in developing countries should be drawn up.

## **CATTLE**

### To FAO/UNEP and National Governments

5. The Panel recommends that, in consultation with national governments in Latin America, FAO/UNEP should establish a permanent consultative committee on experimental designs for crossbreeding programmes in Latin America involving Criollo and Zebu with European breeds. F<sub>1</sub> hybrids have proved successful, but data are still scanty on the effect of continued crossing. The permanent committee should give priority to schemes which would add to knowledge, and should help design and implement an experiment or series of experiments to answer questions on unresolved areas of concern, such as:

- the extent of F<sub>1</sub> heterosis (or recombination) at different levels of stress, and its loss in subsequent generations;
- the efficiency of milk, meat and draught production, based on total lifetime merit.

6. The Panel recommends that, together with national governments, FAO/UNEP should establish procedures periodically to identify superior Sahiwal bulls and cows in India, Kenya and Pakistan; their use should be directed towards the propagation of superior F<sub>1</sub> offspring for farmer programmes in tropical areas. The international sale of F<sub>1</sub> Sahiwal hybrids of unknown dairy merit should be discouraged.

7. Where cattle breeds are spread over many countries, (e.g., the Sahiwal in Pakistan, India, Kenya, Malaysia, Australia, and so on), the Panel recommends that FAO/UNEP working with national governments should develop programmes of inter-country linkages so that data, semen, and embryos can be exchanged, with the aim of maximizing production and with due regard to animal health requirements. Such programmes could be developed between India and Latin American countries for the Ongole, GIR and Haryana breeds, and for the Criollo breeds.

## **SHEEP AND GOATS**

### To FAO/UNEP and National Governments

- 8. The Panel recommends that FAO/UNEP together with national governments:
  - i. Should stimulate the evaluation of indigenous breeds of sheep and goats, beginning with those which are numerically more important and whose product is in keeping with the local needs, such as meat, milk and wool.

- ii. Should direct attention to the evaluation of breeds for their potential in crossing with local breeds for increased meat, milk and wool production (quantity and quality). This evaluation should include breeds from within and outside the region.
  - iii. Should particularly promote more detailed and extensive documentation on the performance characteristics of African sheep and goats, such as West African dwarf sheep and goats and the D'man sheep.
9. Since most sheep breeds in the tropics have long breeding seasons and since in some breeds ewes cycle throughout the year, and in some sheep breeds' two peaks of breeding activity have been reported, the Panel recommends that more use should be made of this sheep trait. There is sufficient evidence under experiment station conditions to show that it is technically feasible to breed every eight months, but field tests should be made to identify practical problems under nomadic and transhumant conditions.
10. The Panel recommends that studies on the reproductive behaviour of indigenous sheep breeds in the tropical environment are needed, as there is growing interest in the use of hormones for synchronization of oestrus, superovulation and induction of early sexual maturity. However, the physiology of reproduction in the local environment should always be thoroughly investigated first.
11. The Panel recommends that research be encouraged to develop two strains of Java Thin-Tailed (JTT) sheep, one homozygous for the "prolificacy" gene and the other without it. Ewes of this breed show considerable variation in litter size. A homozygous strain should be uniformly high, while a strain without the gene would have singles or twins - an adequate level of prolificacy for most current practical management conditions.
12. The Panel recommends that for sheep meat production:
- i. Selection on body weight gain, which is heritable, should be encouraged to improve the poor body weight gains and efficiency of conversion of most indigenous breeds.
  - ii. Crossbreeding of extremely coarse and hairy wool breeds with exotic mutton breeds should be undertaken to improve meat production, especially under intensive feed management.
13. The Panel recommends that for wool production:
- i. Where breeds produce fleeces with high average fibre diameter and percent medullation, suitable for various grades of carpets, selection on first six-monthly fleece for high greasy weight and lower medullation should be made to improve both fleece weight and quality; with breeds having very coarse and hairy wools, the animals should be crossed for meat production.
  - ii. Where the aim is apparel wool production, attempts might be made to cross exotic finewools on to native breeds which have a lower average fibre diameter and medullation percentage. Exotic inheritance should not exceed 50%, with subsequent selection in the crossbreds for greasy fleece weight and against percent medullation.
14. Since some Indian goat breeds with valuable genetic traits are declining numerically {for example the Barbari, present population 30 000, and Jamunapari 5000), the Panel recommends that conservation is needed.
15. Since selection within breeds of sheep and goats seems the most favourable method at present for genetic improvement of small ruminants, the Panel recommends that such schemes should take account of habitat and flock size. The practice of population screening for individuals of outstanding merit should be more widely used to supplement normal selection and breeding methods. It should be noted that crossbreeding and development of new breeds should also have a place under improved husbandry conditions and in the more developed countries; also that milk production in goats can be improved through selection for first lactation milk yield and age at first kidding.

### **CAMELS AND CAMELIDAE**

The camel species is widely distributed among the Far Eastern (two-humped camel), Middle Eastern, North African and Sahelian (one humped) countries. The species is well adapted to desert climates and is used for milk, meat, draught, transport and racing. Camelidae exist in the Andean high altitude areas, where pastoralism is the main activity.

The Panel took note of the extreme importance of camels in providing milk, meat and transport for populations living in sub-desert and desert areas, and of the camelidae in producing meat, fibre and transport for people in the Andean regions. It recognized there are still wide gaps in knowledge about both camels and camelidae.

#### To FAO/UNEP and National Governments

16. The Panel recommends that FAO/UNEP:

- i. Should establish a research network in countries where camels are numerous, and actively support studies on breeding, management, nutrition, performance and reproductive behaviour.
- ii. Should emphasize the need for collecting information on camels for inclusion in regional data banks. Descriptors for camels and the camelidae should be developed.
- iii. Should produce comprehensive publication(s) covering available information on camels and camelidae species.
- iv. Should promote the establishment of regional centres to enhance conservation and improvement of camels, one in Africa for the one-humped, and the other in Asia for the two-humped.
- v. Should stimulate studies on range utilization, particularly the interactions between alpacas, llamas, sheep, pastures, parasites, etc., since animals and pastures are so closely linked.
- vi. Should promote studies on various aspects of the biology of the camelidae. Information is urgently needed on reproduction, disease control and the genetic basis of the traits of economic importance (colour, fleece weight, skin follicle types in relation to the production and marketing of specialist fibres, body weight).

17. The Panel recommends that:

- i. Extensive crossing between camelids be discouraged until more adequate information is available for individual species (or breeds) and the effect of crossing on production.
- ii. Integrated management of wild vicuna and domesticated alpaca and/or llama should be studied. Of particular interest is the use of surplus castrated vicuna males as fibre producers.
- iii. Attempts should be made to tame vicunas. One possible approach would be to transfer vicuña embryos to domesticated alpacas; the new-born vicuna could then be imprinted with alpaca and managed in a flock as domesticated animals.

### **PIGS**

The Panel noted that in most developing countries, two kinds of pig production have developed over the last three decades:

- i. An industrial structure, based on well-developed exotics and their crosses with local breeds.
- ii. Smallholders who raise indigenous populations/breeds as scavengers with zero inputs. These animals have generally low production but high qualities of survival.

18. The Panel recommends that FAO/UNEP:

- i. Should stimulate an examination of the smallholder system followed in Asia, so that breeding programmes could be developed to improve the system and benefit smallholders.

- ii. Should stimulate studies on the digestive capacity of indigenous pigs, in view of their value as scavengers and converters of waste vegetable products to edible protein. Considering the importance of this role of the indigenous pig in utilizing roughages there is little research on its special capacity. Some breeds which apparently live entirely on pasture, such as some in Mongolia, might be particularly appropriate for such studies, and for evaluation as a potential genetic resource for developing countries.
- iii. Should encourage national governments to develop organizational structures which would allow reasonable selection intensities and estimates of heterosis when indigenous pigs are crossed to temperate exotics. It further recommends that these organizational structures should support the utilization of heterosis either by breeding crossbred females with a second exotic breed, or by backcrossing to the exotic parent.

19. The Panel recommends:

- i. That development of synthetics based on interbreeding of F<sub>1</sub> crosses should be avoided as far as possible, although this is the most easy to do organizationally. Wherever sufficiently large populations now exist, as in China, efforts should be made to select them with well defined breeding goals.
- ii. That it would be desirable to improve prolificacy in many tropical breeds by introducing high prolificacy genes from some Chinese breeds.
- iii. That research on feed efficiency/conversion using agro-industrial by-products should be encouraged and non-conventional feed resources should be examined to help smallholders.
- iv. That research on the Asian pigmy hog should be encouraged, as little is known about it.

### **BUFFALOES**

20. The Panel recommends that FAO/UNEP:

- i. Should encourage the extension of a network between countries in Asia for the exchange and evaluation of the Murrah and Nili-Ravi, both as purebreds and in crosses with swamp buffalo. The exchange should include data, semen and live animals. The Panel understands that Peninsular Malaysia is willing to conduct a study on these lines, with international technical and financial assistance.
- ii. Should cooperate with other international agencies in organizing research on the evaluation of breeds and crosses, with particular emphasis on the improvement of reproductive efficiency.
- iii. Should promote an evaluation and selection programme for draught, growth and semen quality in the swamp buffalo. Although this is not yet an endangered species, superior genes are lost through bulls being removed from herds.

### **EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN THE TROPICS**

There was general agreement on the high priority to be attached to education and training in the tropics. Courses of various kinds should be set up with defined objectives using methods and languages appropriate to the participants. While courses should be set at suitable technical levels it was emphasized that screening of applicants is essential. The proper sharing of experiences will only be achieved by bringing in some experts from outside the Region and at the same time balancing this with local personnel with a good knowledge of local production requirements. In this latter respect it is very important to appreciate socio-economic aspects of current animal production and their interaction with the intended changes.

21. To FAO/UNEP the Panel recommends that FAO/UNEP, in association with national governments, should organize training courses at three levels:

- i. For administrators and heads of departments such as extension and animal health, designed to give an appreciation of what is to be attempted in managing animal genetic resources, and explaining the major steps of documentation and subsequent plans for conservation and improvement.
  - ii. For professionals with a basic training in animal breeding but perhaps requiring updating, including specialized information which is still unfortunately missing from some animal breeding courses.
  - iii. For technicians responsible for execution in the field of schemes. These are seen to be of high importance because of the need to convey reasons for the scheme and to obtain cooperation by using methods set at levels of literacy and numeracy appropriate to those concerned.
22. Training manuals should be compiled in association with the planning of the relevant courses above.
23. The Panel recommends that FAO/UNEP should make special merit awards to recognize outstanding performance by individual technicians. This is suggested to encourage pride in achievement; strong motivation is required to create close involvement and commitment from the farming community.
24. On the subject matter of courses, the Panel recognizes that various types of courses will be required varying in length and technical content according to particular requirements. It recommends the following subjects to be considered:
- animal breeding and genetics (including organizational aspects);
  - conservation and management of animal genetic resources;
  - design and analysis of genetic experiments;
  - data acquisition; data banks and computing;
  - cryopreservation and techniques for the manipulation of reproduction;
  - extension methods and socio-economic factors.
25. The Panel recommends that:
- i. Courses should be evaluated to check on their effectiveness.
  - ii. New educational methods such as videos, etc., be used to maximum advantage.

#### **PROFESSIONAL TRAINING IN EMBRYO TRANSFER METHODS**

Embryo transfer is a basic method in all aspects of applied and experimental embryology, and knowledge of embryo collection, evaluation and freezing is essential in relation to cryo-preservation of genetic material from endangered breeds and in the improved utilization of germ plasm in certain situations.

26. To FAO/UNEP the Panel recommends that:
- i. Training of local staff is a more effective and cheaper long-term approach than bringing in groups of foreign technicians to carry out embryo transfer work.
  - ii. Knowledge of embryo transfer has to be considered for the future use of such special techniques as:
    - embryo manipulation

- fertilization in vitro
  - production of transgenic animals.
- iii. Semen collection and freezing are also likely to be used in gene preservation and the technology is popular. Difficulties in semen collection from males of less-domesticated species have to be considered. Two techniques available are:
- electro-ejaculation, which, however, gives semen of lower quality;
  - use of the imprinting effect, which involves artificial rearing of newborn males, but leads to easy handling of mature animals.

#### **PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN THE TROPICS**

27. The Panel recognizes that although specific information is not available on decline in numbers in various tropical breed populations, indiscriminate crossing with temperate exotics is putting many of these populations in danger of extinction, e.g. Criollo breeds of Latin America, Sahiwals of India, Pakistan and Kenya, Jamnapari goats of India, Siri cattle of Bhutan and India. The need for preservation/conservation of breeds and local populations with specific adaptations, some of which are clearly endangered for various reasons, has now been clearly established.

A number of methods for preservation have been identified and costs worked out for each. There are two main categories:

- in situ preservation of live animals;
- ex situ preservation of parts in cryogenic storage.

Advantages of the in situ method are:

- the animals are visible, and so pleasing to the eye, and have some cultural value;
- they are a gene bank for future use;
- they are a constant reminder that the needs of posterity must be considered;
- the herd/flock may have some economic advantage (e.g. disease resistance in chickens) which can be exploited and so render the enterprise economically viable.

The costs of in situ preservation worked out so far for Europe are not applicable to many tropical countries; these could be much less and need to be estimated for each ecosystem.

Disadvantages of the in situ method are:

- small population size, leading to inbreeding and random drift. Many models are now available which reduce inbreeding to a minimum, but some scientists argue that random drift over long periods (say hundreds of years; may lead to a population very different in genetic composition from the initial one;
- gene x environment interactions.

Because of random drift and possible gene by environment interactions, ex situ methods are generally preferred over in situ.

Ex situ storage can be of semen, ova or embryos. At present, embryos are preferred for obvious reasons, as the breed can be reconstructed at any time. There is agreement, however, that it is desirable to store semen as well as embryos.

The fast growing science of biotechnology may lead to newer techniques of gene preservation. DNA recombinant techniques, embryo manipulation, cloning of desirable genes from the same or other breed populations may one day become commonplace.

28. To FAO/UNEP the Panel therefore recommends that:

- i. FAO/UNEP should take note of the trends in biotechnology and assist appropriate developing countries to generate the necessary information bases, infrastructures and manpower capabilities in this important area.
- ii. A survey should be made of various breed populations in the tropics to identify rare or endangered breeds for which action programmes for preservation need to be initiated immediately.
- iii. Cryogenic storage of embryos/germ plasma should be organized on a regional basis under international control. Problems of access to the gene bank, and how the access is to be arranged between donors and recipients, need to be clarified.

### **HORSES**

29. The Panel recommends that:

- i. Although other species may be more important for the economics of developing countries the breeding of equidae not be neglected.
- ii. Generally speaking, indigenous horse populations which are free of English and Arabian Thoroughbred genes should be studied and where necessary, preserved. This is because all the light horse populations (even the ponies) seem to have a high level of English and Arabian Thoroughbred genes, which are not endangered.
- iii. In the regions having distinct horse breeds or lines well adapted to harsh conditions (e.g. in North Africa and the Arabian Peninsula), these breeds should be maintained under their original environmental conditions, even when they are also used as improvers in developed countries.
- iv. The developed countries should preserve the genetic variation of light and heavy horses and ponies. The large scale of their utilization ensures the use of some of them also in developing countries.
- v. The programme for saving the Przewalski horse in the wild in its natural habitat in Mongolia should be supported.

### **DONKEYS**

30. The Panel recommends that:

- i. The maintenance and improvement of donkey populations of the world should also be surveyed, since in the tropics and for some developing countries this species is more important than the horse. The different breeds should be evaluated and preserved where necessary; the first steps have been taken in Brazil and France.
- ii. In the evaluation of donkeys, not only draught power but also meat production, the extent of other uses and above all, the adaptability of the breeds should be emphasized.

### **CRYO-PRESERVATION OF GENETIC MATERIAL**

There is a substantial risk of transferring contaminating agents when cryo-preservation of genetic material is used for breeds not kept under strict hygienic control.

- semen may be contaminated;
- viruses may stick to the zona pellucida of the embryos;
- contaminating agents are effectively frozen with semen or embryos and may be preserved indefinitely;
- contaminating agents cannot be removed from semen;
- addition of antibiotics does not offer guarantee of neutralization of contaminating agents.

31. To FAO/UNEP the Panel recommends that:

- i. Only specific pathogen free animals as semen donors should be used.
- ii. Embryos should be treated according to the rules of the International Embryo Transfer Society (Organisation Epizootique Internationale).

# **PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN THE TROPICS**

## **CONSERVATION OF THE KENANA BREED IN SUDAN**

E.P. Cunningham 1/

### **1. INTRODUCTION**

Sudan is the largest country in Africa. It has approximately 20 million people, 20 million cattle, and a GNP per head of population of \$500. At present growth rates, the population will double in the next 30 years. The country therefore faces enormous challenges in the most fundamental element of economic development - food supply.

In meeting this challenge, the development of the potential of the cattle population is a major factor. The various cattle breeds and types in the country have so far been relatively untouched by modern crossbreeding, immigration or selection practices. They have, on the other hand, been subjected to natural selection in a domesticated environment for many centuries. The two best defined breed types within the national population are the Kenana and Butana. These breeds will inevitably be subjected to substantial pressures from outside genetic sources in the coming decades. The Government of Sudan therefore faces the same difficult task as confronts authorities in other countries in the developing world: how to balance conservation of the undoubted merits of these breeds with the opportunity and necessity for rapid economic development. To help in the resolution of these questions, FAO commissioned a study of the alternative strategies for the conservation of these breeds in 1983, and this report is based on the results of that study. The report concentrates on the Kenana breed, because it was considered to be most immediately in danger.

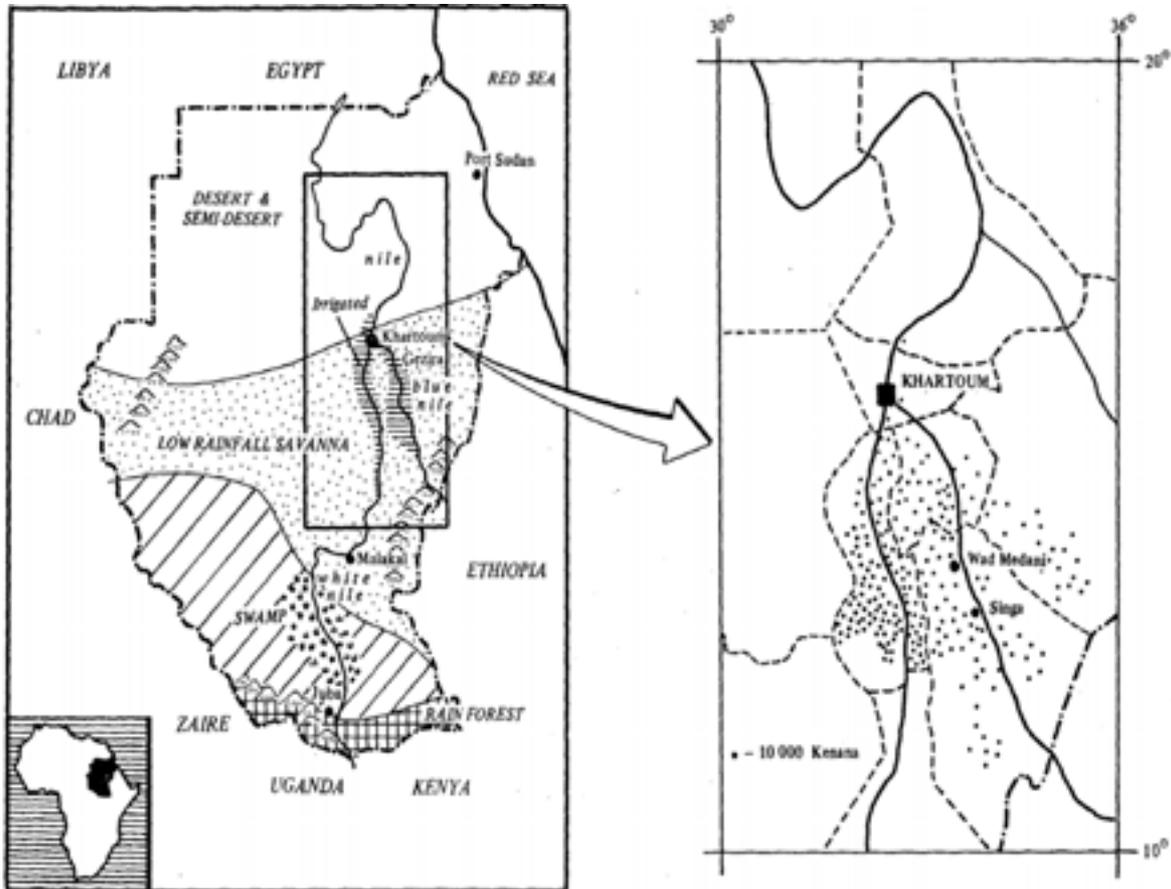
### **2. THE KENANA BREED**

There are estimated to be about 3 million Kenana-type cattle. This definition includes populations known locally as White Nile type. They are found largely in their traditional areas of origin, the plains adjacent to the White and Blue Nile rivers, in an area stretching south from Khartoum to the Ethiopian border (Figure 1). This ecological zone is typically a low rainfall savannah area, with high temperatures and low humidity. Traditional cattle systems in the area involve seasonal migration, though not to the extent of the true nomadism found further west in Sudan. Since the 1920s, about 1 million hectares of irrigated land has been developed in the area, largely for cotton production. The availability of crop residues and the growing of forage crops have led to greater stability in the cattle population. In the last two decades, the rapid expansion of Khartoum, Omdhurman and Wad Medani has increased the local demand for milk, and stimulated the initial development of commercial milk production. This has led to some crossbreeding, mainly with imported Holstein-Friesian semen.

The Kenana is a true *Bos indicus* or zebu type. Its origins are not known, but it has been suggested (Boyns, 1947) that they were introduced many centuries ago with migrants from Asia.

The location of the Kenana area within Sudan, and the estimated breed distribution are both shown in Figure 1.

Fig. 1. LOCATION AND ESTIMATED DISTRIBUTION OF KENANA CATTLE IN THE SUDAN.



Production data on the breed in its native environment are difficult to find. The Agricultural Research Council (1975) reported that a sample of the population contained 82 percent females and 18 percent males. The percentage of cows in milk was found to be 37 percent, and average daily production was estimated to be 2 kg. The calving rate was given as 70 percent and mortality was estimated at 5 percent in adults and 10 percent in calves.

The fact that the environment is extremely limiting was illustrated by the work of El-Khidir et al., 1979. They reported that a control group of Kenana heifers had a daily gain of 138 g and calved at 47 months, while a parallel group given extra nutrition had a gain of 470 g per day and calved at 32 months.

The most extensive recorded performance data come from research stations of the Animal Production Research Administration, Nishishiba (near Wad Medani) and Umbenein (near Singa). These data have been summarized and analysed by Fangaly (1980) and some of his results are given in the following table.

Table 1 AVERAGE MILK YIELD, CALVING INTERVAL AND AGE AT FIRST CALVING IN KENANA COWS IN TWO STATIONS (Fangaly, 1980)

Station	No. of Records	Mean	C.V. %
<b>Milk Yield (kg)</b>			
Umbenein	1920	1359	60
Nishishiba	882	763	89
<b>Calving Interval (days)</b>			
Umbenein	1539	434	24
Nishishiba	639	413	26
<b>Age at First Calving (months)</b>			
Umbenein	471	45.0	18
Nishishiba	331	51.5	17

### 3. PRODUCTION SYSTEMS

Conservation or development plans must be considered in the context of the production systems in which they are to be implemented. In the case of the Kenana breed, it is clear that more than one system will apply in the future. At one end of the spectrum, there are Kenana cattle involved in pure nomadic systems, in very stressful environmental circumstances. At the other end, there is the development of a relatively modern milk production sector to service the urban requirements of the country. This range of production systems is categorized in Table 2. In each case, appropriate breeding systems are also indicated.

Table 2 CATTLE PRODUCTION SYSTEMS IN SUDAN

	Production System	Breeding System
1.	Intensive high-capital dairy production	Importation of Holstein-Friesians, Brown Swiss, or Jerseys - possibly using embryo transfer.
2.	Existing city-supply producers	Grading up to Holstein-Friesians, Brown Swiss, or Jerseys. Alternatively, use of 1/2 and 3/4 exotic bulls leading to development of a synthetic population.
3.	Settled producers, now beginning milk production	Possibly as for (2) above. Opportunity to use system of grading up to F1 bulls.
4.	Settled, traditional systems	Opportunity to develop an improvement programme using station plus owners' herds.
5.	Transhumant systems	Crossbreeding (particularly of exotic breeds) to be discouraged.
6.	Nomadic systems	Interference in existing breeding practices not recommended.

From experience in other countries, and also in Sudan, it is clear that breeds like the Kenana will not be used in their pure form in the more intensive dairy production systems. Most existing city supply producers, even in considerably less intensive production systems, are at present involved in crossbreeding, largely with Holstein-Friesian. In these circumstances, some producers will continue grading up to the exotic strain, while for many

the use of half of three-quarter bred exotic bulls will permit the development of synthetic grades, usually more than 50 percent exotic in genetic background.

In the third level, there are many settled farmers in the Khartoum and Gezira areas now beginning to produce milk for sale, though in conditions where cow nutrition and management are often poor. In these circumstances, some will continue to use Kenana cows, but the tendency is to involve some exotic genes also.

Developments in all three of these levels of milk production threaten the existence of the Kenana. Since these populations are largely crossbred, it is impossible to base a conservation programme for Kenana on them. Kenana genes will, of course, survive for some generations in the crossbreds. If synthetic populations are developed, some of the genetic material of the native breed may survive in this form indefinitely. However, even in this case, planned conservation of genetic background of the native breeds is not possible.

At the other end of the scale, large numbers of animals are involved in true nomadic systems. Imposing any kind of external selection programme on animals involved in such systems is extremely difficult for a number of reasons. Because the environment is demanding, and food supply irregular, overall reproductive rates tend to be low. Because animals are so much on the move, regular contact with the herds and their owners, necessary for any kind of consistent selection scheme, is difficult to maintain. Finally, it is questionable if the selection goals of higher milk or meat output from individual animals are desirable in such populations, since the primary requirement is the physiological resilience to cope with the demands of the system. While amelioration of the environment (e.g. by control of parasites and disease, and by improving the feed supply) is highly desirable, it is difficult to envisage the operation of a useful breed improvement programme within the population.

Where the environment is somewhat less stressful, many cattle are involved in systems which are a mixture of settled and migratory patterns. Thus, in the Singa area, some of the stock migrate seasonally to areas where crop residues are available. As with the nomadic systems, these transhumant patterns of farming should also be based entirely on indigenous breeds. For the same reasons, but in a lesser degree, it is difficult to see a development or selection programme operating in such circumstances.

Finally, there are large numbers involved in what are essentially settled farming systems, but systems which are still largely traditional in many respects. They are not involved in commercial milk sales through organized channels. Productivity levels are not particularly high, and the feed supply situation is not likely to permit rapid changes from that position.

It is in this sector, where the indigenous breeds have a relatively secure place in traditional though settled production systems, that the best opportunities lie for introducing a conservation and development programme.

#### **4. CONSERVATION PLAN**

The scheme proposed for the Kenana population is outlined in Figure 2. Its essential elements are a consistent selection programme carried out within the herd at Umbenein Research Centre, combined with an annual round of selection from village herds. Technically, this kind of structure is known as an open nucleus system (James, 1977). The primary selection goal should be milk production, defined as yield of fat-corrected milk per lactation. Attention will also need to be given to weight for age, udder conformation, and beef potential. Prior to the commencement of the scheme, a written, agreed definition of the breeding goal will need to be developed.

#### **5. SELECTION IN THE FIELD**

Since no records are kept by the herd owners, this selection will have to be on the basis of inspection, together with perhaps some on-the-spot measurement of milk output. These selections should be carried out by a

qualified officer of the Ministry. Since a large element of judgement will be involved in these selections, it is essential that consistency is maintained in the judgements exercised.

The procedure envisaged is as follows. In each season, a campaign of visits to village herds would be planned. The aim of the campaign would be to select and purchase for recruitment to the Umbenein herd approximately 20 outstanding cows. Some number between 20 and 50 village herds would need to be visited. In each village, the bulk of the cows can be fairly readily inspected as they move out to grazing in the morning. The officer would identify a few cows (perhaps 3) which he regarded as the best, and during the day would make contact with the owners of these cows. As the herd returns in the evening, his assistants could be present at the milking of these particular cows, and weigh the milk produced. Some objective measurements (e.g. wither height) would be taken, and on the basis of all the information available to him, the officer would attempt to purchase the best one or two animals. In making these selections, attention would be concentrated on cows in the first three lactations.

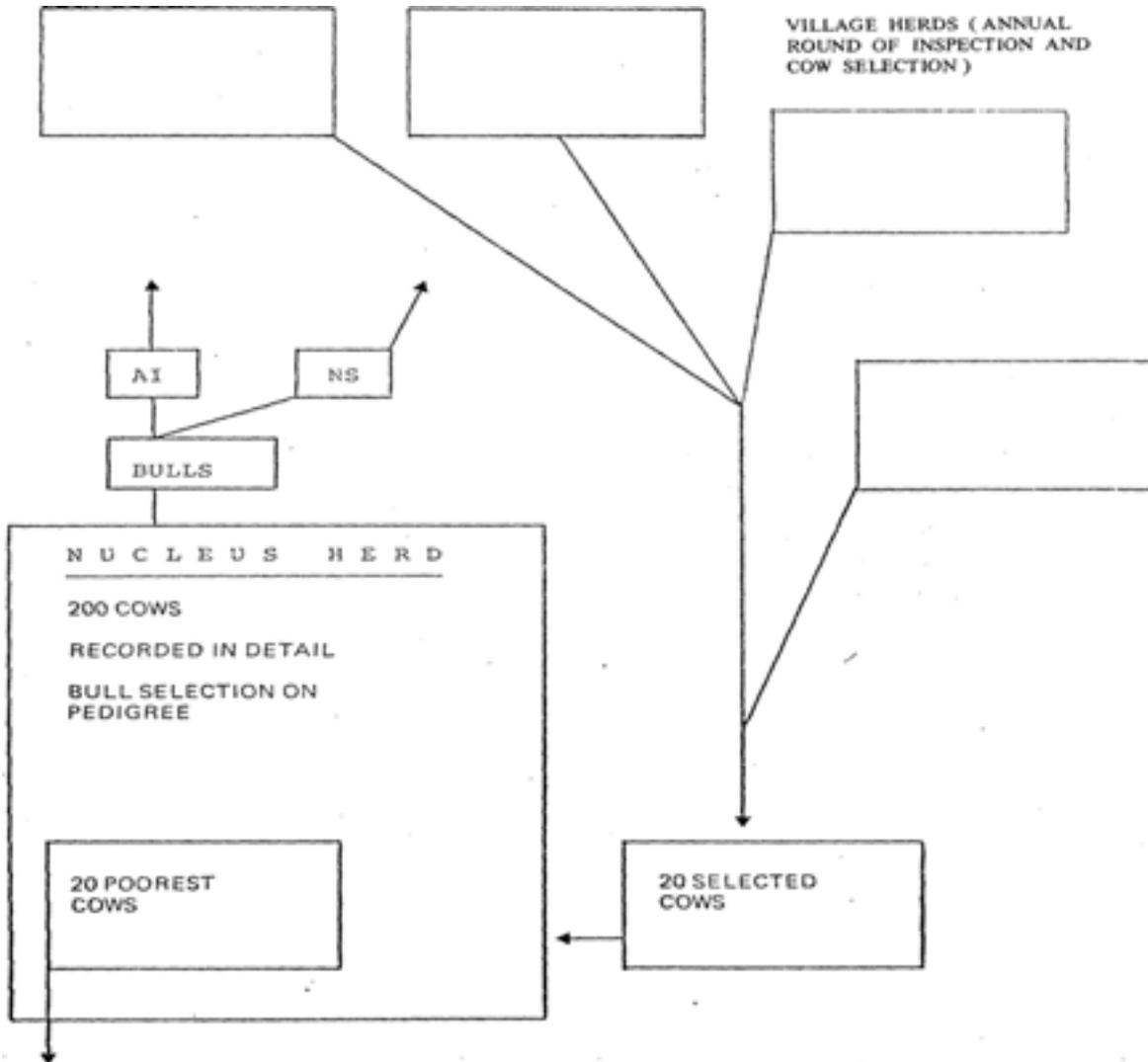


FIGURE 2: SELECTION SCHEME INVOLVING VILLAGE HERDS AND GOVERNMENT STATION.

In operating this scheme, there are several imponderables. Since the selection is largely a matter of judgement, it is difficult to predict how effectively it will identify superior cows. However, similar schemes applied consistently in the early days of the formation of the European dairy breeds appear, in retrospect, to have been reasonably successful. It is also difficult to know in advance what success there will be in persuading herd owners to sell (or lease) their animals. A process of trial and error may be necessary to develop a procedure which works well.

## 6. SELECTION IN THE STATION

While the selection in the field must be done entirely without documented performance records, the opposite is the case in the research station. Here, the necessary scientific and technical personnel are available, together with any equipment required, and the primary purpose of the Centre is the assembly and use of objective data on the cattle herd. Detailed records can therefore be kept of all aspects of reproduction, growth, production and behaviour of all animals. The protocols at present in operation in the herd cover the obvious and immediate requirements (gestation length, birth weight, body weight at suitable intervals, mortality together with causes, breeding age, age-at first calving, milk production, and subsequent lifetime reproductive and production records). In order that the substantial commitment to the new development and conservation programme is justified, it will be necessary to review all of these procedures to ensure that suitable levels of precision are aimed at in the different measures, and that absolute reliability of data can be guaranteed. In addition, there should be provision for extending the range of characters measured to include suitable metabolic indicators, and, as may be feasible, records of response to parasitic infections both internal and external, together with various tests related to disease resistance. Furthermore, objective measurements of temperament and dairy conformation, dairy traits (particularly udder functionality), such as have been developed for dairy breeds elsewhere in the world, should be applied.

Most of these secondary traits will play a minor role in the selection programme, and it is not therefore an essential point that they should be fully developed in the first few years of the programme. Nevertheless, since the primary motivation for the conservation of the Kenana breed is the presumption that it has some advantageous physiological differences from other breeds, and since there is a great lack of information on such characters in this breed, and in zebu cattle generally, the encouragement of physiological and metabolic studies on the herd is strongly recommended.

The selection goal in the herd should be the same as that in the field programme, albeit with more detailed and objective measurements on which to base selection. Again, an agreed, consistent selection goal needs to be defined in advance, and the criteria and levels of selection also need to be predetermined. Since milk production will be the most important trait in this selection goal, it is possible to draw on studies elsewhere to make some advance estimates of the likely rate of improvement for this major trait. In a closed herd of adequate size to minimize inbreeding effects, annual rates of improvement of between 1 and 2 percent are achievable. In an open nucleus structure, as proposed here, the rate of improvement could be significantly greater.

As is suggested below, some additional studies to guide the selection procedure, and to explore the way in which it depends on the herd and population structure, are justified.

While it is unlikely in the years immediately ahead that any extensive use of embryo transfer techniques can be used in the herd, it should be kept in mind that at some future date the introduction of these techniques could significantly assist the programme. The primary benefit to be derived from the introduction of embryo transfer would be the intensification of selection on the female side which it makes possible. Since each selected cow can, under embryo transfer, provide multiple calves per year the selection exercised on the cows can be that much more stringent. This has particular relevance in the Kenana breed, since it is female performance which is the main criterion for selection.

One of the great difficulties experienced in Umbenein, and indeed in similar stations in other tropical countries, is that because of inadequate and uncertain forage and feed supplies, growth of heifers tends to be very slow, with age at first calving frequently exceeding five years of age. The same causes lead to long calving intervals. The net effect is that too few females are reared in relation to the herd size to permit much selection either in the incoming females, or among the cows in the herd. The statistics of the Umbenein herd in recent years indicate that, as at present operated, it would have some difficulty in carrying out an effective selection programme. It

will therefore be essential that a new regime of feed and fodder supply be developed for the station. The work of El-Khidir et al., 1979 has clearly shown that growth and puberty rates can be dramatically improved with adequate feed. In the new provisions, therefore, adequacy and security of fodder and feed supply will be essential.

## 7. SUPPORTING STUDIES

There are considerable deficiencies in the data base required for the development of future breeding plans for the Kenana breed. The following are some areas which require further investigation:

- a. Estimates of population size, sex and age distributions in the Kenana population are tentative. In addition, field productivity is not well documented.
- b. Information on migratory patterns in the Kenana population is limited and becoming out of date.
- c. The evolutionary and historical background of the breed is relatively unknown. It would be worthwhile to measure the genetic similarity between Kenana and Butana, and to compare both breeds with other zebu and non-zebu cattle populations. Such a study could be undertaken using electrophoretic techniques, and perhaps DNA hybridization techniques also.
- d. A critical comparison of the production potential of the Kenana and Butana would clarify which population merits greatest attention in the future.
- e. A further study is required of the possible rates of genetic change achievable in the open nucleus type of structure proposed here.
- f. Since inevitably a section of the Kenana breed will be involved in crossbreeding with European-type cattle, some systematic experiments are required to measure the additive and heterotic differences between Kenana and the selected European breed.

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**CROSSBREEDING CATTLE IN LATIN AMERICA**

F.E. Madalena 1/

The economic efficiency of cattle production may be improved by the appropriate choice of breeds, mating system and selection of individuals within breeds, to obtain increased product yield or quality per unit of input resources (land, labour, capital).

Experimental results on the comparative performance of cattle breeds and crosses in tropical Latin America indicate that, in general, crossbreds outperform purebreds both for beef (Madalena, 1977; Hernandez, 1981; Plasse, 1981, 1983) and for dairy production (Vaccaro, 1979; Wilkins et al. , 1979; Muñoz and Deaton, 1981; Madalena, 1981; Madalena et al. , 1983b; De Alba and Kennedy, 1985). Crossbreeding allows exploitation of heterosis, maternal effects and complementarity between breeds but the appropriate strategy depends on the characteristics of the production system considered.

## **1. PRODUCTION SYSTEMS**

Tropical cattle production systems in Latin America were described by several authors (Plasse, 1976; Wilkins et al., 1979; Paladines, 1980; Madalena, 1981; Ruiz, 1982; Cubillos, 1982; Sere and Vaccaro, 1984; CIAT, 1985). In general, beef cattle herds are kept in ranches and dairy cattle in smaller properties, but there is also a wide range of dual purpose systems. Coarse pastures/roughages limit nutrient intake, aggravated by periods of drought or flooding. Other constraints to cattle performance are: mineral deficiencies, incidence of diseases, ticks, torsalo grubs and gastrointestinal parasites, heat, humidity and solar radiation. Natural service is common, controlled matings and artificial insemination being practised at a minority of farms. Socio-economic constraints such as absentee ownership and low education level of rural populations are important background factors causing poor farm and herd management. It should be recognized that wide variations exist between and within regions, with many examples of good farming based on modern husbandry techniques.

## **2. MATCHING CATTLE GERMPLASM TO PRODUCTION SYSTEM**

Latin American cattle breed resources may be conveniently grouped into four classes:

- i. the founder Criollo naturalized initial populations, now mostly graded up;
- ii. zebu breeds;
- iii. the modern European breeds selected for high performance in temperate regions; and
- iv. new breeds derived from crosses between European and adapted breeds, like the Santa Gertrudis, Canchim and Ibage for beef production and the Jamaica Hope, Pitangueiras and Siboney for milk production, to mention some examples.

Modern European breeds may be utilized only in the more intensive production systems with no important climatic constraints, but are totally unfit for the harsher environments. Criollo and zebu breeds are adapted to harsh environments because of their heat tolerance, low metabolic rate and disease and parasite resistance but have comparative low performance in improved environments. For a wide range of intermediate environments, complementarity between highly productive and adapted breeds results in superior overall performance of crossbreds.

Our own results on crossing red and white Holstein-Friesian (HF) x Guzera (G) in Brazil may be used as an example of this situation (Madalena, Lemos, Teodoro and Monteiro, in preparation). Milk yields, calving intervals and milk yields per day of calving interval of six crossbred groups (grades) are shown in Figures 1, 2, 3. The six HF grades were: 1/4, 1/2, 5/8, 3/4, 7/8 and > 31/32 or HF. The halfbreds were F1 out of G dams by HF sires. The 1/4 and 3/4 were first backcrosses of F1 dams to, respectively, G and HF sires. The 7/8 were second backcrosses to HF sires, and the 5/8 were obtained by inter se matings of 5/8 sires and dams.

Animals were produced at an experimental farm and distributed to 66 cooperator farmers at mean age 22 months, to measure dairy performance under a wide range of commercial practices. Cows were milked in the presence of the calf, which suckled after milking, according to the generalized practice in the region. However, no milk was intentionally left for the calves on recording days. Farms were grouped into high and low management level classes for purpose of analysis. Figure 1 is based on 921 observations and Figures 2 and 3 on 699.

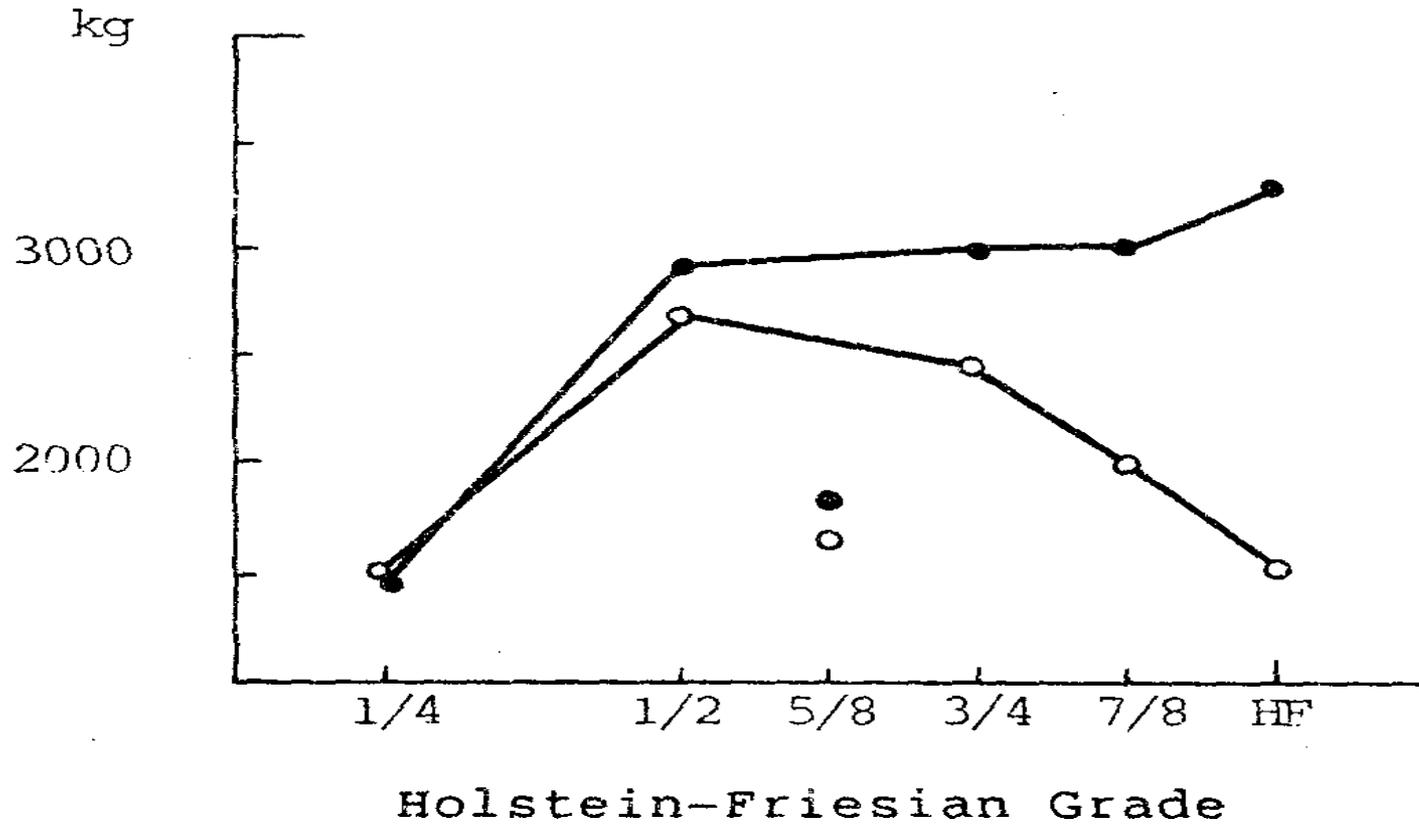


Figure 1 Lactation milk yields for six Holstein-Friesian x Guzera grades at high (\*) and low (°) management levels.

Cunningham (1981) described the situation depicted in Figures 1 and 3 as a double interaction of additive breed difference and heterosis by environment, the additive effect becoming more important and heterosis less important as the level of environmental stress is reduced. Results from another farm with mean milk yield of 9.8 kg per day of calving interval indicated no differences in this trait for grades 3/4, 7/8 and HF in HF x Gir crosses (Madalena et al., 1983a). Cuban results are in agreement with this conclusion (Ponce de Leon et al., 1982).

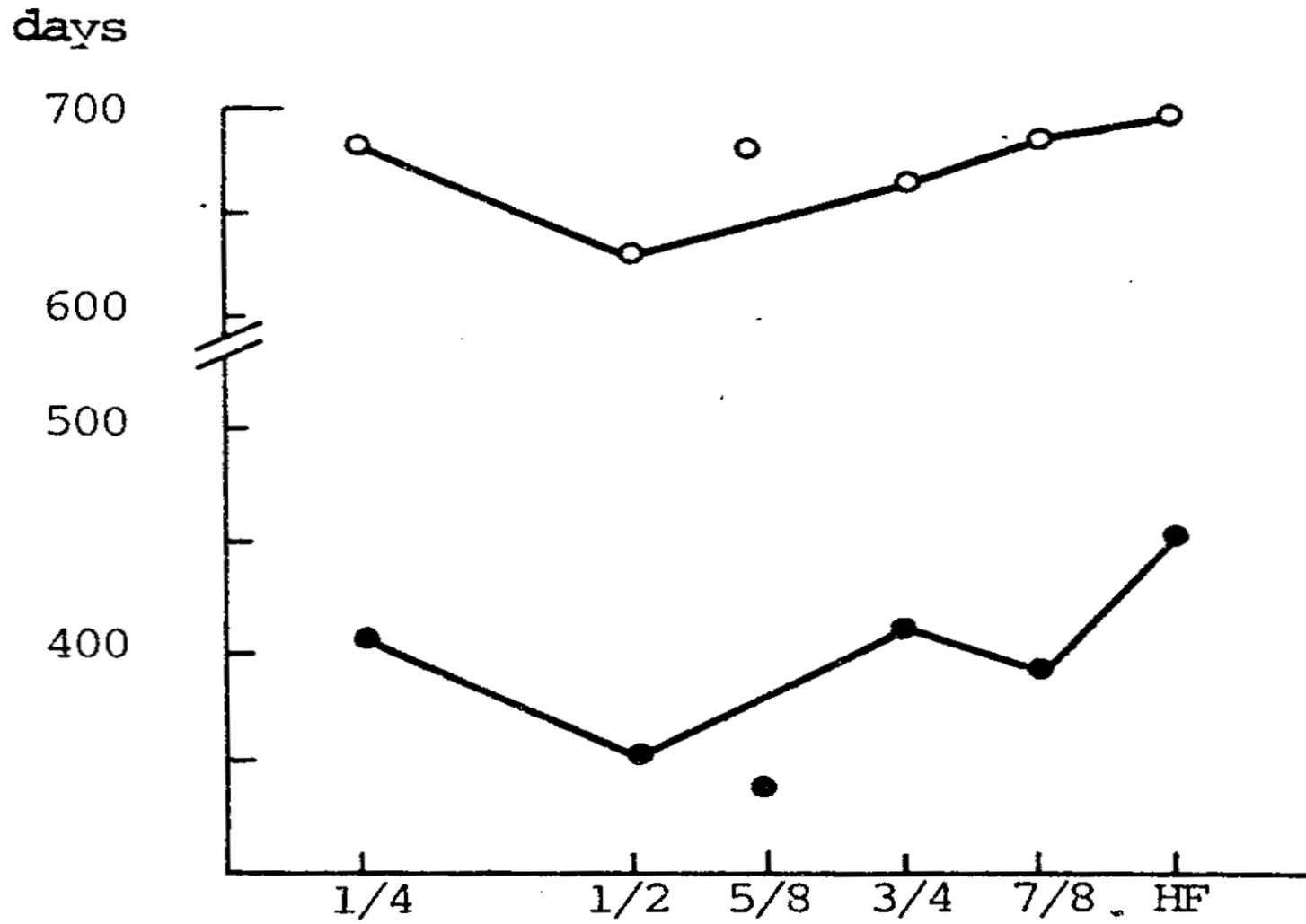


Figure 2 Calving intervals for six Holstein-Friesian x Guzera grades at high (\*) and low (°) management levels.

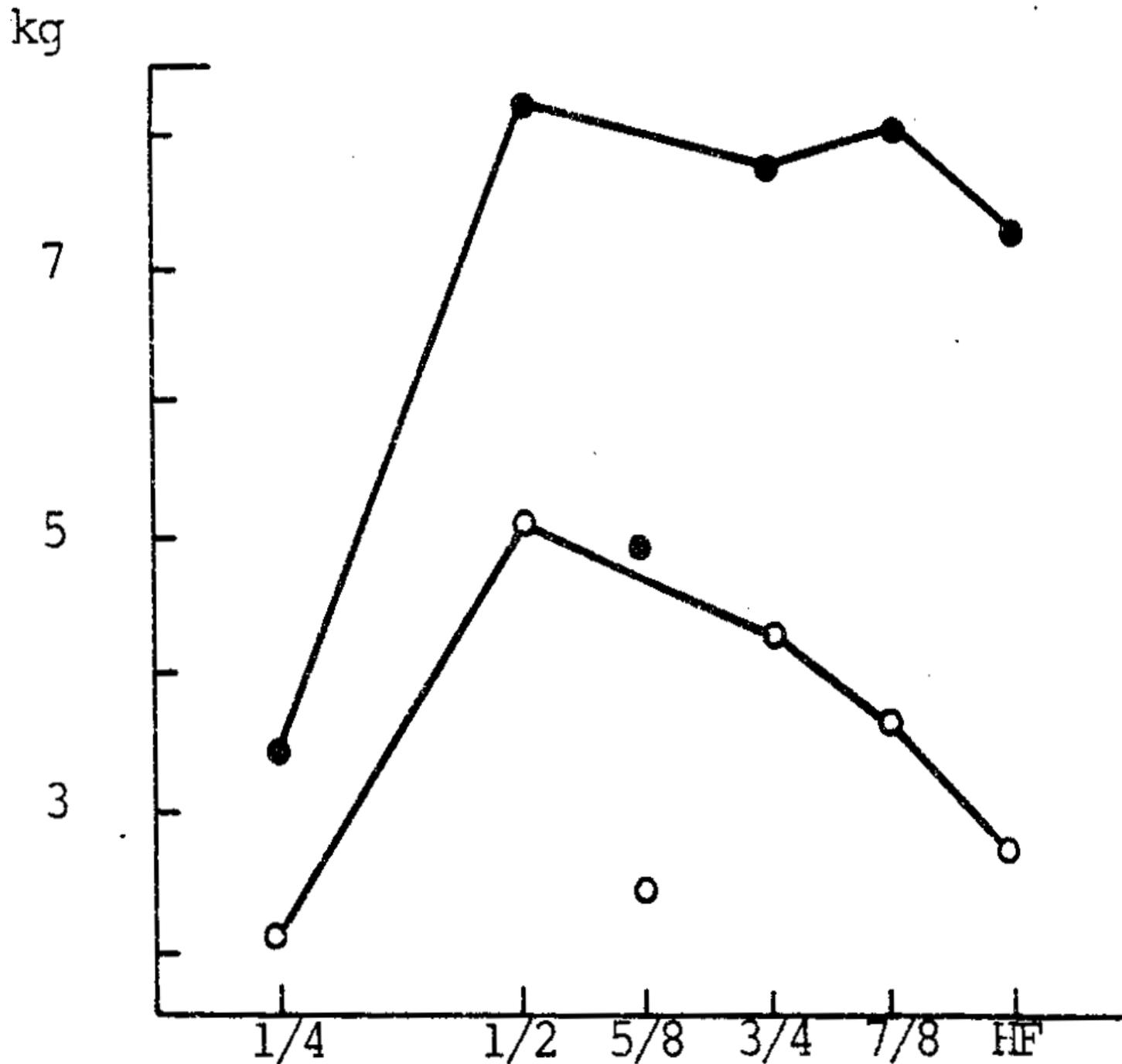


Figure 3 Milk yield per day calving interval for six Holstein-Friesian x Guzera grades at high (\*) and low (°) management levels.

Another example of genotype x environment interaction - perhaps an obvious one - is shown in Figure 4, where tick (*Boophilus microplus*) field burdens are shown for heifers of the six HF x G grades at 12 different occasions (Lemos et al., 1985). At the low levels of infestation, differences between grades in tick resistance were small, but they amplified at higher infestation levels. The economic values of the genetic tick resistance of zebus and Criollos (Ulloa and De Alba, 1957) depends on level of infestation, and would become irrelevant should ticks

be controlled by pasture spelling (Sutherst et al., 1979) or, in the future, by vaccination (R.W. Sutherst, personal communication).

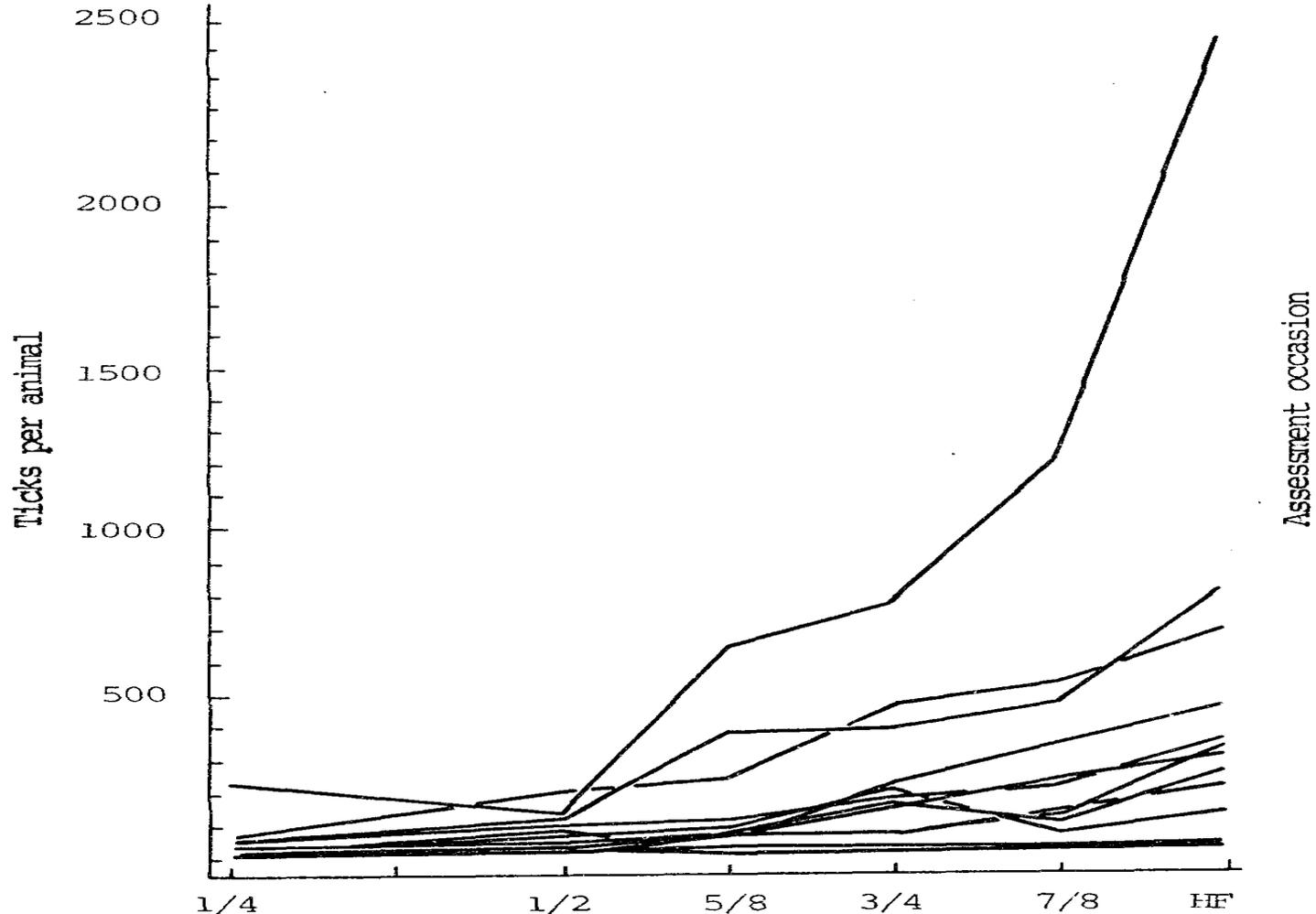


Figure 4 Average tick count per heifer for six Holstein - Friesian: Guzera grades at twelve assessment occasions.

### 3. CROSSBREEDING STRATEGIES

The HF x G results presented above belong to an experiment designed to compare the following crossbreeding strategies (Madalena, 1981):

1. Grading up to HF (represented by the HF group).
2. Creating a new breed (represented by the 5/8 group).
3. Crisscrossing, or rotation in each generation of HF and G sires.
4. Modified crisscrossing, repeating the HF sire breed for two generations, followed by G sires.

The latter procedure was suggested by Madalena (1981) to maintain the crossbred population at higher European grades (3/7, 5/7 and 6/7) than would be possible by crisscrossing (1/3 and 2/3). Mean performances for these two strategies were estimated from predicted means of the resulting grades under a breed additive difference and heterosis model (Dickerson, 1973). The results for milk yield per day of calving interval are

shown in Table 1. F1 were taken as a reference because they had the highest performance of all six groups (Figure 3).

Table 1 MEAN MILK YIELD PER DAY OF CALVING INTERVAL FOR SEVERAL CROSSBREEDING STRATEGIES OF HOLSTEIN-FRIESIAN (HF) X GUZERA (G), RELATIVE TO F1- PERFORMANCE

Crossbreeding strategy	Management level	
	High	Low
F1 Crisscrossing	100	100
HF-HF-G	98	85
HF-G	77	75
New breed	59	47
HF grades	80	53

Does not consider the purebred herd necessary to produce the F1. Continuous production of F1 heifers would not be practical on a regional scale, but it might be a good commercial proposition for individual farms in specific cases (Madalena, 1981).

Crisscrossing repeating the HF sire showed the second highest performance at both management levels (Table 1). Although the practical rule to apply this scheme is very simple, it requires the mating of females with a grade higher than 3/4 HF to the G bull and the other females to the HF bull, most farms would lack the organization required to keep track of which females should be mated to each sire breed. The scheme requires keeping at least one bull of each breed, which would not be economical for small herds, so it is better suited for artificial insemination in this case.

Dairy farmers unable to organize rotational crossing would still have two ways of maintaining the herd at intermediate grades:

1. Periodic switching of the sire breed (Roger, 1973). This is the prevailing practice at dairy farms in southeast Brazil (Madalena, 1981). It has the disadvantage of producing a high proportion of extreme genotypes, with too much or too little zebu breeding.
2. Use of crossbred bulls. Poor performance should be expected from inter se matings of unselected crossbred bulls and cows, as those used in our experiment. Negative effects of heterosis breakdown should be counteracted by selection for milk yield. Conventional progeny testing (using elite herds) would be quite possible in many Latin American countries, so that bulls for natural service could be produced by artificial insemination of the better cows with semen of proven bulls. In my opinion, difficulties for the implementation of a scheme of this sort lie more in poor organization of public institutions than on other factors.

Purebred European cattle may be the preferred option for the more intensive systems, particularly when climatic stress is attenuated by high altitude. Based on the results mentioned above, it would appear that purebred HF may be recommended for systems capable of sustaining lactation milk yields of at least 4000 kg, 10 kg per day of calving interval and calf mortality of 15 percent or less up to one year of age.

The elements for deciding on breeding strategy for beef cattle are quite different from those considered for dairy cattle. Practical problems to implement rotational crossing should not be very important as separate breeding herds may be kept for each sire breed (Madalena, 1977). On the other hand, reproductive efficiency of non-adapted European bulls may be seriously impaired in natural service under extensive conditions (Table 2), so

the introduction of genes from these breeds would require the use of crossbred bulls (or artificial insemination when possible). However, heterosis breakdown seems to be less important for reproductive and growth traits than for milk yield and lactation length. Plasse (1983) indicated that zebu-Criollo rotational crossing or composite populations including also other European breeds are promising alternatives, although not enough information is available yet for a final comparison of breeding strategies.

Table 2 REPRODUCTIVE EFFICIENCY OF BULLS OF SEVERAL BREEDS IN NATURAL SERVICE TO NELORE FEMALES IN BRAZIL (from Razook et al., 1985)

Breed of bull	Number of females exposed	Calving percentage
Nelore	177	79.7
Canchim	171	83.0
Sta. Gertrudis	168	48.8
Holstein-Friesian 1/	206	47.1
Brown Swiss 1/	204	52.5
Caracú	170	73.5

1/ Includes some artificial insemination.

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CRIOLLO CATTLE OF LATIN AMERICA  
Jorge de Alba

## 1. INTRODUCTION

The term "Criollo" has been used since early colonial times in Latin America in reference to both people and animals born in the newly-discovered land from imported parents. The word is thought to be French origin, from the equivalent "créole". In Portuguese the term is "crioulo".

As applied to cattle it specifically refers to types and "breeds" of "bos taurus" that evolved and differentiated from the parent stock through the joint action of natural selection and the husbandry to which they were subjected by early settlers. Very distinct ecotypes were created specifically adapted to harsh environments. For this development to take place, early isolation, as well as sufficient time was required for the initial variability to change frequencies and shape the gene pool into something very different from that of the original importations. In this context the Longhorns of the North American western plains are true Criollos. They developed from some lost herds of the earlier Spanish conquerors with minimal intervention of man, after the 16th century, in the vast expanses of Texas, New Mexico and Oklahoma. They acquired great adaptability to very dry conditions and ability to reproduce very effectively where forage was sparse. Their capacity to walk swiftly was well appreciated by drovers when the famous trails to the first railheads were utilized to give a market outlet to the accumulated numbers; this walking ability paradoxically, practically drove them to extinction. The creation of ecotypes is repeated in various regions and environmental niches from the Rio Grande to Patagonia, not excluding the islands of the Caribbean, though man's farming practices were more evident in the evolution of some types. No Criollos developed in the American colonies of the present US because the early bovine populations were constantly influenced by new importations, particularly at the time when specialized breeds were being perfected in Great Britain, the Channel islands and the European continent. On the other hand the "Canadienne" developed in Quebec is really a Criollo breed developed for extreme winter hardiness and ability to thrive on poor roughages by farm owners who appreciated milk for the household.

This paper deals in more detail with the Criollos of Spanish and Portuguese America, with particular emphasis on tropically adapted Criollos. This attitude is based on the conviction, supported by experimental evidence, that tropical adaptability constitutes their most valuable economic asset. This, the author believes, is valuable for the development of human welfare in those regions. Temperate zone Criollos have a lower claim for preservation or survival since more productive types, easily obtained from developed countries, also in the temperate zone, can, and do, manage to live very well and produce effectively in Latin American regions further north or south of the tropical band, or within tropical latitudes in areas where altitude makes for a temperate climate; all this is true provided feed resources are created by man to meet their higher needs. The present status of the types discussed and their relation to the preservation efforts and organization of breed or performance records is summarized in six tables presented in this article.

## 2. ORIGIN AND GENERAL PATTERN OF EXPANSION

Christopher Columbus brought the first livestock to the American continent on his second voyage. The provisioning of his seventeen ships took place in Cadiz, sailing on 25 September 1493. No record has been revealed yet of how many animals he procured from the Spanish mainland. But he made a second attempt to provision his ships at La Gomera, in the Canary Islands, where he recorded taking in cattle, sheep, goats, chickens and pigeons. His fleet arrived at Hispaniola on 22 November, after discovering Dominica, Guadalupe, the Virgin Islands and Puerto Rico. Columbus was a very sick man on this voyage and his diary is incomplete,

but it can be surmized that no animals were landed on these islands where no Spanish settlement had yet been attempted. Indeed the animals could not have been landed in the first settlement at Hispaniola that he had founded on his first voyage (Nativity) because he found it destroyed and chose a second site for his second attempt at colonization; this time near the first on the northern coast, at a spot he called Isabella. This little seaside port still exists. Some of the Criollo cows recruited for a conservation and study herd founded in 1973 at Santiago, some 50 miles inland in the Dominican Republic, came from that very spot. Indeed one of the cows with superior conformation that convinced this writer to strongly recommend that a herd be founded was sited a couple of kilometres from Isabella.

The northern coast of Hispaniola is very humid east of Isabella, and very dry to the west, hot all the year round. In 1493 it was heavily forested and that environment yields very little forage for bovines. They soon found their way to the interior, where more open country and fertile river beds afforded ample forage. The herd multiplied and became somewhat feral in a land of no fences and no European settlements. A tropical Criollo had started to evolve from the Andalucian and Canary Islands foundation.

The multiplication of cattle, horses and pigs in the interior of Hispaniola was in full acceleration by 1510, some four generations after their arrival. It was from Hispaniola that cattle were sent on all the voyages of intended settlement, immediately after conquest, first to the immediate islands of Jamaica and Cuba and then to the continent. It is known that a man named villalobos arrived with cattle near Tampico, Veracruz in 1521. Similar conquests followed by colonization occurred on all continental lands from Florida to many spots on all coasts of the Caribbean. In most cases, ships that brought cattle obtained their stock from Hispaniola or Cuba, some from Jamaica and few direct from the Canary Islands. The introductions to Brazil and southern South America were not from Caribbean origin but direct from Portugal, Spain or the Canary Islands. The multiplication of cattle in America after 1521 was phenomenal. It suffices to say that the first cattle to enter the present day United States territory occurred in 1540 with the expedition of Coronado which started in central Mexico and ended in southwestern US. He gathered without much trouble 500 head of cattle. This story is flamboyantly told in such books as Dobie's "The Longhorns" (1941). The increase in numbers is documented in other historical anecdotes. For instance in the province of Jalisco in Mexico, where natural grasslands existed for the benefit of the early cattle, it is reported that one ranch by the end of the 16th century, only 79 years after *Bos taurus* had arrived in Mexico, branded 30 thousand calves, not counting many strays lost to other regions since there were no fences (Rangel, 1924). From the same source we learn that in Mexico city by 1614 one hundred bulls could be spared from breeding and used for a mammoth celebration upon the arrival of a new Viceroy with the staging of multiple bullfights.

Incidentally, the fighting bulls of today in Mexico, Colombia, Venezuela and Peru are not a true Criollo type since they are the result of multiple and recent importations from Spain; no doubt it shows particular genetic drift in each location but it is not the product of the forces of natural selection acting upon a transplanted population. Other instances of the multiplication of all Criollos in the Americas have been told and documented by Rouse (1977) in a book dedicated in its entirety to the subject.

The seedstock arriving at the Caribbean islands was of varied origin and genetic constitution. Spain at the time of the conquest had no recognized breeds of cattle, except some strains of fighting bulls. The Canary Islands had different stock with some probable admixtures from Africa and again the cattle of Portugal were somewhat different. This diversity meant also genetic variability so that the limited number of imported stock subjected to expansion, could rearrange and change the gene frequencies of its pool. Even within one country like Colombia which received all its European seedstock of cattle through the river Magdalena produced divergent types adapted to tropical and non-tropical environments, essentially short-haired cattle for the former and long-haired cattle for the latter, or more remarkably a third type for the intermediate mountains, the Blanco Orejinegro. This ecotype has white hair on most of its coat except the ears and extremities, and besides its distinct coloration

(that has absolutely no connexion whatsoever with the White Park cattle of UK which it superficially resembles, and proves that coat colour genes are older than breeds) developed the toughest and thickest skin and possibly internal immunity defences against the tropical Ox Warble (*Dermatobia hominis*) and could prosper on the steep middle mountains of Colombia where the parasite prospers on all other kinds of cattle.

### **3. CROSSBREEDING AND THE DECLINE OF CRIOLLOS AS DOMINANT ECOTYPES**

Four centuries elapsed between introduction early in the 16th century and the decline and substitution of the Criollos by introductions of other cattle in the second part of the 19th century with great acceleration early in the present century.

The distinct populations that developed can best be described as ecotypes to emphasize their adaptability to particular regions. Some of the groups have been described as "breeds" and preserved in experiment stations run by governments. The result more often than not has been deleterious to the ecotype. Small populations moved to management situations that were not identical to those practised by practical farmers and, committed to the perfection of pure lines as judged by minor exterior "points", soon became zoological curiosities, inbred and very "pure" by criteria of breed definitions defined by station technicians, not breeders, and with little attention to improving their productive performance. Some became extinct precisely in the hands of government run stations, in some cases the breeders went a separate way and saved the "ecotype" by making a living from more productive lines. In most cases though identity of the ecotype was destroyed by indiscriminate crossbreeding. In both beef and milk production the introduction of European modern breeds (unadapted to the tropics) or zebus (highly adapted, but not necessarily more productive) resulted, in particular in the first cross, in populations that were obviously more productive through the phenomenon of hybrid vigour.

Experimentation followed breeders' observations and the value of heterosis is well documented; in the case of crosses for beef production, when Criollos were used as the mother breed, superior beef calves are produced in the F1 (steers) and the corresponding crossbred cows are also superior (in fertility and producing ability) than the average of either parent. But the average of the recently introduced breed in the form of bulls was unknown to the rancher or farmer: he could judge only the miracle of the hybrid. Experimental data confirmed these observations but warned at an early stage that F2s or backcrosses were not as good. (Data for Bolivia, Plasse et al., 1975; for Venezuela, Linares et al 1974; for Costa Rica, Muñoz and Martin, 1969 and Perozo et al., 1971) However few or no experimental evidence has been gathered on F3 or later inter se crossbreds.

Besides the benefits of hybrid vigour in two generations, research points out the high fertility of the Criollo as a mother cow. This was a quality not so easily observed by the breeder. In milk production the number of published papers with sufficient data and good designs is more limited. Crossbreeding of milking-type tropical Criollos with European dairy breeds is well documented in the case of the Jersey (de Alba and Kennedy, 1985) though growth rate is nowhere as responsive as occurs in crossbreeding with zebus; the longevity of the F1 Criollo x Jersey or its reciprocal in one generation renders stability in the milk line 90 percent greater than the average of the parent breeds in the same environment (de Alba and Kennedy, unpublished).

The experimental observations came after the experience of the overall results by practical farmers, the flourishing hybrid enamoured the breeder to the newly introduced breed and attributed all benefits to the new bulls. The experimental data arrived a bit late and was not complete in many cases since backcrosses or F2s were so slow in coming and so expensive to maintain in well balanced trials. The most common consequence has been, particularly since 1920, that the Criollo has been substituted by a series of less adapted mongrel populations. In Brazil the substitution has been most complete in favour of zebus. It should be said in all fairness that the zeal and new interest in cattle breeding that the zebu generated has been a step forward in organization, something that the early Criollos never benefitted from. A similar case happened in Argentina

where Criollo types were substituted by absorption to Shorthorn first and then these substituted and absorbed by Angus and Herefords, a process not very different from that of the elimination of the Longhorns in the US by the same English breeds and now they are being threatened by the continental breeds. Colombia and Central America which were strongholds of Criollo ecotypes have also travelled the same road.

In the case of tropical milk production the loss is more lamentable because zebus in their own right are respectable meat producers but very poor milkers. Many primitive milk producing and cheese manufacturing areas of the Latin American tropics have turned to beef and abandoned milk production.

The stage was set, after 1960, for more refined studies and for an assessment of which ecotypes, in what circumstances, should be preserved under the knowledge that it was recurrent crossbreeding that would create the demand and justification for improved Criollos. In all this work it has become more urgent that official government effort adopt an intelligent dialogue with breeders and conviction should be mutual that the preservation effort needs both performance data and interchanges of ideas and germplasm with breeders. The interchange of ideas with the practical man who makes a living from cattle raising has not always been deemed indispensable by the preservation efforts of the past. We shall see that in the individual ecotypes, listed in the rest of the paper, whenever breeding efforts have involved both experiment stations and farmers the usefulness of the Criollo types has made steady progress. On the other hand when the preservation efforts in closed herds have become subjected to the whims of shortsighted technicians, bureaucrats or politicians, an expensively set up station has become a practical failure.

#### **4. DESCRIPTION AND PRESENT STATUS OF EXISTING CRIOLLO ECOTYPES**

In this section we will attempt to make a brief description of Criollo breeding groups including some true breeds which can claim some breeder organization behind them and we will make an effort to state their preservation status. The groups will be classified by broad geographical and climatic zones where they evolved and for which they are adapted. Repetition will be avoided by grouping related types with beef and dairy Criollo populations treated separately, with a shorter description of non-specialized groups. Some selected key references are included for each type, though some of the descriptions and statements may stem from first-hand knowledge as observed by the author.

##### **4.1 Criollo Beef Types in the Lowland Tropics**

Table 1 LOWLAND TROPICAL BEEF CRIOLLOS  
Location, Population Trend and Knowledge

Name	Country of origin	Present numbers (approx.)	Population trend	Descriptive and research literature
Romosinuano	Colombia	9 000	+	+
Senepol	U.S. Virgin Islands	3 000	+	0
San Martinero	Colombia	4 000	+	+
Cuban Criollo	Cuba	4 000	0	0
Mocho Nacional	Brazil	?	-	+
Yacumeño	Bolivia	30 000	-	+
Chaqueño 1/	Bolivia Argentina	10 000	0	0
Casanareño	Colombia	17 000	-	0
Llanero	Venezuela	20 000	0	+
Curraleiro or Peduro	Brazil	500	-	+

1/ There is an effort to select Chaqueño Criollos for milk in Sauzalito, Argentina.

0 = static      0 = scanty or nil  
+ = increasing    + = fragmentary  
- = decreasing   ++ = ample

Table 2 LOWLAND TROPICAL BEEF CRIOLLOS Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Romosinuano	2 1/	3 2/	2 3/
Senepol	0	3	3
San Martinero	1	1	0
Cuban Criollo	2	2	0
Mocho Nacional	1	0	1
Yacumeño	0	2	0
Chaqueño	1	0	0
Casanareño	0	0	0
Llanero	0	1	0
Curraleiro	1	0	0

1/ 0 = none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

#### 4.1.1 Romosinuano

Origin, location and adapt ability - The Romosinuano derives its name from the plains of the river Sinú where it evolved, in the northern humid tropical coastal plains of Colombia, as well as the fact that it is polled (Romo). It is a breed capable of producing early maturing beef on an all-pasture regime, is tick resistant and heat tolerant. When first recognized, it was thought to be exclusively adapted to the humid and sometimes swampy coastal plains of northern Colombia with over 1 700 mm of fairly well distributed yearly rainfall. But it has extended its foothold recently to less fertile regions with poorly distributed rainfall, or a prolonged dry season, though the same total or even more water may fall in the rainy season.

Distinguishing characteristics and performance - Very short legged, pale red hair predominating though some individuals are dark red, a uniform unbroken coat colour with pigmented skin that may be either red or black. A definite beef type with wide loin and long wide rump in the best individuals. Two of its most valuable characteristics are tameness and high fertility. Data from Colombia (Hernandez et al., 1971) demonstrate attainment of calving intervals of 373 days in 1835 observations with 54.3 percent of them being below 365 days. In crosses with other breeds and breeding groups it has repeatedly produced higher calving and rearing percentages than Brahmans or zebu-derived beef breeds (though often but not always surpassed by hybrid cows of these breeds). Low milk yield of the purebred cows is probably related to their high fertility, weaning weights are therefore relatively low individually but weaning tonnage from the whole herd is high. Weaning weights of calves at 210 days rarely surpass 190 kg for males with averages of 170 and females reaching 170 and averaging 156. Weaned at 240 days, males have averaged 220 and females 190. At 18 months males have been equal to Brahman herd mates with 285 kg, while F1 hybrids at the same age have reached 310. Very acceptable carcasses are obtained from liveweights of 350 kg at 24 months on all-grass green-year-round pastures. Average mature weights of cows are at 470 kg and bulls 700 kg. Evidence for heterosis for beef production in crosses between Romosinuano and zebus is well documented with increases of 22 percent in post weaning weight gain over parental average (Hernandez, 1978b).

Related and similar types - Fairly identical to the Senepol of the US Virgin Islands of St. Croix. Also similar to the Mocho Nacional of Brazil.

Conservation status - The breed was threatened through absorption by zebus due to the success of the hybrids. A preservation herd was maintained by the Colombian Government at Monteria, Sinú, but was not very successful in improving performance or expanding numbers. Since 1958 a policy of lending groups of 25 cows and two bulls to interested farmers, though slow to take hold, has been very successful. A breed association was formed in 1976 with interested breeders increasing every year, and herds established outside the original home of the breed.

The "Asociación Colombiana de Criadores de Ganado Romosinuano" has its address in Bogotá, Apartado aéreo 4255, Colombia and keeps track of about 9000 animals in its books as live breeders in 1985.

The experiment station of the OAS at Turrialba maintains a herd of 150 cows and is promoting the formation of several satellite herds of private breeders and the Costa Rican Ministry of Agriculture. A herd is under formation from that stock in Mexico.

Source of breeding stock and germplasm - CATIE at Turrialba, Costa Rica has a programme of selection on total performance of cows and on weight gains of pasture fed young bulls. Frozen semen is available locally and for export. The Costa Rican Ministry of Agriculture has maintained a registry and freezes semen from its best bulls.

Ideas about its future - The breed no longer has a threatened status and has moved into development wholly supported by breeders in Colombia and the same is expected to occur in Costa Rica, with valuable assistance from experiment stations. It has affirmed its worth mainly due to its demonstrated high fertility under tropical grassland conditions. However it requires more use of gain tested bulls particularly in Colombia where too much emphasis on shows has prevailed. The relatively small original numbers, before expansion, guarantee uniformity but there is danger of excessive breeding. The great similarity that it has with the Senepol of St. Croix would speak for the advantage to both breeds to break away from inbreeding danger with an exchange of germplasm. This would be beneficial to both populations.

Key references - The popular literature of Colombia abounds with articles and photographs but factual data on performance is limited (Pinzon, 1984; de Alba, 1984).

#### 4.1.2 Senepol

Origin, location and adaptability - Derives its name from the belief that some cattle from Senegal were incorporated into its breeding, and the fact that it is polled. It is claimed that N'Dama blood came from Senegal, yet the only existing photograph of that importation shows animals with zebu characteristics, which are not evident in the present day Senepol. It is also known that in the heyday of the sugarcane plantations during the Danish rule in St. Croix, many cattle were brought as draught animals from the small island of Viquez, between St. Croix and Puerto Rico. These cattle were Criollos and it is from them that the Senepol inherited various traits that make it similar to the Romosinuano: wrinkles around the eyes, or on the forehead in some animals, scanty tail switch and long rumps with abundant muscling. Pastures have been improved recently in St. Croix and great uniformity has been attained in the island herd. Well adapted for beef production under lowland tropical conditions.

Distinguishing characteristics and performance - Darker red than Romosinuano, short legged, prominent vertebrae in tailhead associated with ample birth canal. Red or black pigmented skin, short haired, tail switch very short, as in all tropical Criollos, either black or red, ears very small but pointed in some individuals denoting some zebu genes. Abundant data will be available since the local experiment station is interested in bull testing and semen has been exported for crossbreeding studies at the USDA station in Brooksville, Florida. Interest has spread to southern US breeders.

Conservation status - A breed association has been formed in St. Croix and interested breeders have sprung up in southern US and some semen has been exported to Mexico. It is well on the road to rapid expansion.

Source of breeding stock and germplasm - Frozen semen is available from the experiment station in St. Croix, 00850, US Virgin Islands, and the breed association has exported breeding animals.

Ideas about its future - The breed dominates all breeding on the island of St. Croix. It has nevertheless a narrow genetic base, exchange of semen with Romosinuano would benefit it as well as keeping intact its tropical adaptability, which maybe is lost in the more temperate mainland US. Tests for the presence of the zebu "Y" chromosome should precede its use on the Romosinuano.

#### 4.1.3 Romana Red

This a beef breed derived from crossbreeding of Criollo cattle of the Dominican Republic with old importations of zebras other than Brahman. It was relegated to second place by the originators, the Romana Sugar Company when the popularity of the Brahman made its mark. But the early Romanas which were developed for draught were kept separated. Renewed interest on the part of the Company has sprung up. They are generally red with black markings, rather long legged. Some data reveal that they are more fertile than the rest of the cattle on the large farms. Very few breeders exist outside the Sugar Company.

#### 4.1.4 San Martinero

Origin, location and adaptability - This is an improved breed of the Llanos of Colombia. It owes its name to the town of San Martin where Jesuit fathers gathered some Llanero cattle and made some attempts to improve ranching practices with the available stock. Some Durham bulls were imported into the area about 100 years ago. Tradition holds that they perished very quickly but left a few offspring from which the San Martinero evolved. They have a good record on poor soils and long drought periods reaching higher weight for age than zebus or common Llanero cattle under harsh tropical conditions.

Distinguishing characteristics and performance - Hair is longer than in the Romosinuano and not exclusively red, but dun and black-marked cattle are common. The bone frame is taller and more sturdy than in other cattle of the Llanos, though horns and small ears are very similar, but it has a more abundant and longer tail switch. Bulls when well fed reach 700 kg and cows, though extremely variable, range from 380 to 450 under grassland conditions at the end of the rainy season. When fed in dry lot, steers were surpassed in liveweight gains by zebus but hybrids of the two breeds were superior to the parental average at 32 to 34 months of age (Fajardo et al., 1976a and b; Arango, 1976b) with 12.7 percent for liveweight and 13.3 percent in heterosis for warm carcass weight when pure San Martineros weighed 425 kg, zebus 472 and the hybrids 509 kg. Yield of boneless beef was 136, 160 and 180 kg respectively.

Conservation status - As with the Romosinuano a preserved herd has been maintained by the Colombian Government at Iracá in the Llanos, near San Martin. Not much progress has been attained but breeders are now interested and a breed association has been organized, with some 4000 individuals initially counted prior to formal registration.

Sources of breeding stock and germplasm - The breed lacks sufficient records to guarantee selection of superior animals. All stock has been confined to the distant Llanos though some individuals are kept on and off at the highland station of Tibaitatá, where semen is sometimes frozen.

#### 4.1.5 Cuban Criollo

The Cuban Criollo was originally selected as a dual purpose animal with some breeders emphasizing beef and others milk. Recently all breeding has been in the hands of the government with emphasis on beef since little or no milk records have ever been published. It shows some recent admixture of zebu blood in most individuals, though it is predominantly of Spanish origin. Bulls can reach an impressive tonnage in liveweight. They are predominantly dun coloured with red and black skin, short haired, but not as short as in the Romosinuano or Dominican Milking Criollo, its close neighbour. A well documented description is not available, though there are abundant short references in popular literature. Few technical writers have visited the herds kept under government auspices where it is said that selection is being carried out for rate of gain; dry lot feeding is common.

#### 4.1.6 Mocho Nacional

A Criollo breed of Brazil, red, hornless, somewhat smaller than Romosinuanos. The name is mentioned for the sake of completeness and its similarity already mentioned to the Romos. It suffered from lack of foresight and nil contact with farmers of a preserved herd gathered at Nova Odessa, Sao Paulo in 1911 (Jordao, 1956). Too much attention was given to the finer points of a presumed pure type, and the small group soon became inbred. Presumably it had been important in the 19th century. It seems that it can be considered almost extinct by now. A new effort to establish a government herd has been undertaken in 1985 by EMBRAPA, Brasilia.

#### 4.1.7 Criollo Yacumeño

Origin, location and adaptability - This ecotype evolved in the Beni region of Bolivia, on tropical lowlands little known or visited by the Bolivian technicians or visitors from outside the country. It has gained recognition largely through the observations made on a large beef producing establishment (Estancias Eisner) and the association between a dedicated manager and a sound geneticist adviser. Some of the work has been published (Plasse et al. , 1975; Bauer et al., 1976, among others). The most striking find has been the hybrid vigour measured for growth and weight gained in crosses with zebus (Bauer, 1973). Also, the purebred Yacumeño has gained a name for itself as an efficient producer under harsh conditions through early results on a selected elite herd. The name comes from the river Yacumá which has its source in swampy lands partly drained by the river Beni, west of the Yacumá, which passes by, coming from the higher Andes, with both rivers following different courses towards the Amazon. The average altitude is 200 m, and temperature 27 C with rainfall accumulating 1800 mm between October and March and practically nothing between April and September.

The breed is thus adapted to extensive ranching, poor soils and alternating periods of excess rainfall and extreme drought.

Distinguishing characteristics - The breed comes in a variety of solid colours with dun and red predominating; is horned, black-hoofed with short hair; tail and head markings may be black or red, skin is pigmented. More has been published about its performance than its appearance or external variability, a rare case for Criollos.

The selected herd has been created with fertility and breeding performance as its goals. Bulls are produced from this herd as well as from a Nellore herd of Brazilian origin for a criss-crossing programme that involves some 30 000 cows. The selected group of Criollos is made up of a herd of 500 cows obtained by carefully examining records and palpating for pregnancy in an original lot of 6000. This work was started in 1961. By 1974 the selected group showed decided advantage in the number of pregnant cows palpated after a restricted breeding period, with a remarkable 95 percent, followed by the halfbreds (F1s with Nellore) that reached 86 percent. The non-selected Criollos were inferior to these two groups, though more fertile than many other populations, with 75 percent, and were ahead of a group of 1474 purebred Nellores that showed 71.5 percent. In a study involving 15 838 steers coming from commercial crossbreeding and excluding products from the purebred herds the carcass weight averaged 248 kg from F1S when the average was 230 and the non-selected Criollos yielded lighter carcasses. The tropical world looks forward to more advanced results and the use of these improved Criollos by other regions.

Conservation - The ecotype would have been threatened with extinction were it not for the work of Bauer and Plasse. At the moment it constitutes one of the most promising sources of improved tropical beef cattle germplasm. The selected herd of 500 cows will produce all the bulls needed for criss-crossing within the corporate farms; larger numbers will be needed for sale and establishment of other nuclei.

Source of breeding stock and germplasm - At the moment the only source is with the home herd. It is logical to expect, if the work is adhered to for another 10 years, that the improved Yacumeño will constitute a logical source of improved germplasm for all lowland beef production in the tropics. The Colombian and Venezuelan Llanos, the Chaco and headwaters of other Amazon rivers may well look upon the Yacumeño as a source of improved beef Criollos.

Key references - Besides those cited, Bauer has produced a mimeographed description of the Yacumeño, available through Bernardo Bauer, K. Estancias Eisner, Casilla 2, La Paz, Bolivia.

#### 4.1.8 Minor groups of tropical Criollos utilized for beef

Under this heading are grouped poorly characterized ecotypes that are found in several regions of South America. Descriptions are brief since they have not appeared in technical publications. Indiscriminate

crossbreeding and poor contact or identity of owners as interested breeders make the knowledge very fragmentary; some are still numerous and others threatened with extinction.

Chaqueño - Is a group that has survived the rigours of the Chaco region of Bolivia and Paraguay. In what respect they differ from neighbouring types is not known. The Bolivian Government has shown recent interest in establishing a preserved herd.

Casanareño - Derives its name from the Casanare river in the Colombian Llanos; it is logical to think that it is a close relative of the Llanero Venezolano since there are no natural barriers between their respective areas of origin. They come in all colours, always solid with pigmented skin, a few "barrosos" or blue-gray and very few blacks. In colonial times and early 19th and 20th centuries they were milked during the rainy season and were the source of a Llanero cheese that was marketed in the 19th century and has now disappeared with the emphasis on beef production. Their value lies in the fact that they are still abundant (a recent estimate places them above 17 000) and in their ability to produce hybrid vigour with zebus. Its whole area of occupation is under very poor management. Its value and worthiness of preservation seems to be much in doubt particularly if the San Martinero of the same region continues to make progress at the level of breeder organization.

Criollo Llanero - Very similar to the Casanareño, again not much known about it. They are very much present in Venezuelan literature and folklore. A whole system of land use in the Llanero society developed with them. They were milked seasonally in the past. They appear briefly in the scientific literature through the work of Plasse and his colleagues through work carried out at Calabozo, Venezuela (see A.L.P.A. Mem. 1974, 3: 46, 47, 48, 61, 90, 91). Weight at birth was 25 kg for both sexes combined, growth under irrigated savannah pastures was 603 g when Brahmans reached 660 g; weight at 18 months for both sexes again was 420 kg when Brahmans reached 465 (out of purebred cows, but representing crosses with different bull breeds). The F1 heifers out of Criollo cows surpasses averages of the parents with a daily gain of 703 g and weight at 18 months of 497 kg. In this small sample of data, the story repeats itself of the superior hybrid obtained from a very unimproved Criollo when mated with zebus, Brahmans in this case. The data is more surprising with age at puberty, seldom mentioned in this review of known performance, as determined by palpation, of the first corpus luteum. It appeared at 681 days in the Llanero, 730 in, the Brahmans, and 672 (22 months) in the F1 heifers.

The measurement of heterosis was possible in some of these studies and given by Plasse et al. (1974) as 20 percent for birth weight; 6.74 for daily gain before weaning and 8.97 percent for weight at 205 days and 17 percent for weight per day of age up to 18 months. Ordonez and Plasse (1971) took 26 measurements on 43 Llanero cows and give an average adult weight of 371 kg, with corresponding linear measurements confirming that it is a small breed, but fertile and capable of raising superior F1s in outcrosses. There seem to be no interested breeders or government scheme to preserve them or improve their qualities and like the Casanareño is threatened with extinction. If interest is found it should merge efforts with the Casanareño and Yacumeño.

Curraleiro or Pé-Duro of Brazil - This was a very abundant ecotype in Brazil prior to the arrival of zebus (Alves Santiago, 1960). The zebu expansion in Brazil is well documented: few samples came early, starting in 1813 from India, Africa and even Madagascar. In 1890, 200 animals arrived from Mysore, 150 in 1906, 200 in 1908 and 5000 between 1910 and 1955. The multiplication of these massive importations and a policy of grading-up to zebus wiped out the Curraleiro, and everybody forgot that the early fame of the imports owned half its merit to the mother cow. A few attempts have been made to establish preserved herds, but with little support over the years. The most recent has involved the Research Organization of EMBRAPA at a station in Teresina, Piauí, Brazil. It is hard to find animals of any merit in a few scattered remnants. It could benefit from the introduction of semen or bulls of better organized breeding seeking the same aim: a sturdier beef type Criollo destined to be used commercially for crossbreeding with zebus. Certainly the Yacumeño and San Martinero should be

considered, as it should specialize in fertility and growth. A brief reference by de Carvalho (1985) from Piauí serves to identify the recently formed herd.

#### 4.2 Mountain Ecotypes - Lessons in Poorly Understood Preservation and Improvement

There are numerous Criollo nuclei that inhabit mountain slopes up to 4000 metres in altitude in the high Andes of Ecuador, Peru and Bolivia, parts of Argentina and Chile, and at lower altitudes, down to 3500 in Colombia or lower in Venezuela, Guatemala and Mexico. They are generally long-haired and much smaller than some of the improved Criollos of lower altitudes in the same countries. Their claim for survival is the fact that they contribute an important component of the limited welfare of the poverty stricken local populations. In the higher altitudes their immunity to chronic mountain sickness speaks also in their favour against "exotic" improvement schemes. Their productivity is low and scarcity of forage resources makes their substitution by larger, quicker growing or more demanding types virtually impossible or unadvisable. They are called Chusco or Serrano cattle in the high Andes, unspecified Criollos in southern Mexico. Some are even found in the high altitudes of Pico Duarte in the Dominican Republic and, as in the case of the Mexican or Guatemalan cattle, no local name is given to them.

Their improvement or preservation is enigmatic and challenging. Some areas of Peru have utilized Brown Swiss in organized ranches, but the usefulness of a larger framed animal for the poor peasants is very much in doubt. In Mexico much capital was spent on an ill-advised programme of preservation of Criollos of Chiapas. Some of the mountain types were confounded with lowland types and were managed with supplemental feed at great cost. Some were crossed haphazardly with bulls of no known qualities and even with imported semen (of all things with the Salers breed from France on the argument that they were also red). The demise of this programme is not missed, but the money spent will never be recuperated.

Three distinct Criollo groups are included under this heading: the Longhorns, the Frijolillo of Lower California and the Argentine Criollo. As a group they differ radically from the tropical types in having longer hair and a long and abundant tail switch whereas most of the Criollos of the tropical lowlands have very short hair and a very scanty and in extreme cases non-existent tail switch.

#### 4.3 Temperate Climate or Subtropical Criollo Ecotypes

Table 3 MOUNTAIN AND TEMPERATE CLIMATE CRIOLLOS  
Location, Population Trend and Knowledge

Name	Country of of orgin	Present numbers (approx.)	Population trend	Descriptive and research literature
Chuscos,	Ecuador			
Serranos,	Peru			
Criollo de las	Bolivia			
Sierras and	Mexico			
Highlands	Guatemala			
	Venezuela	2 000 000	-	0
Longhorn	U.S.A.	3 000	+	+
Frijolillos	Lower			
	California	5 000	-	0
Argentine				
Criollos	Argentina	2 000	+	+
Blanco				
Orejinegro	Colombia	4 000	-	+

0 = static      0 = scanty or nil  
+ = increasing    + = fragmentary  
- = decreasing    ++ = ample

Table 4 MOUNTAIN AND TEMPERATE CLIMATE CRIOLLOS  
Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Chuscos, Serranos			
Criollo de las Sierras			
and Highlands	1 1/	0 2/	0 3/
Longhorn	1	1	3
Frijolillos	0	0	0
Argentine Criollos	2	2	3
Blanco Orejinegro	1	1	1

1/ 0= none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

#### 4.3.1 Longhorns

This ecotype is of great historical interest, though it has a potentially secondary role as a modern producing breed (Dobie, 1941). Only recently it has been recognized as a satisfactory meat producer. The natural grasslands of Texas, New Mexico and Oklahoma provided ideal conditions for the livestock brought by Coronado in 1540. Between 1866 and 1890 the railheads of the expanding eastern US railways provided markets and originated the famous cattle drives that added up to ten million head driven overland. When the railways were extended to the home of the Longhorn, the cattle drives were no longer necessary. On the return from markets the cattle cars brought Hereford, Shorthorn and later Aberdeen Angus bulls ready to displace the Longhorns with the backing of eastern finances and breed organizations to promote them. By 1925 the Longhorn had almost disappeared.

When the wildlife refuge was founded in the Wichita Mountains of Oklahoma, on 59 000 acres, only two head were found within (Williams, 1957). Funds were appropriated to stock the park and only 30 head were approved as phenotypically "Longhorn" among 30 000 head inspected in remote ranches of Texas and Oklahoma as well as Louisiana. They were taken to the refuge and numbered 300 within 30 years. A few breeders, among them the King Ranch, also took up the idea of preservation for sentimental reasons, as no productive qualities were recognized in the Longhorn. Mounting of horns or heads of steers with very widely spread horns became a fashionable decor for ranches, restaurant or hotels of the West. The Longhorn has returned, through that route, to some degree of popularity and, as is often the case, some important productive qualities are beginning to be recognized: their fertility, mothering ability and their ability to make a good living totally unaided by husbandry in desert grasslands. It is emerging also that their hybrids can be more productive than some of the purebreds of British origin that displaced them. Results of experiments now underway are anxiously awaited. Longhorn numbers are on the increase in the hands of fanciers more than producers though. A breed association has been formed and frozen semen is available from large distributors.

#### 4.3.2 The Frijolillos of Lower California

Related to the Longhorns, they have been isolated in a harsher environment than that of the US western plains. Lower California is a very dry peninsula with many areas receiving less than 100 mm of rainfall per year, but it is full of thorny shrubs, saguaros and some small trees and sources of water are few and far between. Ranching has never been prosperous and always poorly organized. These cattle do not have particularly large horns like their US relatives. They are called Frijolillos more in Sonora than in their native peninsula, because of the high frequency of peculiar coat colours sprinkled with very small irregular spots that resemble a native pinto bean. Steers and bulls coming out of this desert are appreciated by fattening pens since they can show compensatory growth and attain over 400 kg on short sojourns in confinement. They have been subjected to a few studies and much has been said in Sonora and Lower California about conservation, but not much done.

#### 4.3.3 The Criollos of Argentina

Origin, location and adaptability - The story of the Argentine Criollos is the southern counterpart of that of the Longhorns in the north. They multiplied and provided the basis for a huge export industry of beef, first dried and then chilled or canned. They were totally dominant over the Pampas and north to the Chaco where this commerce flourished and produced money so that Shorthorns, Herefords and more recently Aberdeen Angus could be imported in large numbers. A few were early preserved in a small pasture commemorating the work of a writer who is dear to Argentine literature, Ricardo Güiraldes, at Pagos de Areco in Buenos Aires province. They are adapted to fend for themselves and were never completely replaced by British breeds in the drier part of Tucuman.

Distinguishing characteristics - These cattle are strongly built, big framed with fat steers attaining 500 kg. They come in many colours and have a particularly long tail switch, with cows in the habit of resting their coiled tails on their own loins. Some detailed studies have been published under the authorship of Dr. Sol Rabasa of the Institute of Medical Research in Rosario, Argentina. Most of the recent studies are confined to one herd at the experiment station in Leales, Tucuman.

It is encouraging for the practical application of the breed in the future that research results obtained under well managed artificial pastures in the station at Balcarce, south of Buenos Aires (Molinuevo and Miquel, 1979) that F1 calves obtained from Argentine Criollo sires on Aberdeen Angus females were quicker growing than contemporary purebred Aberdeen Angus: birth weights of 72 Aberdeen Angus were 27.6 kg when F1s weighed 30.1 kg, for males the corresponding averages for females were 27.6 and 28.1 kg. At weaning hybrids outweighed purebreds (A.A.) by 6 kg in males and 8.4 kg in females. In adults sexual dimorphism is shown by large bulls outweighing cows by more than 300 kg (Rabasa).

Conservation status - The Argentine Criollo has emerged out of a threatened status to a period of expansion and potential utilization in modern beef production. A breed association has been formed with a very enthusiastic following, and has its headquarters at Rosario.

#### 4.4 Blanco Orejinegro - Unique Case of a Breed Founded on External Parasite Resistance

It is difficult to classify this breed under the group of beef producers or milk producer, or separated from temperate climate adapted Criollos. It is a mountain breed, but not of high altitudes. Its producing ability is lower than many of the better types of Criollos yet it deserves very serious consideration for its resistance and in some individuals total immunity to attacks of external parasites.

Origin, location and adaptability - The breed originated on the slopes of the Colombian Andes that have a mild climate and are heavily populated by an external parasite that produces suppurative sores where more vector flies are attracted to deposit more larvae and the sore may increase on susceptible animals to harbour 400 parasites in one huge lump. This is the Tropical Ox Warble, also known as Nuche, Tórsalo, Berne etc. (*Dermatobia hominis*). The slopes of its home grounds are very steep, perennially overgrazed and covered by short *Paspalum* grasses and some important tiny legumes. Pastures are green almost all the year round, one factor very much to the liking of the skin parasite, since there are two distinct rainy periods per year. This is where the northern winds that originate in Canada die out as they sweep south across the Gulf of Mexico and the Caribbean to dissipate their moisture against the first solid obstacle of mountains, the north face of the Colombian Andes.

These intricately woven mountains were taken over by the very fast expansion of coffee growing in the early 19th century. This brought wealth and purchasing power to a scattered population in the Departments of Antioquia and Caldas. Commerce developed before the coming of the railways (which have never been too successful in Colombia). Mules were scarce, so the Blanco Orejinegro was trained as a beast of burden and its appreciation rose in the eyes of the whole population since other cattle could not carry any loads if their backs, or sides at the rib cage were covered with Nuche sores. Even the red Criollos from the North Coast, partially resistant, could not be used. The surefootedness of the Blanco Orejinegro, and docility made them ideal for the purpose. Furthermore the small coffee grower could keep a few cows fed on nothing but an enlarged corral and gleanings from the coffee rows or pruning from the shade trees. His deficient diet of expensive rice was well supplemented by the little milk he could obtain from white black-eared cows.

Distinguishing characteristics and performance - The Blanco orejinegros possess the strongest, tightest, toughest and thickest hide known to the author in any bovine. The hide is totally pigmented jet black and the hair is medium to short and white, except for the ears and extremities. This is the product of the dominant white gene

on a black self-base, often not homozygous, giving origin to whites with red ears (foolishly referred to by semi-technical writers as the red mutation of the breed). It is the same combination of genetics of coat colour that give rise to the White Park Cattle of Great Britain as well as some individuals of the Fjallrasse of Norway. This only proves that gene versatility for coat colour of bovines is very old; it provided good material for Mendelian segregation and changes in gene frequency that were beneficial to the adaptability of this naturally evolved breed for the circumstances of the middle mountains of Colombia. The gene can as easily be found in the genome of a unique Criollo adapted to a parasite infested country as in the shaggy cold tolerant breeds that have an otherwise totally different genome. It should be stated that the partially dominant white is rare in other populations of Criollos, but not unknown. The author has seen and photographed individuals in Yucatán, Mexico, and Mr. John Cypher, professional animal photographer for the King Ranch, was kind enough to donate to me a picture of a white bull with black ears he saw near Managua, precisely in the regions in which I had told him all Criollos were either red or dun only.

The dominant white is incompletely dominant and never affects the ears which are jet black. It is also incompletely dominant because in crosses with solid coloured breeds the white is less extended in the extremities. There is a variety called "Azul Pintado" much favoured by some Colombian breeders which has abundant "flea bitten" small black spots giving the bluish appearance. But the black and white hairs mingle little so that the meaning is not synonymous with that of the Belgian Blue which has different genes in operation.

Only one work has been located by the author that proves that the immunity to Dermatobia is real. Colmenares (1961) classified the cattle found at the Nus experiment station (that included some crossbreds) at the time, by the number of parasites they carried in one season. It is well known of course that parasites are more abundant in some months. He found no difference between the black-eared and blonde-eared animals. These are referred to as Blanco Orejimonos, from the Colombian meaning of "mono", which besides monkey, means blonde human beings. In 873 individuals examined 575 or 66 percent were totally free of Dermatobia and for the whole population an average of 4.8 parasites were counted per individual. Of 21 Jerseys none were totally free and they averaged 27 parasite counts per head. In 194 halfbreds of the two breeds the average count was 22 larvae per individual. It is not stated whether all animals came from the same pasture.

Crossbreeding studies for beef production - In one trial at El Nus 225 BON cows were divided so as to produce comparable numbers of offspring from the service of three bulls each of the BON, zebu or Charolais breeds. The results are presented in table form for birth weight and weaning weights at 270 days (Rodriguez et al., 1971).

	Birth weight kg		Weaning weight per day of age, in grammes	
	Males	Females	Males	Females
Pure BON	28	26	780	560
F1 with zebu	36	32	830	800
F1 with Charolais	33	31	850	770

It is interesting to note that there was no significant difference for the two types of F1s for weaning weight but birth weight was greater for the zebu crossbreds, an unexpected result. The coat colour of the F1s is also of interest. With zebus the extension of the dominant white was reduced and with Charolais the dilution gene gave rise to "barroso ears" and equally black diluted small spots on legs and neck.

Fattened F1 steers and bulls (in dry lot) marketed at 30 months of age gave the following results in liveweight, kg (Arango, 1976a).

	Bulls	Steers
Charolais x BON	542	526
Zebu x BON	558	504

Studies on milk production improvement of the BON have been done in crossbreeding with Jerseys. These studies have been greatly hampered by poor planning in relation to milk let-down without the calf. The BON is particularly difficult to milk without the calf by its own inheritance as well as by cows having been used that had not been trained before or selected for easier let-down. The milk improvement brought by the Jersey was not utilized to produce a better milking strain within the BON, one trait that the coffee peasant is sure to have appreciated.

Conservation status - There is a breed association of BON breeders and with the proven local adaptability, experimental results and popularity of the breed with small producers its future should be assured. Such is not the case. The experiment station has wavered too much in its goals and sporadic trials on beef or milk as the specialized future of the breed. It is not very valid also from the lack of contact and interchange of genetic material with the small producers who need the breed for their own household needs. The association, with headquarters in Bogotá, is made up of larger producers. How to improve the BON for the future is still an enigma..

Sources of stock and germplasm - About 3080 head are presently recognized by the association, but large numbers in the hands of the small coffee planters may be still in existence. Frozen semen could be obtained from the Ministry of Agriculture from bulls at El Nus with no particular performance known.

#### 4.5 Tropical Milking Criollos

A single heading is chosen for a group of similar ecotypes, though each evolved in a different country or region. Most of them have been pursuing similar goals and the existence of a few performance records has made interchange of bulls and semen across countries a reality, though it has not reached large-scale programmes for farmer-breeders. In all cases the environment in which the ecotypes developed was a similar lowland tropical environment, with varying length and severity of dry season and total annual rainfall ranging from 1500 to 2500 mm. Summer temperatures reach a maximum of 38 C and external parasites are always ever present, particularly ticks of the geni *Amblyomma* or *Microplus*. Some areas have mild numbers of *Dermatobia*, but certainly not as severe as in the areas of prevalence of the Blanco Orejinegro. All have a history of empirical selection for milk production under tropical grassland conditions and seasonal production of cheese, which has been dwindling in the past decades. The similarity is greater among the ecotypes derived directly from Dominican or Caribbean Criollos; in that respect the Caracú of Brazil is a bit apart; though similar in appearance it evolved from Portuguese imports. For the sake of brevity some headings will treat several of the ecotypes together. The Criollo group has the most abundant literature.

Table 5 TROPICAL MILKING CRIOLLOS  
LOCATION, POPULATION TREND AND KNOWLEDGE

Name	Country of of orgin	Present numbers (approx.)1/	Population trend	Descriptive and research literature
Central American	Nicaragua			
	Honduras	1500 2/	0	++

Dominican	Dominican Rep	2000	0	+
Limonero	Venezuela	3000	0	++
Barroso	Guatemala	1000	0	+
Costeño con				
Cuernos	Colombia	500	-	+
Chino Santanderano	Colombia	1700	0	0
Harton del Valle	Colombia	5500	-	0
Lucerna	Colombia	2000	0	+
Santa Cruz	Bolivia	1000	+	+
Caracú	Brazil	6 000	+	+

1/ Breeding cows.

2/ Includes herds in Costa Rica and Mexico.

0	=	static	0	=	scanty or nil
+	=	increasing	+	=	fragmentary
-	=	decreasing	++	=	ample

Table 6 TROPICAL MILKING CRIOLLOS  
Conservation and Improvement

Name	Preserved herd(s)	Performance and/or frozen semen	Breed association
Central American	3 1/	3 2/	0 3/
Dominican	3	3	0
Limonero	3	2	3
Barroso	0	0	0
Costeño con Cuernos	1	0	0
Chino Santandereano	1	0	0
Harton del Valle	1	0	0
Lucerna	0	2	0
Santa Cruz	3	2	0
Caracú	1	1	0

1/ 0 = none; 1 = isolated, academic; 2 = yields research data; 3 exchanges knowledge and germplasm with breeders.

2/ 0 = no data; 1 = sporadic measurements; 2 = continuous measurements; 3 = frozen semen with sound genetic background.

3/ 0 = none; 1 = inactive; 2 = active and expanding; 3 = active and interested in performance.

#### 4.5.1 Milking Criollos of Central America and Venezuela

Most of the data and observations presented come from either the Turrialba herd or the one started at Maracay and now near Carrasquero in the department of Zulia in Venezuela. The latter is in close contact with farmer-breeders in the area. Turrialba is in a climate which is more humid and with more rainfall than the area where most farmer-breeders were who supplied the foundation stock. Germplasm has gone from Turrialba to Venezuela, but unfortunately no way has been found for the opposite to take place on account of foot-and-mouth disease in South America and not in Central America or the Caribbean islands.

Origin, location and adaptability - Two strongholds of the ecotype are recognized, one in Rivas, Nicaragua and another in the area of Rio Limón in the Goajira of Venezuela. It was from Rivas that the first outstanding animals originated that were sent to Turrialba. The beginning of that story is described in a publication by de Alba and Carrera (1958). Rivas was the home of the most outstanding breeder of Milking Criollos, D.N. Joaquin Reyna. This herd survives to this day in the hands of his widow. Important references and research results related to the Turrialba herd are given in a more recent bulletin (de Alba, 1985).

Rivas is in the strip of land that separates Lake Nicaragua from the Pacific Ocean. It rises from sea level to the average altitude of lake Nicaragua which is 40 m. It has a rainy season that adds up to 1500 mm and a dry season of almost zero precipitation from January to April. Mean monthly temperatures above 25 prevail for 8 months of the year. The climate is not very different from that which prevails in other areas of the Pacific side of Central America where similar ecotypes are found in Choluteca, Honduras and in Guatemala where the Barroso breed is found. The climate is also similar in the Goajira of Venezuela. However irrigation is common in most ranches of the Rio Limón.

The herd at Turrialba is located in a more humid climate, with total rainfall averaging 2800 mm and a very short dry season, but high relative humidity, reaching 100 percent for many days, acid soils and heavy infestation of *Dermatobia* as well as ticks and internal parasites.

The experimental herd was founded in Turrialba in 1950 with animals imported from Rivas (before the discovery of the Reyna herd) which supplied most of the later imports as well as 33 cows that came from Choluteca in the Honduras (de Alba, 1985). The Venezuela herd was founded following the recommendation made in a study of the Venezuelan Livestock Industry (Morrison et al., 1954) and housed initially at Maracay. The foundation animals came "From Rio Limón and Goajira peninsula on the Colombian border; in 1956 the herd was enriched with the purchase of 11 cows and one bull from D.N. Joaquin Reyna and 1968 saw nine Turrialba bulls sent to the herd that was located by then in the Rio Limón area. The story of the Venezuelan Milking Criollos and data from the experiment stations are well documented and summarized in two publications (Abreu et al., 1977 and Rios et al., 1959) ,

A herd in Tampico, Mexico, that is beginning to yield results was founded in 1965 with 18 cows of the then deceased D.N. Joaquin Reyna and two bulls from Turrialba. Semen from Turrialba was utilized to produce the first generation of selected Milking Criollos in Santiago, Dominican Republic and important work has been carried out in Santa Cruz, Bolivia, based on locally selected cows, that includes comparisons and crossbreeding with Brown Swiss (Wilkins et al., 1984).

Distinguishing characteristics and performance - Solid colour with or without markings, very short hair, pigmented skin, wrinkles in the hide around the eyes, neck and in extreme cases very unique wrinkles in the forehead and poll. Very short tail, scanty switch.

Birth weights of males and females respectively at Turrialba were 29 and 26 kg in one sample and 26 and 25 in another. In Venezuela these were 28.3 and 26.1 kg. Weights of cows at Turrialba: of Rivas origin 430, of

Honduras 356. In Venezuela, first calvers weighed 366 kg, and for second, third and fourth 406, 442 and 462 kg.

Superior fertility. In Turrialba 834 calving intervals averaged 383 days; in Venezuela the interval was 413 days in one sample, when contemporary Brown Swiss in the same environment averaged 448. In Turrialba, 1.58 services per conception when contemporary crosses of Swiss x Zebu averaged 1.63; in Venezuela 1.45 when contemporary Brown Swiss averaged 1.94. In Venezuela 169 purebred Criollos in private farms averaged 367 days for calving interval when on the same farms those with apparent recent admixture of European dairy breeds averaged 381 days. In Caroa, again in Venezuela, where a new breed has been proposed based on Milking Criollo x Brown Swiss, cows predominantly Criollo averaged 439 days when those predominantly Brown Swiss averaged 453.

Age at first calving. In Turrialba 35 months, when contemporary jerseys in the same environment and management calved at 34 months of age. In Mexico purebred Criollos calved at 38.9 months when groups of Jersey and crosses with Brown Swiss averaged respectively 29 and 43 months.

Milk production . In Turrialba in a final assessment of performance including 2 300 lactations accumulated from 1954 to 1981, 305-days 4 percent fat corrected milk yield was 1627 kg when comparable Jerseys produced 2035 kg per lactation and F1s (2 reciprocals) averaged 2240 kg. In Venezuela, on breeders' farms Milking Criollos averaged 1670 kg, when comparable cows with evidence of recent European dairy breed crossing averaged 1849 kg, and mixed undefined crosses produced 1685 kg. Butterfat percentage at Turrialba was 4.57 when Jerseys produced 4.53 and hybrids 4.6. In Venezuela the average percent butterfat for first lactation was 4.62 in Milking Criollos when comparable Brown Swiss gave 3.91. Percent protein in the foundation herd at Turrialba was 3.56 while contemporary Jerseys gave 3.39.

Calf mortality . Studies have been limited, and little data has been gathered on private farms. In tropical lands calf mortality is generally very high, particularly when artificial rearing is practised, reaching easily 40 percent. This is one reason for milking with the calf being still favoured even when milk pricing is favourable in respect to beef prices. In Venezuela, under artificial rearing and an initial period of confinement comparable data between Milking Criollos and Brown Swiss shows: a total loss in relation to number born of 16.7 percent for Milking Criollos and 32.3 for Brown Swiss. In relation to the total lost in both breeds, neonatal losses accounted for 31.8 percent in Brown Swiss and 12.5 in Criollos, respective percentages in confinement to 7 months were 25 and 25.5 and at 18 to 12 months (when calves were exposed to ticks) 43.2 and 31.2 (Bodisco and Carnevalli, 1960).

Resistance to ticks and Dermatobia . In Turrialba, foundation cows from the Reyna herd had 10.9 ticks and 2.3 Dermatobia per monthly count on a 10 x 10 cm area in the scutcheon and ribside, and 4.0 and 1.5 for cows of Honduran origin, when Jerseys showed 21.8 and 10 (respectively for ticks and Dermatobia).

Heat tolerance . Climatic chamber studies at 40.5°C after exposure for 6 hours showed rectal temperatures for Criollos as 39.7 C when Jerseys were 40.3 and Ayrshires 40.9; in the same trial Holsteins averaged 40.2 while halfbred Brown Swiss x zebu were showing 39.7 C. In Venezuela no difference could be found in loss in milk production, following a very hot day, in Criollos compared with Brown Swiss, but cows were receiving concentrate feeding in relation to initial production. On dry cows observed on pasture, Criollo cows (sample of only 4) showed 29.6 bites per minute when Brown Swiss averaged 24.6 in March; and in September comparable figures were 19.4 and 16.6. From observations made on respirations per minute (5 cows each breed), Criollos in March were breathing at 44.6, while Brown Swiss were at 56.8 and respective figures for September were 43 and 61 respirations per minute (Castillo and Bodisco, 1964).

Crossbreeding results . At Turrialba (de Alba and Kennedy, 1985) halfbreds (with Jersey) outproduced both parental breeds exhibiting 22 percent heterosis for one lactation. The difference in favour of F1s increased with accumulated lifetime production reaching 93 percent heterosis. Production was lower in the back crosses than in F1, though the 3/4 Jersey was superior to the 3/4 Criollo. Results with crosses with other breeds show the same tendency, though comprehensive studies with valid purebred controls are few. The results from Bolivia with Brown Swiss constitute the best planned work now in progress.

#### 4.5.2 Additional notes on related types

Though most of the experimental data quoted comes from Venezuela and Costa Rica, and mention has already been made of the herd in Mexico, note should be made of other distinct Milking Criollos that although short on experimental results may become more important in the future if they manage to stimulate interchange with local farmers.

##### Dominican Milking Criollos

These are ancestrally the parent stock from which all Caribbean cattle on the islands or mainland descended. Yet very little has ever been recorded about their history or performance. They suffered the invasion of zebus and specialized dairy breeds early in the 20th century and were on the verge of extinction. A survey made under the auspices of FAO prior to writing a UNDP project (Petersen et al. , 1972) included in its recommendations that something should be done about gathering some very outstanding dairy type Criollos that had been seen in the central and northern regions visited. The idea was taken up by a Civil Development Society in Santiago and largely through the efforts of the farm manager, Emilio Olivo, a herd of 100 purebreds and 65 grades was assembled. By 1981 there were enough lactation records to select dams from which to produce bulls. The herd is being perfected through a registry scheme in joint effort with the Ministry of Agriculture and Criollo breeding on private farms is now in progress.

##### Costeño Con Cuernos

This is a group of northern Colombia that has suffered the consequences of conservation schemes followed with few input ideas and burdened with bureaucracy, and is almost extinct. The existence of some superior lines of Milking Criollos in the lower Magdalena valley and the Goajira has historical evidence with the existence of a local cheese industry of a primitive nature, particularly on the island and near the town of Mompos. A preserved herd was assembled by the Ministry of Agriculture in about 1950 in Valledupar, close to the area where cows for the Venezuelan project were bought. The herd moved to Tolú Viejo which the author visited in 1954. Some excellent individuals were seen. The herd was later moved to Monteria where more qualified personnel could take charge, yet records were very fragmentary and the appearance of the herd had deteriorated by 1970. No systematic use of records has ever been made for the purposes of selection for milk production. It is estimated that in all Colombia only about 571 individuals remain, and the area surrounding the experiment station is wholly interested in beef and no interested breeders have been contacted to look for a brighter future.

##### Chino Santandereano

An ecotype of the Department of Santander in Colombia, with more mountainous topography than the area of the Costeño. It is similar to other Milking Criollos, the word Chino being applied to its characteristic of having very short hair. A preserved population nucleus is now being formed and breeder interest seems to be awakened and some 1700 individual animals have been located.

##### Harton del Valle

This is a Criollo ecotype of the middle Cauca valley which lies at a 1000 metre altitude. It was much appreciated by early milking enterprises and some breeders maintained that it was a more economical producer

under all-grass feeding than imported dairy breeds. The Breeder Organization known as Fondo Ganadero del Valle has recently decided to push more energetically an old preservation project and carry out selection, as there are no reliable local records by which bulls can be selected. Results are not available. Some 5500 individuals are estimated as remaining.

#### Lucerna Cattle

The Harton went into the formation of the emerging breed which under the name of Lucerna has been developed by members of one family. It may be important in the future if more nuclei are created.

#### Barroso

This ecotype is particular to the western coast of Guatemala. It has been improved on one farm near Chiquimulillas by the Melgar family, and some scanty data published. For the last few years it has benefitted from irrigated pastures. It is a larger framed variety of the Nicaraguan Milking Criollo and of a different coat colour, diluted black, very much like the one seen in the first cross between Charolais and Angus. The dilution gene is fairly common in red populations giving rise to duns, or yellows. Occasional Barosos are encountered in other countries, and the double dilution which gives rise to white of a very different genetic nature than the one found in Blanco Orejinegro, is seldom seen. Lack of continuous milk recording halts progress of this fine herd.

#### Milking Criollos of Bolivia

This ecotype was discovered by John Wilkins who conceived the idea of gathering outstanding cows in a breeding project initially sponsored by the British Council in about 1970. The project has been making steady progress since its foundation. Since no records could be found on the purchased cows or the first generation offspring, the purebred herd has been developed from inseminations with semen from Turrialba and from the Reyna herd in Rivas (processed at Turrialba). Contact with farmers gives a bright outlook to this project.

#### Milking Criollos of Honduras

The Honduras Milking Criollo went into the formation of the Turrialba herd with purchases from Choluteca, and many outstanding cows located in other areas, but impossible to transport with the money available at the time. The breeders in Choluteca have disappeared. But the ecotype is mentioned because of a recent attempt to gather a herd at La Ceiba, by a local branch of the National University.

Source of breeding stock and germplasm . The Reyna herd has been regarded as the most reliable source of superior milking stock since 1950. It still deserves that distinction. But in the days of A.I. it is more logical to obtain semen from Turrialba, from sons of cows with a long milking record history. The Venezuelan project has been slow in supplying semen from superior bulls and also in the incorporation of superior bulls from its milk recorded farms. Semen is now available from CATIE in Turrialba, CAMPA in Tampico and from CIMPA in Santiago, Dominican Republic.

#### 4.5.3 Caracú

This is the most noteworthy Criollo breed of Brazil. It was known to early writers on the Brazilian animal production scene. A description appeared in the first issue of the Brazilian "Revista do Dpto NI de Produção Animal (Lopez, 1934). A preserved herd at Nova Odessa in Sao Paulo was the subject of a review by Pacheco Jordão (1956) with some fine animals found there in 1958 by the author. But this preserved herd suffered the consequences of extreme preoccupation on the part of technicians with the pure line and no emphasis on performance. Furthermore the preserved herd lost contact completely with the few remaining private breeders and ended up as an extremely inbred, zoological curiosity. Fortunately for the breed a large estate at Pocos de Caldas kept and improved the breed for milk production and as draught animals for coffee plantations. Though the selection has been rather empirical it is obvious that some progress has been attained and recently has been

the subject of genetic studies under the pen of Dr. Jonas Pereira and a complete set of articles is in preparation. A new breed association has been organized and the breed seems now on the road to recovery.

The Caracú is generally dun coloured with bulls exhibiting darker brown on head and shoulders, some individuals being totally red. Fine legs and ability to cover much ground in grazing hilly country are among its qualities. Milk production for some of the dams of bulls has been above 3200 kg under grassland conditions, though the herd averages so far known are quite variable and below 1200 kg. Liveweight in bulls ranges from 500 to 680 kg and females from 380 to 500.

Source of breeding stock and germplasm . Though a breed association was founded at Nova Odessa in 1949, and a register undertaken, starting with the preserved herd which had been started as early as 1908 (Jordão, 1949), it was obvious by 1960 that the private herd of the Carvalho Dias family at Pocos de Caldas had made more progress in developing a productive type. Breeding stock can be obtained from that source. Other breeders have now been recognized and hopefully performance records will officially appear in the future.

## 5. SUMMARY AND CONCLUSIONS

Brief descriptions of the origin, location, characteristics and conservation status of 31 Criollo ecotypes, of which some eight can claim to be true breeds (with a breed association or close contact between several breeders) are presented separately for each ecotype. Of these, 12 are classed as beef producers and another 12 as milk producers, 3 as mountain types and the Blanco Orejinegro standing alone for its unique resistance to external parasites; all these ecotypes are within the tropical zone, and the list is completed by three that are north or south of it and thus in the temperate zone. Preservation schemes have played a major role in the understanding of these breed types in some cases but have been very detrimental to improvement in several cases. The experiment station approach with goals of proving qualities and defects by research methodology has been more fruitful. Where the data justify the effort for productive purposes the next necessary step is of course to stimulate farmer-breeders to take the initiative beyond the confines of the experimental herds. Crossbreeding has proved to be both a blessing and curse of the Criollos. Unfailing and very high heterosis has been proven in all crosses between Criollos and zebus for beef or Criollos and specialized European dairy breeds for dairying. But haphazard crossbreeding beyond the F1 has proven much inferior; so it is proven that the original Criollo stock must be on hand to repeat crossings with pure and better bulls obtained through performance testing which has been the weakest point in all ecotypes,

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## **L IMPROVEMENT IN THE TROPICS - THE PROGRAMMES FOR INDIA**

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### **1. INTRODUCTION**

India is the seventh largest country in the world. It is well-marked off from the rest of Asia by mountains and the sea, which give the country a distinct geographical entity. Bounded by the great Himalayas in the north, it stretches southwards and at the Tropic of Cancer, tapers off into the Indian Ocean between the Bay of Bengal on the east and the Arabian Sea on the west. It covers an area of 3 287 263 sq. km. The mainland lying entirely in the northern hemisphere extends, between latitudes 8°4' and 37° 6' north and longitudes 68°7' and 97°25' east, and can be categorized under four well-defined regions as, the great mountain zone, plains of Ganga and the Indus, the desert region and the Southern Peninsula. The climate broadly is tropical monsoon type with four distinct seasons which are winter, summer, rainy and post-monsoon. The rainfall is ill distributed and varies from place to place and year to year. The total cropped area is 175 million hectares while only 38 million hectares are under irrigation.

India is predominantly an agricultural country with about 70 percent of its population dependent on income from agriculture. Most of the land is used for cereal production and a negligible portion (around 4 percent) is

under permanent pastures and grazing land. Indian agriculture depends mostly on cattle to meet its draught requirements. Bullocks supply the motile power for ploughing, lifting water from wells and transport needs in the rural areas for crushing sugarcane and oil-seeds and for a variety of other purposes. Cattle also provide milk and milk products for human consumption thus meeting part of the need for animal proteins of high biological value for the human diet.

## **2. CATTLE NUMBERS AND THEIR TRENDS**

According to the 1982 livestock census, there are 182 million cattle and 79 million buffalo which produce around 31.8 million tonnes of milk annually against the requirement of 54 million tonnes to feed the human population of 712 million at the recommended level. The deficiency in milk production is not caused by lack of cattle numbers, but more so by their low level of production. Low productivity is mainly due to large incidence of disease, inadequate nutrition, hostile climate, unorganized breeding, social unawareness of economic benefits and non-commitment to social change in the society.

The livestock trends indicate that the cattle population has increased by 15 percent over the 1959 base. The corresponding increase in the human population during the same period was 79 percent. The population of working bullocks has also increased over the years in spite of the use of fossil energy for agricultural operations suggesting increased usage of bullock power in agriculture. The total area under permanent pastures and grazing land as percent of the reporting area has, however, slightly gone down from 4.2 percent in 1970-71 to 4.0 percent in 1978-79. These trends suggest that more and more land is being used for cereal production for human use and that the feed resources for livestock are likely to be further reduced. There is thus an urgent need to reduce cattle numbers to match existing feed resources and improve the quality of our cattle both in respect of their milk production and draught capacity.

## **3. CATTLE RESOURCES**

There are 26 well-defined breeds of cattle which constitute around 18 percent of the total cattle population in the country. The remaining cattle populations have not yet been defined into breeds and are generally named after the area and habitat they occupy. The performance potential of these cattle is related to the economic needs of the area. These local cattle have a poor growth rate (100 to 150 g per day), later maturity (age at first calving, 60 months) and low milk production (500 kg in a lactation). In any programme of improvement they form the core for action. The defined breeds can mainly be classified as milch, dual purpose and draught type. Some of the important ones are Sahiwal, Red Sindhi and Gir - milch type; Tharparkar, Hariana, Deoni, Ongole, Rathi, Kankrej and Goalao - dual purpose; Kangayam, Hallikar and Khillari - draught type. The age at first calving in these breeds ranged from 40 to 50 months except in Hariana where it was slightly higher. The calving interval was between 15 and 20 months. The milk yield, barring a few breeds like Sahiwal, Red Sindhi, Tharparkar and Gir, where was more than 1500 litres, in all others was below 1000 litres in a lactation. The milk yield per day of calving interval ranged between 1 and 4 kg. There are no breed societies which register animals, maintain herdbooks and ensure purity of breed and its improvement.

Most of the cattle breeds that exist today have been evolved over centuries due to large variation in soil, climate, agricultural practices and through natural selection mostly for adaptation to agro-climatic conditions, survivability and to a very limited extent these have been selected for milk for draught quality. These breeds have considerable adaptability to harsh climate, poor nutrition and possess good resistance against certain animal diseases and are economically well suited to the areas where they exist. Experimental evidence shows that zebu cattle have lower metabolic heat production which suits them well in hot climates and makes them a comparatively better utilizer of low quality roughages. It is for these qualities that some Indian breeds have been used in crossbreeding in Latin American countries, Australia and southern parts of United States to evolve breeds

for beef and dairy production. Improved zebu breeds, viz. Gir, Kankrej and Sahiwal, have been bred and raised in Brazil, West Indies, Australia and Kenya as purebreds for milk and meat.

#### **4. HUSBANDRY AND MANAGEMENT PRACTICES AND EXISTING INFRASTRUCTURE**

Animal husbandry is a normal adjunct to crop agriculture and cattle are kept for milk production and for motile power for various farm operations, village transport, irrigation and production of manure. The animals are generally maintained on agricultural byproducts and crop residues. Animal rearing is done mostly by small and marginal farmers and landless labourers with a holding size of 2-3 animals per farm household. Average land holding with these owners is very meagre, being 1/2 to 2 acres. This is the kind of input available in most of the areas.

Animal husbandry is a state subject; health and breeding aspects of cattle are looked after through a network of veterinary hospitals and artificial breeding centres. A veterinary surgeon is the focal point around whom most animal improvement programmes are centred. In most of the planned improvement programmes, this focal point has been given the main responsibility of artificial insemination and field recording of data. Supplementary staff in the form of animal husbandry specialists, livestock assistants and field supervisors are provided to implement the development programmes. An artificial insemination network is used for dissemination of superior sires of temperate dairy cattle through crossbreeding to increase milk production. In order to meet the semen requirement, sires of temperate dairy breeds are maintained at the main germplasm units which also have the facilities of deep freezing of semen. Improvement in cattle production is also directed at improvement through feeding, generation of marketing facilities, advisory services and veterinary aid including artificial insemination.

Institutional structures funded by the government also exist. These maintain herds of cattle which act as nucleus or multiplier herds for purposes of training and research in various colleges and universities. Some farms have been established with the purpose of producing quality bulls and undertaking progeny testing programmes for some important indigenous breeds. Large government herds like military dairy farms also exist for commercial milk production. These herds are used for spreading superior germplasm to rural populations for improvement of their native cattle. This is the kind of structure that exists today on which any breeding plan has to become operational.

#### **5. PROGRAMMES OF IMPROVEMENT**

The breeding policy to begin with was to improve the defined indigenous (both dairy and draught) breeds through selection and local cattle through grading up with superior indigenous breeds. This was done through a number of cattle development programmes such as the key village scheme, hill cattle development programme, Goshala development and Gosadan schemes etc. In 1961, the animal husbandry wing considered the need for an effective and rapid increase in milk production in cattle and set up a working group to review the cattle breeding policy in the country. The working group examined the cattle breeding policy followed in each state and recommended broadly a revised policy for achieving increased milk production. The policy envisaged a) crossbreeding of cattle with exotic breeds in areas having local cattle, b) selective breeding among improved indigenous purebreds and c) grading up of local with improved indigenous breeds. It was suggested that the bulk of exotic inheritance should come from Jersey; Brown Swiss and Holstein might be tried to a limited extent. Simultaneously, attempts were to be made to provide suitable inputs.

According to the revised breeding policy, extensive areas were to be covered by such recognized dual purpose and dairy breeds as Hariana, Tharparkar, Gir, Sindhi, Sahiwal etc. To achieve the ultimate objective of raising the quality of cattle, both in regard to milk production and draught, it was thought necessary to undertake

production of a large number of superior bulls, preferably progeny tested or pedigreed, of these breeds of cattle for extensive use through natural and artificial breeding and for future replacement.

Scientific programmes, to improve the productivity of the native breeds, were initiated and a number of farms of these breeds were established for production of superior quality bulls. The bulls produced were far below the numbers required for the development programmes. Bulls at these farms were selected on the basis of breed characteristics, body conformation and milk yield of their dams wherever available. Examination of records of these farms, in general, does not show any significant improvement in production over the years. It was, therefore, decided that infrastructure should be developed to test the bulls on the basis of their daughters' performance before they are used in developmental programmes. Accordingly, progeny testing programmes for some of the improved indigenous breeds, like Tharparkar and Red Sindhi under centrally sponsored schemes and Sahiwal, Hariana and Gir, under the state sponsored schemes were initiated. Results of these schemes were not encouraging mainly because of the small herd size used. Non-existence of deep freezing facilities at these farms also contributed to the failure of these schemes because by the time bulls became available after test, they were too old to donate any semen.

A fundamental change has taken place in the cattle development programmes since the formulation of breeding policy. Crossbreeding, which was to be taken up in a restricted manner, and in areas of low producing cattle, has now spread indiscriminately all over the country including the tracts of well established improved indigenous breeds. The country since then has advanced in the area of deep freezing of semen and use of liquid semen is being replaced by frozen semen. Large-scale crossbreeding programmes are being undertaken through programmes such as intensive cattle development projects, Operation Flood and other bilateral projects. Due to the energy crisis, there is a belief that animal power should be developed on scientific lines. In view of these changes, it is essential that a fresh look at the cattle breeding policy of the country be made.

The major strategy for development of indigenous cattle for milk has been to crossbreed with improved European dairy breeds. Initial crossbreeding attempts were not encouraging because of diseases such as rinderpest and other such killer diseases. With the control of these diseases with prophylactic vaccines, planned crossbreeding experiments with various Euro-American breeds (Holstein, Ayrshire, Jersey, Guernsey, Red Dane, Brown Swiss) were taken up in different parts of the country. Crossbred grades with different levels of exotic inheritance from one or two exotic breeds have been produced and their performance tested under different agro-climatic conditions. The following conclusions emerge from these experiments:

- i. Exotic inheritance of around 50 percent is the most ideal for growth, reproduction and milk production, and the yield in higher crosses falls short of theoretical expectations. The grading up, therefore, to a total replacement of genes will not lead to higher production in cattle (Taneja and Bhat, 1972; Bhat et al., 1978a, b; Taneja et al., 1979; Rao and Taneja, 1982).
- ii. The crosses of temperate with improved indigenous breeds (Sahiwal, Red Sindhi, Gir, Tharparkar) attained the same level of performance under uniform feeding and are superior to crosses from other native cattle.
- iii. Holstein crosses were superior to other temperate breed crosses for growth and production while Jersey crosses have better reproductive efficiency (Bhat, 1974, 1983).
- iv. Decline in milk yield from F1 to F2 generations on account of inter se mating among F1 crossbreds is small (Taneja and Bhat, 1978). The Targe decline in some experiments is due to poor quality of crossbred bulls used.

These results indicate that in areas with good feed resources, specially irrigated cultivated fodder, crossbreeding of indigenous low producing cattle with Holstein and stabilization of exotic inheritance at 50 percent through

inter-breeding and further improvement through selection may be adopted. Such crossbreds would produce around 3000 litres of milk per lactation and would have improved reproductive performance.

A number of breeds like Taylor, Jersind, Karan Swiss, Karan Fries and Sunandni have been evolved using crossbred populations as the base foundation. In addition, five crossbred genotypes (two and three breed crosses) with Hariana, Gir and Ongole as the indigenous breeds are under performance testing at five locations in the country under the All India Coordinated Research Project on Cattle. The three breed crosses with 75 percent exotic inheritance from two breeds have shown high potential for growth, reproduction and production under optimum input conditions and are under further testing. The work on their nutritional requirement and adaptation is in progress. These genotypes are also proposed to be used as a base for developing new strains of crossbred dairy cattle.

Most of these breeds have existed at the Institutional farms except Karan Swiss and Sunandni which have been developed using crossbreds available in the field. Field recording is not in practice in most parts of the country and, therefore, progeny testing is restricted only to Governmental/Institutional farms. This is a serious limitation in accurately assessing the sire values, and achieving the desired selection intensity because of the use of few sires. There is, thus, a need to produce crossbreds in larger numbers under field conditions. These animals should be identified, registered and breed societies formed which should take up performance recording and develop programmes for synthesis of the breed and its improvement.

## **6. CURRENT ACTION PROGRAMMES**

India is a vast country with a large variation in climate, agriculture and economic conditions. A large part of the area in the country is with low inputs and would, therefore, need well adapted indigenous breeds both for milk and draught animal power. Crossbreds have shown high performance where plenty of green fodder and other essential inputs like health care are available. The breeding programmes, therefore, for improvement of both indigenous breeds and crossbreds need to be drawn up. A system needs to be set up which would allow selection within the population to be effective. While developing strategies for genetic improvement, location specific parameters especially inputs have to be given first preference.

The indigenous breeds to be improved through selective breeding need to be identified. The magnitude to which these are to be used in grading up of local cattle and their numbers required should be worked out in detail so that appropriate programmes for their multiplication, improvement and production of quality bulls are drawn up. The existing set up of small independent farms of these indigenous breeds has not given desired results.

In order to overcome the problem of small herd size and make the within population selection more effective, the programme of associated herd testing has been introduced. This has so far been attempted for Sahiwal which is one of the high yielding dairy breeds of the Indian sub-continent. The breeding tract of this breed has now been left in Pakistan and only a few herds are available in India. The herd strength on most of these farms varies between 50 and 300. These farms were established with the purpose of producing quality bulls for use in the developmental programmes. Most of these herds did not register any improvement in milk over their period of existence. This was because of small herd size; use of sires selected on the basis of their dam's record and conformation resulted invariably in a negative genetic trend. It was observed, that only in a few herds was there an improvement in the milk yield over the years, which was due to use of sons of outstanding sires.

Initially nine farms covering a total population of around 900 Sahiwal animals were included in the associated herd testing programme. Most of these herds had varying levels of inbreeding ranging from 0 to 12 percent. The average milk yield in 305 days was around 1600 kg, body weight at first calving around 320 kg, mature weight of 360 kg, and the calving interval 450 days with herd life being around nine years. Semen of the first set of Sahiwal bulls was used in these farms during 1980-81. In the second cycle of mating, 8 Sahiwal bulls were

used. A number of daughters of these bulls have now become available at these farms. The programme is in its third cycle of mating. The progeny test information on the first set of bulls is likely to become available this year. It is hoped that 1 to 2 bulls from each set with 10-20 percent superiority over the herd average would become available. These bulls then could be used on existing farms and also in the Sahiwal herds in the country or outside for herd improvement and in designed matings for production of young bulls for use in progeny testing.

Recognizing the importance of indigenous breeds for draught power and the need for developing animal power on scientific lines, the Indian Council of Agricultural Research has initiated a much larger programme for Haryana and Ongole breeds. The major objective is to conserve and improve these breeds for milk and draught qualities. Haryana is a dual purpose breed and is widely used in the Indus-Ganges plains. Initially six breeding farms with a total population of more than 1200 Haryana breedable females were included in the programme. The semen freezing facilities are being developed at the Germplasm Unit at Haryana Agricultural University, Hissar. A total of 20 bulls coming from high yielding dams and selected on the basis of body conformation will be used in each cycle. The bulls will be brought to the Germplasm Unit and semen frozen for use in six herds. Each bull will be allotted 60 cows for breeding. The female progeny born will be raised at the respective farms for performance recording while 5 male calves each for breeding and draught (work) per bull will be brought to the Germplasm Unit. Draught studies on these selected bull calves will be made. Bulls will be finally ranked on the basis of their daughter's milk production and draught qualities of their sons and the top 2 to 3 bulls identified for use in production of future bull calves and improvement in the herds. Correlation between milk yield and draught power will also be studied. As soon as the programme commences, around 10 000 females registered with the Central Herd Registration scheme, operational in Rohtak, Ajmer, Mahendragarh and Bhiwani districts, will be involved in the programme. In addition, around 15-20 percent of total animals available with small and landless farmers could also be associated in the programme by developing the field recording system for progeny testing. The bulls, thus selected after the progeny test, will be used in the Haryana breeding tract and other adjoining areas where the Haryana breed has been used for upgrading the local cows.

A similar programme for Ongole has been proposed during the 7th plan. Ongole is a dual-purpose breed. Its breeding tract extends over parts of Krishna, Kistna, Guntur, Nellore and Vizagapatam in Andhra Pradesh. The centre of the Ongole area is embedded with rivers. The banks of these rivers form excellent grazing land, as due to the fear of floods they are less cultivated. Very few farms of this breed are available. However, a large number of animals of this breed are registered with the Ongole Breeders Association. The existing Ongole farms are being strengthened by adding more animals so as to have at least 800 breedable cows at the farms. The Ongole animals on the farms, and those registered with the breeder's association, are proposed to be involved in an improvement programme on the pattern suggested for the Haryana breed.

Some of the other well-defined breeds like Gir, Kankrej, Nagore and Rathi are being improved through the use of semen of selected bulls under various state developmental programmes. No crossbreeding is permitted in breeding tracts of these herds.

A number of breeds/genotypes, on account of crossbreeding, have been produced in the country. These have shown high performance under optimum inputs and are well adapted to local conditions. For the survival of these breeds, it is essential that these are multiplied and produced in large numbers under field conditions so that an effective progeny testing programme for continuous improvement could be undertaken. For this, the development of a field recording system is very important. In order to explore the factors affecting field recording, the Indian Council of Agricultural Research has initiated a project on "Standardization of field recording of performance data and its use in progeny testing". This project is operating at four locations in the country where they have a well-developed field recording system. A large number of crossbred genotypes with

50 percent exotic inheritance around these four locations are available. Emphasis is to stabilize around this level through inter se mating among crossbreds, followed by intensive selection.

Military dairy farms are a government organization having a very large population of Holstein x Local (Sahiwal, Red Sindhi, Gir, Tharparkar) crosses with 3/8 to 5/8 Holstein inheritance. These crosses have been produced as a result of continuous forward crossing to Holstein and backcrossing to indigenous breed bulls. These farms maintain more than 10 000 breedable crossbred females of the Holstein spread over different regions in the country. These facilities of men and material available at the military dairy farms are being used for developing a new dairy breed, 'Frieswal', by using Holstein x Sahiwal crossbreds as the base. Initially, 4000 Holstein x Sahiwal crossbred females at four large farms in northern India have been included in the programme. The objective is to stabilize the breed at 50 percent Holstein level. For this the elite Sahiwal cows available at the military dairy farm, Meerut, with a herd average of more than 3000 litres of milk are being used for production of crossbred bulls using semen of top progeny tested Holstein bulls. A total of 40 halfbred bulls (50 percent Holstein inheritance) are proposed to be used each cycle for progeny testing. Bull rearing and semen freezing facilities are being developed at the military dairy farm, Meerut. These facilities of military dairy farms will permit progeny test evaluation of large numbers of crossbred bulls. The semen of the tested bulls will also be made available to the developmental agencies. A series of crossbred strains/genotypes with high performance through these crossbreeding programmes will become available in the next few years.

The future emphasis on crossbreeding research in cattle would be to study the genetic aspects of production of crossbreds, effects of inter-breeding among crossbreds and to develop a suitable criterion for selection of these cattle for making further improvements in production and reproduction traits. This would require production of pedigreed progenies of large numbers of crossbred bulls, their performance recording and analysis of such records to obtain estimates of genetic and phenotypic parameters and their utilization for development of a selection criterion. This will also provide data for determining genetic merit of crossbred sires based on their progeny performance.

The programmes suggested for improvement of these indigenous breeds and synthesis of crossbred strains, if implemented with suitable financial inputs and technical manpower, are expected to improve substantially both the quality of draught animal power and milk yield.

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### **SAHIWAL IN KENYA AND PAKISTAN**

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1. The Sahiwal cattle are an international animal genetic resource able to contribute to many developing countries.
  2. Their ability to survive, produce and reproduce at medium levels of milk per lactation in tropical conditions makes them a valuable option to consider for crossing with lower producing indigenous breeds in the developing countries or for breed substitution.
  3. The countries with the largest populations are Pakistan (about 10 000 purebred animals), Kenya (about 2500 purebred animals) and India (about 2000 purebred animals).
  4. Many other countries have crossbred Sahiwal cattle, either produced from indigenous breeds or from black and white temperate cattle. The demand for these types of animals is increasing, shown by the growing demand for semen under the FAO semen donation scheme.
  5. The population of Kenya has recently been studied by a graduate student of the Kenya Government who has analysed the records from the Sahiwal stud at Naivasha from a genetic angle.
  6. FAO is currently supporting a similar genetic analysis of the Pakistan Sahiwal kept for many decades on the government livestock stations. This is being undertaken under contract for FAO by the Pakistan Agricultural Research Council in cooperation with the Swedish Agricultural University.
  7. It is hoped that the analyses of the Kenya and Pakistan populations may be combined at a later stage, in order to identify the genetic differences, if any.
  8. It is also hoped that a rational basis for using the limited numbers of this breed for the benefits of both the home countries and the importing countries may then be developed and be the means of accelerated genetic improvement.
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### **IMPROVEMENT AND CONSERVATION OF BUFFALO GENETIC RESOURCES IN ASIA**

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## 1. INTRODUCTION

The contribution of buffalo to the Asian agrarian economy is considerable by way of milk, meat and draught power production and as a source of security that requires minimum inputs. The domesticated buffaloes in Asia, representing 98 percent of the world buffalo population, are broadly grouped as the river and swamp types. The former which constitute approximately 69 percent are found predominantly in the Indian subcontinent. In India they supply 59.3 percent of the total milk produced.

The multipurpose swamp buffalo (30 percent) predominates in other parts of Asia especially China, Indonesia, Philippines, Thailand and Vietnam providing draught power and meat in rice growing areas and milk in other regions. The Mediterranean type predominant in west Asia, represent about 1 percent. The buffalo distribution in Asia is given in Table 1 by country. It is sufficient to mention here that the wild buffalo such as Anoa of Celebes, Tamarao of Mindoro and the Ami or Indian wild buffalo do exist and could provide potential genetic resources for further investigation.

Table 1 BUFFALO POPULATION IN ASIA BY COUNTRY, 1984

Country		Population (x 1000)
West	Asia	
	Iran	230
	Iraq	140
	Syria	3
	Turkey	758
South	Asia	
	Bangladesh	1 750
	Bhutan	28
	India	64 000
	Nepal	4 400
	Pakistan	12 777
	Sri Lanka	951

East	Asia	
	China	19 196
South	East Asia	
	Brunei	15
	Burma	2 100
	Indonesia	2 391
	Kampuchea DM	600
	Laos	915
	Malaysia	255
	Philippines	2 900
	Singapore	2
	Thailand	6 150
	Vietnam	2 664
	Total	122 225

Source: FAO

The trends in the growth of human and buffalo populations in Asia are given in Figure 1. There is a steady increase in the human population while that of the buffalo is not sustained at a similar pace. Buffaloes produce 45 percent and 31 percent of all milk and meat produced in 1984 by large ruminants in Asia, respectively (FAO statistics).

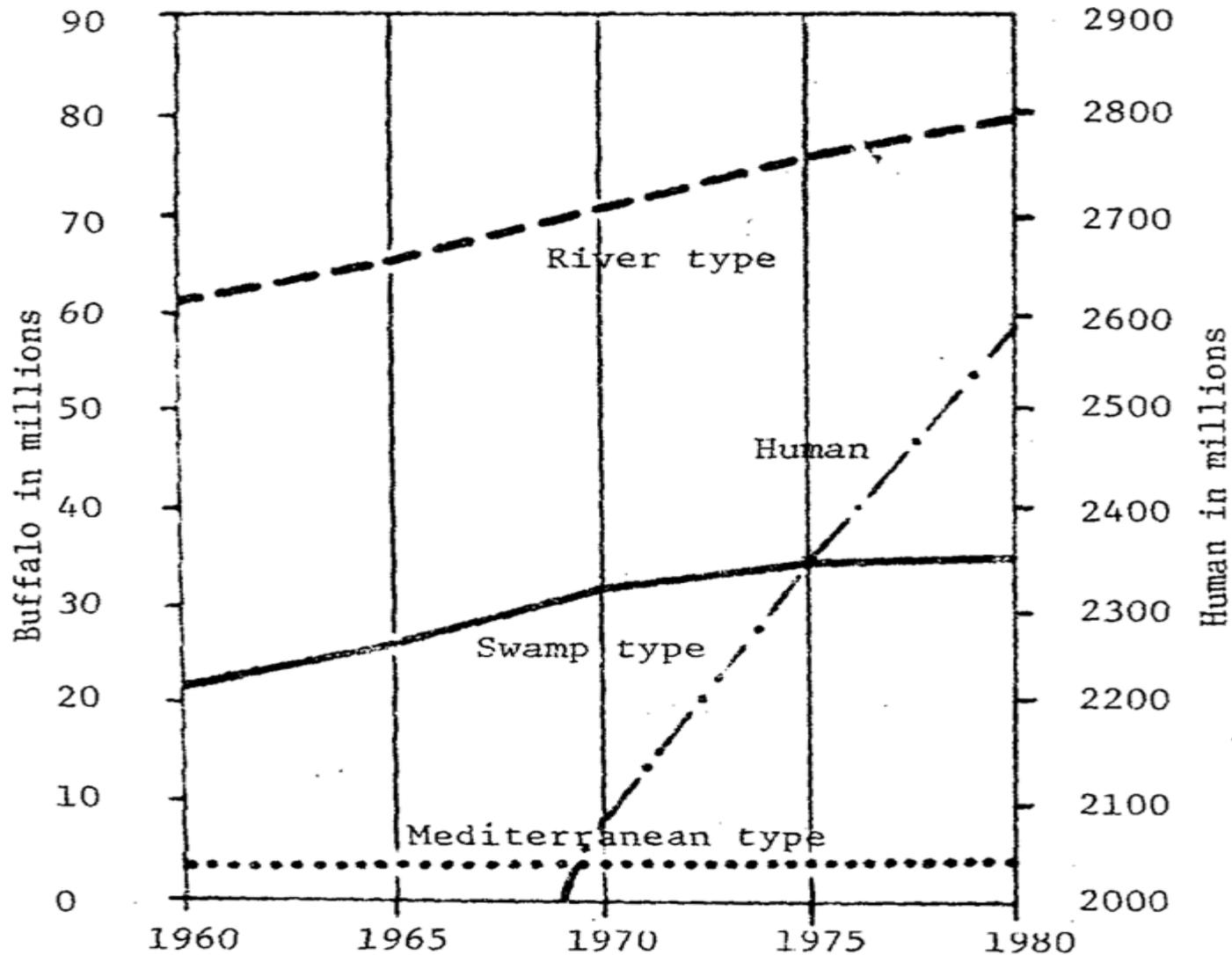


Figure 1. Trends in buffalo and human populations in Asia (Adapted from Mahadevan, 1983, Proc. Preconf. Syrap. of the 5th World Conf. on Anim. Prod., Tsukuba, Japan and FAO, Production Yearbook 1970-1983).

Buffaloes have been domesticated over several centuries. However, they have been subjected to genetic manipulation such as selection and crossbreeding only during recent decades. By virtue of the fact that it is often considered a neglected species, much of its genetic variation may not have been lost except through natural selection in the domestic environment. However, two areas of concern need to be mentioned. Firstly, a complete documentation and evaluation of the variability and characterization of the various breeds and strains are lacking. Secondly, the animals, the swamp type in particular, are being displaced from their traditional ecosystems due to changing farming practices, agricultural intensification and inadequate allocation of multiplication facilities. These problems are worsened by their low reproductive rates.

This paper is mainly concerned with the potential of the buffalo germplasm which is the basis for improvement, effective methods of conservation and utilization and constraints of buffalo rearing in Asia. This will be discussed under the following headings:

## 2. Buffalo Performance Characteristics

- 2.1 Milk yield and length of lactation
  - 2.2 Weight characteristics
  - 2.3 Size characteristics
  - 2.4 Carcass characteristics
  - 2.5 Breeding efficiency
  - 2.6 Draught characteristics
- 3. Genetic Improvement of Buffaloes
    - 3.1 Selection for size
    - 3.2 Breeding and selection for milk
    - 3.3 Breeding and selection for beef
    - 3.4 Breeding and selection for draught
    - 3.5 Multipurpose breeding strategies
  - 4. Crossbreeding River and Swamp Buffaloes
  - 5. Conservation, Improvement and Utilization
    - 5.1 Genetic conservation - why?
    - 5.2 Genetic conservation - how?
    - 5.3 Improvement within conservation
  - 6. Conclusion

## **2. BUFFALO PERFORMANCE CHARACTERISTICS**

The potentials for improving the river and swamp buffaloes depend on the existing genetic variability within and between breeds, standards of health, feeding and management and infrastructure for recording of production data. A considerable amount of evaluation or documentation studies or both have been reported on buffaloes under varying environments. A brief review of the various production traits is given below only to show overall characteristics of the buffalo breeds.

### **2.1 Milk Yield and Length of Lactation**

Milk is an important source of animal protein (including essential amino acids), vitamins and minerals. Efforts to improve buffaloes and cattle have been undertaken in many developing countries where the rural poor are largely dependent on livestock. A summary of yields of buffalo breeds is presented in Table 2.

The river buffalo, extensively used in the Indian subcontinent for milk production, has a production average between 1181 kg to 1934 kg with lactation lengths ranging between 283 and 313 days. The most widespread breed is of the Murrah type which has also been exported to several southeast and east Asian countries for crossbreeding with swamp buffalo. The latter breed, rarely used for milk production, produces less than 800 kg per lactation of about 250 to 330 days. Work on persistency and milk let-down in milch buffaloes is limited. It is a usual practise to allow calf suckling for about 30 to 40 seconds before milking to initiate milk let-down. Whether this is really necessary needs further investigation. Table 3 shows overall averages for buffalo milk constituents. Fat percent ranged between 7 to 10 with a mean of 7.5 amongst dairy breeds. Values for swamp buffalo were within a similar range but only a few samples were available. These values for buffalo are more than double that of cattle for which the mean is 3.7 percent. Protein percent is also higher than for cattle where mean is 3.5. The calorie value of buffalo milk is 31.5 percent higher than that of Bos taurus cows such as Friesian and Guernsey (FAO, 1959).

Table 2 LACTATION MILK YIELD AND LENGTH

Country	Breed	Mean lactation		Source
		Milk (kg)	Length (days)	
India	Murrah	1 813	283	Bhat <i>et al.</i> 1980; Gill 1985; Mostager <i>et al.</i> 1981; Rao and Nagarcenkar 1977
	Nili-Ravi	1 765	309	Bhat <i>et al.</i> 1980; Rao and Nagarcenlcar 1977
	Bhadawari	1 181	276	Bhat <i>et al.</i> 1980; Rao and Nagarcenkar 1977
	Surti	1 934	313	Bhat <i>et al.</i> 1980; Rao and Nagarcenkar 1977
China	Swamp	778	293	Liu 1978; Cheng 1984
Malaysia	Swamp	245	240	Camoens 1976; Braend 1981
Thailand	Swamp	333	250	Chantalakhana 1975
Philippines	Swamp	490	245	Eusebio 1975; Rigor 1958
Sri Lanka	Swamp	355	248	Jalatge 1980; Wijeratne 1962
Nepal	Nepali	255	121	Keshary and Shrestha 1980
	Murrah	1 272	255	Keshary and Shrestha 1980

**Table 3 MILK CONSTITUENTS OF BUFFALOES**

Country	Breed	Fat %	Protein %	Total Solids %	Source
India	All	7.5	4.3	16.8	FAO 1959
China	Swamp	9.8	-	-	Cheng 1984
Thailand	Swamp	9.3	-	18.1	Chantalakhana 197E
Philippines	Swamp	9.4	5.2	20.4	Eusebio 1975

### 2.2 Weight Characteristics

Body weights at various ages of adult buffaloes are given in Table 4. Birth weight and subsequent weights are higher than indigenous cattle in these areas of Asia. Mature buffaloes over three years of age weigh between 450 and 800 kg. A number of comparisons have been made on weight gains between buffaloes and cattle, from which no definite conclusions could be made bearing in mind the low quality of inputs we need to consider reflecting the actual conditions of the smallholder farms. It is interesting to note here the trials of Shute (1966) in Trinidad where the daily gain of buffaloes was 0.21 kg compared to zero values for Jamaica Red cattle and Brahman cattle under poor pastures. The gains increased to 0.62 kg for buffaloes and 0.50 and 0.30 kg for the other cattle breeds respectively on moderate pastures.

Table 4 BODY WEIGHTS AT VARIOUS AGES (KG)

Country	Breed	Birth	6 mths	12 mths	18 mths	Mature	Source
India	Murrah	29	119	212	264	500	Bhat 1977; Randhava 1962
	Nili-Ravi	31	134	219	289	510	Bhat 1977; Randhava 1962
China	Swamp	34	167	250	-	577	Liu 1978
Malaysia	Swamp	32	138	204	281	-	Aman and Othman 1983; Camoens 1976 Liang <i>et al.</i> 1982
Thailand	Swamp	29	98	144	-	473	Chantalakhana 1975, 1981, 1984
Philippines	Swamp	28	88	121	141	463	Campos 1985
Sri Lanka	Surti	21	-	-	-	-	Thamothanam 1980
Taiwan	Swamp	-	-	-	-	425	Ma 1980

### 2.3 Size Characteristics

The milk buffaloes of India are strikingly larger than their swamp counterparts in east and southeast Asia where they are used for draught purposes as shown by the three body measurements in Table 5.

Table 5 BODY MEASUREMENTS

Country	Breed	Weight (kg)	Body length (cm)	Wither height (cm)	Heart girth (cm)	Source
India	Murrah	Adult	150	138	222	ICAR 1939, 1941, 1950, 1960
	Nili-Ravi	Adult	153	133	222	ICAR 1939, 1941, 1950, 1960
	Surti	Adult	141	128	188	ICAR 1939, 1941, 1950, 1960
China	Swamp	495	147	128	193	Liu <i>et al.</i> 1985
Thailand	Swamp	500	140	126	190	Chantalakhana 1975, 1981
Taiwan	Swamp	425	138	127	193	Ma 1980
Philippines	Swamp	Adult	-	128	197	Bacaiso 1951

#### 2.4 Carcass Characteristics

In Table 6 some characteristics of buffalo carcass are given. Most of the work has been concentrated on the swamp type. Dressing percentage in most reports is below 50 percent whereas in cattle it is usually a little above 50 percent. However, the Murrah buffalo proved to be superior in many carcass traits (Ognjaovic, 1974) including a dressing percentage of 54.7 percent. There are considerable differences between the swamp buffalo reports due to the wide differences between reports, in the methods of characterization of the various cuts, variation in feeding, age and sex of the animals and regional genetic differences within the swamp buffalo.

Table 6 CARCASS CHARACTERISTICS

Country	Breed	Trait	Sexes	Mean	Source
China	Swamp	Dressing percent	M,F,C	43	Cheng 1984
Thailand	Swamp	Dressing percent	M,F	46	Chantalakhana 1984, 1975
Philippines	Swamp	Dressing percent	M,F,C	45	Castillo 1975
Malaysia	Swamp	Dressing percent	M	47	Liang <i>et al.</i> 1982
Sri Lanka	Swamp	Dressing percent	M,F	51	Tilakaratne 1980
Taiwan	Swamp	Dressing percent	M,F	44	Ma 1980
China	Swamp	Bone percent	M,F,C	34	Cheng 1984
Thailand	Swamp	Bone percent	M,F	22	Chantalakhana 1984
Philippines	Swamp	Bone percent	M,F	25	Castillo 1975
Thailand	Swamp	Slaughter wt, kg	M,F	500	Chantalakhana 1975
Philippines	Swamp	Slaughter wt, kg	M,F	364	Castillo 1975
Malaysia	Swamp	Slaughter wt, kg	M	306	Liang <i>et al.</i> 1982
Philippines	Swamp	Carcass length, cm	M,F	115	Castillo 1975; Eusebio 1975
Malaysia	Swamp	Carcass length, cm	M	131	Liang <i>et al.</i> 1982
Thailand	Swamp	Hide percent	M,F	13	Chantalakhana 1975
Philippines	Swamp	Hide percent	M,F	12	Castillo 1975
Thailand	Swamp	2 Rib eye area, cm <sup>2</sup>	M,F	42	Chantalakhana 1984
Philippines	Swamp	Rib eye area, cm <sup>2</sup>	M,F	37	Castillo 1975

Thailand	Swamp	Loin eye area, cm <sup>2</sup>	M,F	42	Chantalakhana 1984

M = male, F = female, C = castrates

Ages range between 2-5 years.

A number of studies have compared carcass characteristics between buffaloes and cattle (Kissir *et al.*, 1969; Ognjanovic, 1974 and Charles and Johnson, 1972 and Charles, 1982) and showed only marginal differences in quantity and quality indicating that the buffalo has a potential role to play in the beef industry of Asia.

### 2.5 Breeding Efficiency

A major concern in buffalo production is its low reproductive efficiency. The oestrous cycle in buffalo is similar to that of cattle although their external manifestation is not as strongly expressed as in cattle. Peak luteal levels of plasma progesterone are lower (1 to 2.5 ng/ml) and occur later in the cycle (Kamonpatana *et al.*, 1979 and Jainudeen *et al.*, 1982).

Overall reproductive performance compiled by a review of references is given in Table 7. Age at puberty amongst swamp buffaloes was reported to be at 2.8 years and first mating usually after the third year. However, these values largely depend on management factors. Among Murrah buffaloes, first signs of heat were also observed at the age of 2.8 years (Bhattacharya, 1954). Late first calving age and long calving intervals are common. Longer calving intervals are frequent especially among the swamp types used for draught purposes because they are rarely exposed to bulls and pregnancy when having a suckling calf running along is considered a nuisance in the field. Oestrous cycle varies between 20 and 28 days with some variation in the oestrous duration. Postpartum oestrus and bull fertility are also largely affected by seasonal variations.

### 2.6 Draught Characteristics

The draught power of the swamp buffalo has been reported in various countries in southeast Asia and China (Table 8). They are often used in rice cultivation for ploughing. On the average they plough between 0.025 to 0.032 hectares of padi land per hour. Number of working days vary between two months and five months depending on the type of agricultural activity. Buffalo have been reported to be far superior to contemporary indigenous cattle in Taiwan (Ma, 1980). Buffalo can plough an area almost three times that covered by Yellow cattle per day. They also outlive their cattle counterparts by having a working life of 10 to 15 years compared to 6 to 12 years for cattle.

The primary function of the swamp buffalo as a beast of burden has been greatly reduced due to mechanization and the introduction of double cropping in Malaysia, China, Taiwan and Thailand. However, they are salvaged in areas where fragmentation of farms has led to small units as in Thailand and the buffalo remains a significant component. More recently, swamp buffalo are being used to haul bunches of fruit in oil palm plantations in Malaysia. They are superior to mini-tractors in that they could reach all points of collection even on difficult terrain.

## 3. GENETIC IMPROVEMENT OF BUFFALOES

More than 70 percent of buffaloes are nondescript and are in the hands of villagers. Genetic improvement could only be realized if there is a simultaneous alleviation of feeding and management standards including proper recording and AI or a superior bull distribution network on the ground. Objectives, in line with the envisaged

production system, should also be well defined. The buffalo indigenous to China and southeast Asia, covering a wide range of ecosystems, is generally grouped together as the swamp type although distinct types are recognized. The swamp buffalo has a multipurpose role and is usually confined to traditional farming systems. The relative priority of each role varies from region to region. It is important to identify those types of buffaloes that are more efficient in draught, beef production or adaptability so that breeding goals can be more precisely defined.

Recently in 1984 ACIAR organized a workshop on the evaluation of large ruminants for the tropics in Rockhampton (ACIAR, 1984). It was obvious, also in the case of the present review, that the information available was scanty and 'disconnected' in the sense that no breed could be meaningfully characterized and its potential compared with other breeds of buffaloes. It is useful to mention here that some of the workshop's

Table 7 REPRODUCTIVE CHARACTERISTICS

Trait	India	China	Malaysia	Thailand	Philippines	Taiwan	Sri Lanka	Source
Age at puberty (yrs)	2.8	2.8	2.8	3.0	-	-	-	Camoens 1976; Chantalakhana 1975; Cheng 1984; Liu 1978
1st mating age (yrs)	-	3.3	-	-	-	3.0	-	Cheng 1984; Liu 1975, 1978
1st calving age (yrs)	3.5	4.7	-	-	3.6	-	3.6	Bhat 1980; Eusebio 1975, 1984; Jalatge 1980; Liu 1985; Rao 1977
Gestation (days)	308	315	332	-	320	-	309	Liu 1978; Eusebio 1984; Wijeratne 1962; Camoens 1976; Cheng 1984; Jalatge 1980; Mostager <i>et al.</i> 1981; Rao 1977
Calving interval (days)	480	-	651	395	415	-	-	Bhat 1980; Camoens 1976; Chantalakhana 1981; Eusebio 1984; Gill 1985; Liang <i>et al.</i> 1982; Mostager <i>et al.</i> 1981; Rao 1977
Post partus oestrus (days)	-	296	-	-	-	-	-	Liu <i>et al.</i> 1985
Oestrus cycle (days)	-	23	28	20	22	-	-	Camoens 1976; Campos 1985; Chantakakhana 1981; Cheng 1984; Ensebio 1984; Liu 1984
Oestrus duration (hr)	-	43	4	32	22	-	-	Camoens 1976; Campos 1985; Chantakakhana 1981; Cheng 1984; Ensebio 1984; Liu 1984;



same environment, especially cattle. It has also been reported that buffaloes have a larger gastrointestinal volume than cattle (Moran and Wood, 1982) in relation to total body size. This has a bearing on feed intake which is in turn positively associated with rate of passage of feed and negatively related to digestibility. The complex relationship between size and other factors such as intake, digestibility, heat load and its dissipation within the river and swamp types needs to be further studied before breeding goals can be formulated. A curvilinear relationship was observed between body size and milk yield among Holsteins where sires that were just above average for size proofs produced daughters that yielded more milk than smaller or larger contemporaries (Sivarajasingam *et al.*, 1984). A similar trend may be expected in the tropical environment.

### 3.2 Breeding and Selection for Milk

A considerable amount of work has been done in India including progeny testing for milk (Nagarcenkar, 1979; Gill, 1985 and Tiwana and Dhillon, 1985). The milk yield in 305-days and total yield increased from 1062 kg and 1120 kg in 1971 to 2346 and 2450 respectively after 12 years of selection through a progeny testing programme. Heritability for milk yield among river buffalo shows a medium to high value (Table 9). However, reproductive traits in Table 10 show lower estimates but higher than in most cattle breeds. These figures indicate much genetic progress could be achieved through selection of superior bulls for milk production. The current genetic limit for milk yield which is as high as 4000-4200 kg (5 animals) per lactation of 305 days is encouraging (Gill, 1985). It will be of interest to study the efficiency at these high levels compared to cattle of similar production.

**Table 9 HERITABILITY ( $h^2$ ) AND REPEATABILITY ( $r$ ) OF LACTATION YIELD AND LENGTH**

Country	Breed	Lactation			Source
		Yield $h^2$	$r$	Length $h^2$	
India	Murrah	0.24	0.50	0.11	Agarwala 1955; Bawa and Dhillon 1980; Bhat <i>et al.</i> 1981; Dhinsa 1963; Mangurka and Desai 1981; Rao and Nagarcenkar 1977; Singh and Desai 1962; Sreedharan and Nagarcenkar 1978
Pakistan	Nili-Ravi	0.20	-	-	Ashfaq and Mason 1984
Sri Lanka	Murrah	-	0.49	0.06	Mahadevan 1960

Table 10 HERITABILITY OF SOME REPRODUCTIVE TRAITS

Trait	Country	Breed	Mean	Source
1st calving age	India	Murrah	0.25	Agarwala 1955; Bhat <i>et al.</i> 1981; Gokhale and Nagarcenkar 1974; Goswami and Nair ?; Gurung and Johar 1983; Mangurka and Desai 1981; Rao and Nagarcenkar 1977
Calving interval	India	Murrah	0.17	Bhat <i>et al.</i> 1981; Rao and Nagarcenkar 1977
Gestation period	India	Murrah	0.11	Arunachalam <i>et al.</i> 1981; Bhat <i>et al.</i> 1981; Ghanem 1955; Rao and Nagarcenkar 1977

### 3.3 Breeding and Selection for Beef

An improvement programme for beef production has been limited to the last few years mainly in China and Thailand. Main characteristics were weights at weaning and later ages. Heritability for body weights are given in Table 11 and are generally medium to high as in the case of beef cattle.

information regarding river buffalo is limited but genetic variation is expected to be high. Response based on performance testing for growth and family selection for carcass characteristics will prove effective. As for dairy buffalo, implementation of improvement programmes with farmers will involve high costs and management difficulties. A possible solution is to establish test stations around the country to evaluate selected bulls for growth, carcass (using relatives), reproductive and draught characters. Top bulls are selected and used to improve the national herd. Embryo transfer technology could be a useful tool here to multiply bulls for natural mating in the absence of proper facilities for AI.

Table 11 HERITABILITY OF BODY WEIGHTS

Age	Country	Breed	Mean	Source
Birth	India	Murrah	0.45	Bhat <i>et al.</i> 1981; Rao and Nagarcenkar
			1977;	Tomar and Desai 1965, 1967
	India	Surti	0.16	Rao and Nagarcenkar 1977
	Thailand	Swamp	0.63	Chantalakhana 1981; Chantalakhana 1984
6 months	India	River	0.37	Bhat <i>et al.</i> 1981; Mangurka and Desai 1981; Tomar and Desai 1965
12 months	India	River	0.57	Bhat <i>et al.</i> 1981; Rao and Nagarcenkar 1977; Tomar and Desai 1965
24 months	India	River	0.57	Bhat <i>et al.</i> 1981; Mangurka and Desai 1981; Rao and Nagarcenkar 1977

#### 3.4 Breeding and Selection for Draught

Breeding for genetic improvement involves retention of superior males for semen collection, and females for regular calf production. However, most of the buffaloes identified for draught are deprived of their normal reproductive activity. Males if not sold for beef, are often castrated. For the females, having to nurse a calf is considered a nuisance by the owner during ploughing. Even if the animals are fertile and given the opportunity to mate, the rate of success is expected to be low due to the low levels of feed quality and stress due to work in the field.

In many countries, the farm sizes are declining due to fragmentation resulting in an accompanied increasing scarcity of feed resources. Under such circumstances the decline in body size as a result of castration of larger animals for draught purposes may prove to be a compromise or even an advantage (Mahadevan, 1985). He cites the work of Vercoe *et al.* (1985) who favour more efficient utilization of small animals for draught purposes under situations of limited feed resources and selecting for superior heat tolerance individuals within the population. However, the choice of identification of existing strains that are heat tolerant, low in maintenance requirement and resistant to parasites and other diseases amongst the swamp buffalo population and using them in crossbreeding programmes may be more applicable in developing countries (Mahadevan, 1985).

#### 3.5 Multipurpose Breeding Strategies

Although selection for site, milk, beef and draught has been discussed separately, they are not mutually exclusive and they are also not the only traits of concern. Buffaloes in smallholder and institutional farms are known to have slow reproductive rates and high mortality rates. These are largely due to environmental and partly genetic factors. As was mentioned earlier, more than 70 percent of the buffaloes in all countries of Asia can be considered nondescript. Well defined breeds and breeding programmes are only confined to institutional

farms. This needs to be extended to improve the national herds hand-in-hand with development of a recording system and related infrastructure. However, costs of operating such a system based on conventional progeny testing will be enormous. An alternative system like the Irish progeny testing and selection programme (Cunningham, 1979) will be more effective. This system will also allow selection for total economic merit to include traits like reproductive efficiency and feed efficiency which are vital in buffalo production.

Breeding strategies tend to vary from country to country. In the Indian subcontinent, breeding for milk first and draught second will continue. In southeast Asian countries, except Malaysia, draught power is of prime importance followed by beef in most areas or milk in the Philippines. In Malaysia and to some extent in the Philippines and Sri Lanka, swamp buffaloes are significant contributors to the beef industry. However, declining buffalo numbers due to the advent of farm mechanization, their slow reproductive rates and few numbers compared to the indigenous Kedah-Kelantan cattle in Malaysia, the future of the swamp buffalo in this country is uncertain. A solution to this problem is to upgrade them using Murrah or Nili-Ravi or both breeds into a dual purpose dairy beef buffalo. This will further enhance the existing village ghee industry and other milk products for which there exists a substantial market. Attempts to conserve the buffalo as a beef animal especially in the Philippines, Thailand, Indonesia, Taiwan and China need to be studied. Besides the fact that their population is decreasing due to earlier mentioned mechanization, low reproductive rates and high mortality rates, the buffalo are also decreasing in size due to reasons discussed earlier in this paper.

Another area that has been extensively discussed, but little work has been done, is efficiency of feed utilization by buffaloes. Buffaloes are considered more efficient utilizers of coarse feeds than cattle but this has not been well documented.

#### **4. CROSSBREEDING RIVER AND SWAMP BUFFALOES**

Crossbreeding has been practised in almost all countries where swamp buffalo predominates i.e. China, Burma, Thailand, Philippines, Malaysia and Sri Lanka with the desire of improving milk yield capacity and size for work in the field. China started crossbreeding work as early as 1960 and produced some 45 000 crossbreds by 1977 (Wang, 1979) through AI. The crosses have been further upgraded with Nili-Ravi resulting in grades with 50, 25, and 25 percent of Nili-Ravi, Murrah and swamp buffalo levels of inheritance. They have been evaluated (Liu *et al.*, 1985) and summarized in Table 12.

The crossbreds in the above report had good conformation, a massive body structure with well developed hindquarters, with an average daily gain of 0.8 kg on grass. Average fat content of crossbred milk was 7.5 percent. The temperament of triple crosses as superior but the same could not be said for the halfbred, Murrah x swamp crosses. Reports on crossbred performance, although on a smaller scale, have also been reported in the Philippines (Eusebio, 1975), Taiwan (Liu, 1975), Sri Lanka (Jalatge, 1980) and Nepal (Keshary and Shrestha, 1980). These reports had lower milk yields ranging from 492 to 956 kg than the work in China shown in the [Table 12](#). However, the results do indicate genetic potentials of crossbreeding to improve the swamp buffalo for milk and meat. In this context, it is also relevant to note that an FAO/UNDP project in collaboration with the Philippine Council of Agricultural Resources, Research and Development (PCARRD) has an ongoing evaluation of the progeny resulting from mating of different breeds/strains of river buffaloes with the Philippines carabao for use as draught, milk and meat animals (Mahadevan, 1985). Preliminary results showed an increase of 32 percent in birth weight, an increase by 100 percent in weight at 18 months (average 300 kg) and a 3 to 4-fold increase in milk yield (1200 l in 300 days) than the native carabao (Ranjhan, 1985).

**Table 12 CHARACTERISTICS OF CROSSBRED BUFFALOES**  
(adapted from Liu, 1985)

Character	Swamp (S)	Murrah (M)	Nili-Ravi (N)	M x S	N x (MS)
Colour	light grey	black	black	grey	black
White chevron	present	absent	absent	present	rare
Switch	black	white	white/ black	white	white (longer)
Horns	long, lateral curve backwards	short, spiral curl	short, curled back	curve semicircle	-
Draught power (kg)	65	-	-	F <sub>1</sub> 80.8 F <sub>2</sub> 88.6	- -
Plough mu/h	0.48	-	-	F <sub>1</sub> 0.73 F <sub>2</sub> 0.55	53.0 -
Dressing percent	48.5	-	-	F <sub>1</sub> 56.2	-
Muscle percent	36.9	-	-	F <sub>1</sub> 42.6	-
Meat:Bone	1:3.8	-	-	F <sub>1</sub> 1:4.8	1:4.5
Puberty age (days)	-	667.0	915.5	669.0	605.3
Age first service (days)	-	1 201.4	1 048.0	974.3	831.3
Oestrous cycle (days)	-	23.2	23.7	21.5	21.6
Gestation period (days)	-	305.5	303.9	309.9	306.3
First postpartum oestrus (days)	-	94.7	127.9	170.6	71.0

Calving interval (days)	-	455.4	465.8	539.5	381.6
Milk yield (kg)	-	1 975.5	2 076.0	2 662.0	1 153.7

Crossbreeding between swamp and river buffaloes raises an area of concern. The differences in the chromosome numbers between swamp ( $2n = 48$ ) and river ( $2n = 50$ ) (Fischer and Ulbrich, 1968) buffaloes may have an effect on the fertility of the offspring considering synaptic possibilities in the  $F_1$ s resulting in some genetically, unbalanced meiotic products that degenerated. This was revealed by Bongso *et al.* (1983) where a large proportion of degenerating spermatocytes and abnormal spermatids were found in testicular biopsies of  $F_1$  hybrids. The  $F_1$  produced by river and swamp matings had a chromosome number  $2n = 49$  (Fischer and Ulbrich, 1968 and Bongso and Jainudeen, 1979). Reports by Bongso *et al.* (1984) showed further segregation resulting in three  $F_2$  populations ( $2n = 48, 49$  and  $50$ ), two populations ( $2n = 49$  and  $50$ ) when backcrossed to river buffalo and two populations ( $2n = 48$  and  $49$ ) when backcrossed to the swamp buffalo. These interesting findings were however limited to small sample sizes. It is now necessary to relate these genotypes (different chromosome numbers within different levels of exotic inheritance) to fertility and extent of heterosis for production traits in smallholder farms and large commercial ones.

## 5. CONSERVATION, IMPROVEMENT AND UTILIZATION

The buffaloes of Asia have evolved within their ecosystem over several centuries and have thus acquired adaptive characteristics and still remain useful in food production. The review of literature above though not exhaustive, and previous meetings on Animal Genetic Resources Conservation (FAO, 1981, FAO, 1983 and SABRAO, 1981) have revealed that although a wealth of information has accumulated, large gaps exist in the total characterization of buffaloes and other species. For instance, efficiency of the buffalo for milk, meat, draught or multipurpose on high and poor quality roughages and byproducts is limited or absent. Such information is vital in agricultural planning strategies and allocation of animals and breeding programmes to various farmers and farming systems. The buffalo of Asia are generally lumped together as the swamp type although wide variation is recognized. Blood markers are useful in the characterization of breed structure and the relationship between the varieties of the buffalo population. Blood markers, especially those related to membrane antigen, may be of value for understanding, control and eradication of diseases (Braend, 1981).

### 5.1 Genetic Conservation - Why?

Conservation of live specimens of buffaloes or other livestock consumes sizable manpower, valuable space and costs besides demanding proper planning skills. However, the buffalo needs to be conserved for the following reasons in brief:

- a. They possess adaptive characteristics to thrive in the stressful environment which could be lost through dilution and intensive selection for production traits.
- b. They also possess the ability of converting poor quality feed resources into meat, milk and working capacity in the field.
- c. The genetic variability should be maintained which is the basis for genetic improvement for the future. Fortunately, buffaloes, unlike cattle, have not undergone massive selection and crossbreeding until only very recently. There is still genetic variability to be salvaged.
- d. The opportunity could be lost to exploit heterosis through cross breeding.
- e. The future expectations of our buffaloes are unknown or unknowable. Selection goals in cattle breeding in the past have changed. From single trait selection we have turned to selection on total merit, when we

may have lost some of the negatively correlated valuable genes. Selection for conformation traits are beginning to show their importance in relation to lifetime stayability and production. With raising production costs, we are now looking at yield per unit dry matter or energy input. In this respect the buffalo has an important role. The future spectrum of diseases and feed availability is unknown. Therefore we need to maintain the present variability or even increase it.

- f. Finally, we ask ourselves, do we have the right to destroy, or even neglect our indigenous germplasm collection which rightfully belongs to our children and grandchildren who may find greater uses for them.

## 5.2 Genetic Conservation - How?

Without going into details, the following points need to be highlighted.

- a. Live animals. An actively breeding population should be maintained, perhaps, each line or variety in a different farm to reduce costs. Two major advantages of live animal conservation are a) they are always available for immediate utilization in the event of any setbacks in the upgraded population; b) they are constantly exposed to new strains of diseases and their resistance evaluated. Such live animals would also contribute to education and to community awareness of the indigenous fauna. Cost of maintenance is often argued to be high. This may be an exaggeration overlooking their cheap maintenance costs, better longevity, lower veterinary costs besides revenue from milk and meat. A major problem that needs to be defined is the type of selection to be practised without altering the genetic variability. It is suggested here that both random selection as well as overall merit (with equal weighting for each trait) should be practised with minimum intensity.
- b. Cryogenic storage. This is convenient and cheap and further work needs to be done. Another advantage is that the genotype will not be subjected to genetic drift. A disadvantage is that the animals, especially in the case of females, have a time lag when live adults are urgently required.
- c. DNA genetic material storage. This is a useful tool but certainly not an immediate task.

Conservation by the last two methods has been discussed at length and mode of action outlined (FAO, 1983).

## 5.3 Improvement within Conservation

It is evident that the buffalo plays an integral part of our farming system and its numbers have been maintained or increased. Various river breeds have been documented and evaluated. Strains of swamp buffalo have been observed but attempts to characterize them genetically have yet to be made. Conservation should begin with a proper sampling technique to represent the existing variability and in sufficient numbers. In these populations for conservation, selection should be minimal and to maintain population size constant, either random culling or culling based on total merit should be practised. However, for the national herds genetic improvement could be achieved through selection and crossbreeding. For both, germplasm collection and national herd data banks are essential to monitor their genetic progress.

## 6. CONCLUSIONS

The total buffalo population now stands at 122 million in Asia. The swamp buffalo population is decreasing in some countries, especially Malaysia, Thailand, Philippines and Taiwan. Growth and carcass characteristics of buffalo and cattle are comparable. Draught capacity and the working lifespan of buffalo is superior to that of cattle. There is a management tendency in smallholders to deprive larger swamp buffaloes from producing offspring leading to a high likelihood that the buffalo body size may be affected. The river buffalo is larger than the swamp. Interrelationship between size, growth, milk yield and draught power needs to be further studied also with respect to feed efficiency and adaptation. The former produce about 1800 kg milk per lactation of 305 days. First calving age, intercalving periods and postpartum oestrus are longer than in cattle and perhaps this is

a physiological phenomenon associated with a longer (310 days) buffalo gestation period. Feed efficiency with complete characterization of the buffalo breeds is timely with data banks having interregional links for exchange of information and material. The various strains of swamp buffalo need to be identified. Their special capabilities and adaptation to the particular niche has to be defined. Conservation of valuable breeds and strains of buffaloes is reemphasized before genetic variation is "diluted". Finally, crossbreeding and its advantages are being pursued in various countries and show preliminary prospects of genetic improvement of swamp buffaloes in spite of initial setbacks of differences in chromosome numbers between the river and swamp buffaloes and the genetic imbalance in germ cells resulting from meiosis.

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### **PHILIPPINE CARABAO CROSSBREEDING RESEARCH**

Report on the FAO/UNDP/Philippine Government Project PHI/78/017

J. Hodges 1/

The Philippines has about 2.9 million carabaos, 99 percent of which are in the hands of smallholder farmers, with 1-2 heads or more integrated closely with their farming systems. These are mainly used as draught

animals. The size and weight of these animals have been gradually declining since the farmers have been castrating the best bulls as work animals and leaving the weaker small sized bulls for breeding. Unknowingly, natural selection for smaller size has been going on. They are poor in milk and meat production. During Phase I (1981-86) the objectives of the project were:

- a. To develop a strain/type of carabao that will be superior for draught, milk and meat under the backyard production scheme of smallholder farmers and commercial ranch production systems.
- b. To generate the appropriate technologies of mating, feeding, care and management, herd health programme and extension strategies best suited for various types of crops-livestock integrated farming systems within the context of small farmer environment and resources.
- c. To meet the country's animal draught power requirement in the present energy crisis and nutritional demands for milk and meat of the increasing human population.
- d. To develop manpower training programmes to enhance the technical capabilities of personnel in various governments and private agencies involved in carabao production.
- e. To build-up the research and training facilities of the pilot institutions through the assistance of UNDP in order to accelerate the development and improvement of the carabao as an important component of Philippine agriculture.

During the first three years (1981-1983) the foundation breeding stock was purchased (518 heads) and bred with the exotic semen of Murrah, Nili-Ravi and Thai bulls imported from abroad. So far 125 crossbreds have been produced in the centre both by artificial breeding and natural mating at the institutional herd as well as with the farmer cooperators. During Phase I, 300 crossbreds are to be produced and their performance has to be tested for draught, meat and milk production. An artificially induced breeding scheme has been successfully developed for smallholder farmers to increase the calf crop from carabao kept in smaller units and showing silent heat. This technology is being tested in the field.

The results so far on the crossbreds raised have shown that F<sub>1</sub> crosses of Phil-Ravi (Native Carabao x Nili-Ravi) and Phil-Murrah (Native Carabao x Murrah) grow 42 percent faster than native carabao up to 24 months of age both under smallholder and ranch management conditions. The draughtability is the same as that of native at the same body weight without any physiological stress in the F<sub>1</sub> crossbreds. Milk production is about 2 1/2 times (1300 litres/300 days) more than the natives (550 litres/300 days). However, the number of animals is still low and confirmation of these preliminary results is awaited from larger numbers of pipeline animals.

Based on the above work, the Philippine Government is planning a 10-year National Carabao Development Project to undertake an action programme on large-scale crossbreeding of the native carabao to produce about seven hundred thousand crossbreds. Induced artificial breeding technology, generated by the project would be used in mass crossbreeding. Carabaos having long generation interval would need more time to produce enough offspring to serve as foundation stock for a new strain or type of carabao/buffaloes that would be superior for draught, milk and meat. Production of sufficient F<sub>1</sub>s of various breeds (Nili-Ravi, Murrah and Thai) may take another 2 years and the evaluation of these F<sub>1</sub>s may take another 3 to 4 years, before inter se matings of F<sub>2</sub>s may be achieved. Hence, a minimum of 15 years may be required to produce a significant number of F<sub>2</sub>s with stabilized characteristics for superior draught, milk and meat qualities. Hence, the second phase has been planned in order to make an objective evaluation of the performance of F<sub>1</sub>.

The project indicates the type of approach which will involve the use of different genotypes from various countries in improving animal production in developing countries in the future.

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## **PRINCIPLES OF INDIGENOUS SHEEP IMPROVEMENT IN NORTH AFRICA**

A. Lahlou-Kassi <sup>1/</sup>

### **1. INTRODUCTION**

The North African region, which includes Morocco, Algeria, Tunisia, Libya and Egypt, raises some 42 million sheep, and is ranked among the top sheep production areas in the world (FAO, 1981).

These sheep are mainly raised for meat and leather production, and to a small extent for wool and milk. Only 6 to 10 percent of ewes are milked in Morocco (Livestock Survey-MARA, 1975). Mutton contributes 6 to 55 percent to the total meat consumption in each country (Egypt 6 percent, Morocco 18 percent, Tunisia 35 percent, Algeria 47 percent and Libya 55 percent - FAO, 1981). Some countries like Algeria, Libya and Egypt import 20 to 50 percent of their meat needs, and the other countries are just self-sufficient.

The meat shortage in the presence of a relatively important sheep flock can be explained by low productivity. It is estimated that the average meat production per ewe per year is around 5 to 8 kg, and carcass weight does not exceed 10 to 15 kg (OADA, 1984).

Improvement of productivity in sheep flocks is then a must, the general principles for improvement being well known (health, feeding and reproductive management, breeding and crossbreeding). However, improvement objectives and the methods to be used should be defined for each country and for each breed according to the environment and management system, as well as the type of production desired.

A better knowledge of the performance of different sheep breeds present in the region, and analysis of experiments on improvement conducted there, will allow us to elaborate some basic principles and recommendations for improving the productivity of sheep in North Africa.

### **2. CHARACTERISTICS AND PERFORMANCE OF INDIGENOUS SHEEP BREEDS**

This is not intended to be an exhaustive study, the paper being limited to the following:

- Phenotypic traits that seem to be linked to adaptation to heat and the general environment as well as walking ability.
- Performance traits that will permit an evaluation of the ewes' productivity level.
- Sheep breeds that are already identified as relatively homogeneous populations.

Most of the data presented in this paper were obtained on experimental stations, where the level of management is medium or relatively good, and consequently the breeds are better able to express their genetic potential.

#### 2.1 Adaptation Traits

Among the most important traits for adaptation to the environment are coat type, colour, legs and temperament, as well as the size and location of fat "reserves". These have been well studied and should be considered in any improvement scheme.

### 2.1.1 Fat-tailed breeds

Almost all breeds of sheep in Egypt (Rahmani, Ossimi and Barki), Tunisia and Libya (Barbary) are fat-tailed.

- Rahmani: Located in the north-west of the Nile delta, relatively long-legged with a long fleece of coarse, kemp wool, generally brown.
- Ossimi: Raised mainly in Middle Egypt, the southern part of the Delta and upper Egypt; long-legged and has a coarse fleece, with kemp.
- Barki: Raised in the western desert; long-legged with a coarse open fleece.
- Barbary: Present in the steppes along the northern coast of Libya, and from the Sahara to the Tunisian coast; very hardy, long-legged and good walker.

### 2.1.2 Thin-tailed breeds

- Rembi: Raised in the Saharan Atlas Mountains and Djebel Amour (Algeria); long-legged, fine fleece.
- Hamra: Raised in the Western Plateau of Algeria; medium-legged, fine fleece.
- Tadmit/Ouled Djellal: Raised in Biska, Tonggout and Ouled Dejellal regions (Algeria); long-legged, strong skeleton good walker, fine fleece.
- Timahdite: Raised in Middle Atlas Mountains; medium-legged, coarse wool, semi-open fleece (Morocco).
- Sardi: Raised in the central plateau Tadla Morocco; long-legged, coarse wool, closed fleece.
- Beni Guil: Raised in the high plateaux of the North and part of the sandy Pre-Saharan Zone of Missouri: short-legged, coarse wool, semi-open fleece.
- Beni Hsen: Raised in the lowlands along the Atlantic coast; long-legged, finest wool, closed fleece.
- D'Man: Raised in the Oases of the South of Morocco; short-legged, mixed hair-wool.

## 2.2 Reproductive Performance

### 2.2.1 Puberty and age at first lambing

All breeds in the region except the D'Man have a late first lambing, the average age being 22 months. Ewe lambs are not able to conceive during their first year of life because of a delayed puberty, the age at first oestrus being about 14 to 16 months. The D'Man is peculiar for its precocity, the age at first oestrus being 6 to 8 months, and the first lambing generally at 11 months (Table 1).

Table 1 PUBERTY AND AGE AT 1ST LAMBING OF INDIGENOUS SHEEP BREEDS

Breed	Age at 1st oestrus (Months)	Age at 1st lambing (Months)
Timahdite	16 - 18	21 - 23
Sardi	14 - 16	20 - 23
Beniguil	-	21 - 23
Benihsen	-	21 - 23
D'Man	6-8	11 - 17
Tadmit/Ouled Jellal	-	18 - 24
Rembi	-	24
Hamra	-	20
D'Man	-	12
Barbary	10 - 12	16 - 22
Ossimi	7-16	21 - 24
Rahmani	-	21 - 24
Barki	-	21 - 24

There is a large variation between animals in the age at puberty for the Timahdite, Ossimi and Barbary breeds, as reported by several authors (278 to 386 days for the Barbary, 240-400 days for the Timahdite).

### 2.2.2 Conception rate and prolificacy

Conception rates for different breeds raised in stations or experimental farms are very satisfactory. They average 95% for the thin-tailed breeds and 85% for the fat-tailed breeds. These rates are higher than those recorded in flocks raised only on pastures (60 to 70 percent), which means that principal causes of failure to conceive are feeding and health management rather than genetics.

The D'Man breeds is outstanding for its high prolificacy or litter size (1.8 to 2.7 lambs/ewe lambled). The frequency of twinning in thin-tailed breeds is 10 percent in Morocco and Algeria. Fat-tailed sheep have 15 to 20 percent twinning in Tunisia and Egypt, except for the Barki breed, which bears twins in only 5 percent of births.

This relatively low prolificacy, when compared to those of prolific breeds such as the D'Man, Romanov and Finn, is compensated by the fact that 10 to 30 percent of ewes can lamb twice in the year (Table 2).

### 2.2.3 Breeding season and post-partum anoestrus

The oestrous activity of different North African breeds in different months of the year and after lambing is reviewed in Table 3.

This table shows clearly that all breeds except D'Man and Rahmani have a prolonged breeding season, generally from May to January (240 to 300 days). The anoestrous season lasts from February to April. However, Lahlou-Kassi (1983) and Khaldi (1984) have noted in Moroccan and Barbary breeds respectively the existence of silent ovulations in 40 to 60 percent of ewes during this period.

**Table 2 REPRODUCTIVE PERFORMANCE OF INDIGENOUS SHEEP BREEDS  
(ADULT EWES)**

Breed	Conception rate %	Litter size	No. of lambings per year	Lambs weaned/ ewe joined/per lambing
Timahdite	77 - 95	1.02-1.07	1.10-1.30	0.08-1.10
Sardi	85 - 92	1.00-1.30	1.10-1.20	1.00-1.21
Beniguil	80 - 92	1.00-1.04	1.10-1.20	0.80-1.10
Benihsen	82 - 93	1.04-1.20	1.00-1.25	0.80-1.20
D'Man	80 - 100	1.76-2.65	1.50-1.97	1.50-2.20
Tadmit Ouled Jellal	75 - 90	1.00-1.12	-	0.97-1.16
Rembi	90	1.15	-	-
Hamra	93	1.13	-	-
D'Man	85	2.12	-	-
Barbary	86 - 96	1.07-1.25	-	-
Ossimi	82 - 83	1.14-1.17	1.10-1.40	0.83-0.87
Rahmani	82 - 86	1.21-1.23	1.10-1.13	0.82-0.93
Barki	85 - 88	1.05-1.07	1.07-1.15	0.83

**Table 3 BREEDING SEASON AND POST-PARTUM ANOESTRUS OF INDIGENOUS SHEEP BREEDS**

Breed	Breeding season	Post-partum 1/ anoestrus	Author
Timahdite	May to January (265 d)	160 d (60-250)	
Sardi	May to January (265 d)	110 d (40-230)	Lahlou-Kassi 1983, 1985
Beniguil	June to March (300 d)	100 d (40-250)	
D'Man	Over the year (365 d)	60 d (20-120)	Kerbaa 1985
Tadmit	May to January (275 d)	-	
Barbary	June to January (242 d)	104 d (80-130)	Khalidi 1984
Ossimi	June to January (240 d)	-	
Rahmani	Over the year (365 d)	-	Aboul-Naga 1985
Barki	April to January (300 d)		

<sup>1/</sup> Post-partum anoestrus of ewes lambing during November-February. The minimum and maximum represent individual variation.

The D'Man and Rahmani breeds have sexual activity throughout the year. The time before resumption of oestrus after lambing is also very short for the D'Man, ( $x = 60$  days) and medium in the other breeds (100 to 160 days). The combination of these characteristics (long breeding season and relatively short post-partum anoestrus) allows these breeds to conceive and lamb more than once a year.

### 2.3 Production

#### 2.3.1 Birth and weaning weights

Birth weights for the indigenous breeds range from 2.0 to 4.5 kg with an average of 3.2 kg.

Weaning weight at 90 days ranges from 14 to 26 kg, indicating the large variation in milk production for ewes of different breeds.

Highest birth and weaning weights are observed in Sardi, Timahdite (Moroccan breeds), Tadmit, Rembi (Algerian), Barbary (Tunisian) and Ossimi (Egyptian). The lowest birth and weaning weights are observed in the D'Man, due to high litter size (Table 4).

Table 4 LAMB GROWTH RATE OF INDIGENOUS SHEEP BREEDS

Breed	Sex	Birth weight (kg)	Live weight gain (g/day)	Weaning weight at 90 days (kg)
Timahdite	M	3.3-4.2	204-243	18-21
	F	3.2-3.6	190-210	17-19
Sardi	M	2.6-4.3	129-195	16-21
	F	3.2-4.0	126-180	14-20
Beniguil	M	2.9-3.6	125-176	11-19
	F	3.0-3.4	117-164	10-15
Benihsen	M	3.4-4.0	100-190	9-17
	F	3.0-4.6	90-170	8-15
D'Man	M	2.1-3.2	100-239	13-17
	F	1.7-3.0	81-180	13-16
Tadmit	M	3.4-4.3	196-220	21-34
	F	3.3-4	174-184	19-19.6
Rembi	F	-	-	26
Hamra	F	3.0	-	17
D'Man	F	2.0	-	15
Barbary	M+F	3.0-5.0	200-250	22-26
Ossimi	M	2.5-4.0	-	21-23
	F	2.0-3.0	-	18/2-19.4
Rahmani	M+F	3.4	-	20-22
Barki	M+F	3.0	-	20-21

2.3.2 Lamb mortality

The average mortality rate varies from one flock to another according to management level. Under relatively good management, it is 5 to 10 percent from Moroccan breeds, except D'Man which has a high average rate (15 to 20 percent), due mainly to the higher losses in triplet and quadruplet lambs (Lahlou-Kassi 1983).

For the Barbary, lamb mortality averages 8 to 13 percent, with 15 to 25 percent for twins (Khaldi 1984) and for Egyptian breeds, 12 to 18 percent.

#### 2.4 Summary

Analysis of adaptation traits and performance of the different North African sheep breeds leads to the following general conclusions.

##### 2.4.1 Interesting traits for future improvement

- Variability of adaptation traits (coat, conformation, fat reserve) for various climates and land types existing in the region (semi-arid, arid, mountain and Sahara).
- Long breeding season and relatively short post-partum anoestrus in these breeds allow good reproductive efficiency even in years where there is a delay in rainfall and vegetation growth and a second lambing, at least for part of the flock, when the year is good.
- Existence of a well adapted prolific breed within the region (D'Man) which can be included in cross-breeding schemes for prolificacy improvement.
- Large individual variability within the same flock and between flocks for either reproductive or productive traits allows good opportunity for improvement through selection.

##### 2.4.2 Actual limiting traits

- Late age of puberty and age at first lambing in the majority of indigenous breeds.
- Relatively slow lamb growth rate from birth to weaning in relation to milk potential of the mother.
- Low or medium fecundity of the majority of the breeds, for intensive sheep production systems.
- Large between-breed variability in quantity and quality of wool.

### **3. TRIALS IN THE REGION FOR IMPROVING LOCAL SHEEP**

#### 3.1 Selection Trials

##### 3.1.1 Improvement of general conformation

National programmes of selection for the improvement of local breeds have been established in Egypt, Algeria, Tunisia and Morocco, the major purpose being:

- Initial phase: Homogenization of phenotype for each breed, based essentially on colour and body conformation.
- Second phase: Improvement of production performance in each breed.

The first phase of the programmes has been achieved with some success in some countries, after establishment of national breeding policies based on the following (Moroccan example):

- Production of selected rams in national selection farms, specific to each breed; these rams are sold to farmers.
- Mapping and delimitation of the area of origin for each breed, called the "zone berceau de race".
- Creation of the National Association for Sheep production, which includes professionals from different areas and breeders. This Association has as its role production of selected rams, and organization of livestock shows and competitions.
- Appointment of the Commission for Sheep Selection, composed of government officials and representatives of breeders. This Commission is in charge of the registration of selected animals in the "Flock book".

Unfortunately no data are yet available on the evaluation of this kind of programme.

### 3.1.2 Improvement of fecundity

To our knowledge, none of these programmes have included fecundity parameters such as age at first lambing or prolificacy in the selection scheme.

The selection programme for prolificacy improvement in D'Man sheep, which started in 1973 at the ORMVA, Quarzazate, Morocco, shows that average litter size in the selected flock increased from 1.66 to 2.33 in 8 years. However the reported data do not make it clear whether this improvement is due to a genetic gain or to improvement of management and feeding.

Because of the tremendous variability existing between individuals at the age of first lambing and duration of breeding season and prolificacy in each breed reviewed here, it is of value to include these criteria in selection schemes.

## 3.2 Crossbreeding Trials

### 3.2.1 Crossbreeding for improving fecundity

Different trials have been conducted for improving the fecundity of local sheep through crossbreeding with imported prolific breeds (Finn, Romanov, Chios) or the indigenous prolific breed (D'Man). We review here briefly the two main trials conducted in Egypt and Morocco.

#### a. Moroccan trial:

With the financial help of the Small Ruminant Programme (CRSP) and the collaboration of Prof. Eric Bradford from the University of California, Davis, a crossbreeding scheme between Sardi and D'Man breeds was

conducted to evaluate the reproductive and growth performance of the two parental breeds and their crosses. Preliminary results are summarized in Table 5 and 6.

Performance of ewe lambs (Table 5): at 10-12 months of age, the conception rate of F1 (D'Man x Sardi) ewe lambs is higher than that of Sardi ewe lambs (64-78 percent vs. 0-27 percent) and similar to that of D'Man. The prolificacy of F1 ewe lambs is intermediate (1.3 vs 1.0 and 1.6).

Performance of adult ewes (Table 6): crsssbred (D'Man x Sardi) ewes are distinguished from the Sardi by:

- i. a higher prolificacy (1.6-2.1 vs. 1.16-1.28);
- ii. advanced breeding season: conception rate for the May-June mating is 9-100 percent vs 57-64 percent.

**Table 5** REPRODUCTIVE PERFORMANCE OF SARDI, D'MAN AND F1 (D x S)  
EWE LAMBS (10 TO 12 MONTHS OLD)

Genotype	Mating period	No.	Conception rate	Litter size	No. lambs weaned/ewe lambing	Weaning rate %	Weight of lamb weaned/ewe lambing (kg)
Sardi	I	26	27	1.00	0.26	100	4.0
	II	28	0		0	0	0
D'Man	I	23	64	1.50	1.10	100	12.7
	II	21	61	1.75	1.25	86	13.5
F1	I	64	78	1.22	0.94	90	10.8
	II	45	64	1.34	0.80	92	10.5

**Table 6** REPRODUCTIVE PERFORMANCE OF SARDI, D'MAN AND F1 (D x S) ADULT EWES: I - MATED DURING SEPT-NOV. 1984  
II - MATED DURING MAY-JUNE 1985

Genotype	Mating period	No.	Conception rate	Litter size	No. lambs weaned/ewe lambing	Weaning rate %	Weight of lamb weaned/ewe lambing (kg)
Sardi	I	136	94-96	1.25-1.28	1.13-1.21	92-100	17.5-19.6
	II	137	57-64	1.16-1.18	0.60-0.70	90-98	10.1-10.8
D'Man	I	43	92-100	2.11-2.65	1.55-1.89	64-90	16.0-20.5
	II	70	86-95	1.96-2.25	1.50-2.00	84-93	16.7-22.4
F1	I	42	92-100	1.61-2.00	1.50-1.81	94-95	19.6-19.8
	II	42	91-100	1.80-2.10	1.50-1.70	81-94	19.6-20.3

On the other hand, the weaning rate is similar for all three genotypes (D'Man, Sardi, D'Man x Sardi).

Average productivity expressed as weight weaned per ewe lambing is 20 to 22 in D'Man and F1 compared with 10 to 20 for Sardi.

The major disadvantage was a decrease in quality and quantity of wool in F1, compared with Sardi.

b. Egyptian trial:

An ambitious programme for crossbreeding between Ossimi and Rahmani breeds and imported prolific breeds (Finn, Romanov and Chios) is in process in Egypt. Data of the resulting crossbreds, under an accelerated lambing system of a crop every 8 months, are presented in Table 7.

Prolificacy and lambing rate were increased respectively by 50 to 70 percent and 5 to 30 percent in the first crosses and by half this figure in the 1/4 Finn. Of importance, the different crossbred ewes showed a good ability for rebreeding every 8 months, which is important in a subtropical environment.

**Table 7 IMPROVING FECUNDITY OF LOCAL OSSIMI (O) AND RAHMANI (R) BY CROSSING WITH FINN (F) SHEEP UNDER THE SYSTEM OF ONE CROP/8 MONTHS**

Breed group	No.	Lambing	Lambs per ewe	Lambs per ewe lambing	Lambings per ewe per year	Lambs per ewe per year
R	775	0.715	1.01	1.37	1.07	1.47
F x R	151	0.880	1.73	2.06	1.32	2.72
F.R x R	160	0.826	1.14	1.54	1.24	1.91
R x F.R	284	0.781	1.20	1.50	1.17	1.76
(F.R=R) F2	104	0.707	1.15	1.54	1.06	1.63
O	411	0.743	0.98	1.28	1.11	1.42
F x O	77	0.768	1.48	1.93	1.15	2.22
F.O x O	108	0.824	1.13	1.42	1.24	1.76
O x F.O	40	0.847	1.31	1.55	1.27	1.97

The evaluation of this crossbreeding scheme, however, should include the incidence of lamb mortality and growth rate to test the adaptability of Finn sheep to a hot humid climate.

### 3.2.2 Crossbreeding for improving lamb production

Most of the crossbreeding schemes for improvement of lamb production are based on crosses between local breeds and European meat breeds. In Morocco, the breeds used are: Merino, Berrichon du Cher, Ile-de-France and Suffolk. These crosses are exclusively for the production of lamb, and are conducted under intensive management, on private farms. As data are lacking, it is impossible to evaluate the results.

In Egypt crosses between Ossimi and Suffolk and Hampshire are reported by Aboul-Naga and Afiji (1980) and Aboul-Nagaga *et al.* (1980). Tables 8 and 9 summarize results from Hampshire x Ossimi crosses.

**Table 8 LAMB PERFORMANCE TRAITS OF OSSIMI (O) AND HAMPSHIRE (H) X OSSIMI(O) CROSSES**  
(Aboul-Naga and Afifi, 1980)

Breed group	No.	Birth wt. (kg) mean $\pm$ S.E		Weaning wt (kg) mean $\pm$ S.E.		Survival to Weaning mean	Yearling wt. (kg) mean $\pm$ S.E.	
0	136	2.98 $\pm$ 0.08	ad	18.89 $\pm$ 0.54	a	0.86	33.35 $\pm$ 1.06	a
1/2 H	91	2.74 $\pm$ 0.11	ac	20.37 $\pm$ 0.72	ab	0.83	33.58 $\pm$ 1.32	a
9/16 H	53	2.52 $\pm$ 0.14	c	22.09 $\pm$ 1.10	b	0.76	39.23 $\pm$ 2.09	ab
5/8 H	88	2.53 $\pm$ 0.12	c	20.73 $\pm$ 0.8	b	0.72	34.71 $\pm$ 1.47	ab
3/4 H	17	2.79 $\pm$ 0.23	cd	18.70 $\pm$ 1.4	ab	0.52	37.82 $\pm$ 4.86	ab
7/8 H	19	3.33 $\pm$ 0.22	bd	18.70 $\pm$ 1.4	ab	0.63	36.73 $\pm$ 2.08	ab

The different H x O crossbred groups were generally inferior to the Ossimi breed for all traits, the only lamb performance trait improved by upgrading the Ossimi sheep with Hampshire being the first greasy-fleece weight. Lamb survival and weaning weight decreased as the percent of Hampshire increased.

**Table 9 REPRODUCTION TRAITS OF OSSIMI (O), HAMPSHIRE (H) AND THEIR  
CROSSBRED GROUPS OF EWES**  
(Aboul-Naga and Afifi, 1980)

Breed group	No. of ewes	Conception rate %	No. of lambs born/ewe lambed	No. of lambs weaned/ewe lambed	No. of lambs weaned/ewe joined
Ossimi (O) x H	115	76	1.20	1.12	0.93
1/2 H x H	145	72	1.22	0.94	0.90
1/2 H x 1/2 H	70	62	1.10	0.85	0.68
3/4 H x H	16	52	1.34	0.89	0.73
5/8 H x H	66	68	1.15	0.74	0.78
Hampshire (H) x H	45	32	1.11	0.77	0.43

#### 4. CONCLUSIONS

This review points out some important principles that should be taken into consideration in any programme for improving sheep productivity in North Africa. These can be summarized as follows:

- Precise knowledge of reproductive and production performance, as well as adaptation of local breeds, as needed.
- Objectives of the improvement programme should be well defined namely, improvement of growth, reproduction of wool.
- The environment and type of management in which the programme is to be conducted (pasture only, or with supplementation, intensive) should be defined.

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**PRINCIPLES FOR ANIMAL IMPROVEMENT IN THE TROPICS SHEEP AND GOATS: ASIAN EXPERIENCES**

P.N. Bhat 1/

## 1. INTRODUCTION

Sheep and goats constitute a sizable population of livestock in Asia, with 322 million sheep (22% of the world total) and 255 million goats (49%). The land area is 2679 million hectares, of which only 426 million are arable (Table 1). The small ruminants are raised in a complexity of farming systems, primarily on small farms where the emphasis is on intensive crop production, but also on extensive systems in large flocks, in groups of 500-1000, which may consist of a collection of small units. These large flocks are nomadic or transhumant, moving to high pastures in summer and plains in winter.

In Asia, sheep and goats are raised in four distinct geographic areas, which have given rise to different management systems, and different breeds/strains. The regions are:

- i. arid and semi-arid, where the majority of the sheep and goats are;
- ii. temperate and subtropical, where most apparel wool sheep are;
- iii. cold deserts, where sheep and goats form the main livestock species;
- iv. humid tropics, where goats are the main species.

Sheep and goats contribute meat, milk, skin, fibre and manure to the agricultural system (Table 2), and help to meet the world's demand for carpet wool, ropes, bags, skins and meat. They are an important source of earnings to livestock owners, and are the sole, or a subsidiary, occupation for many small, marginal farmers and landless labourers, most of whom are poor and engaged in subsistence agriculture.

Many Asian farmers prefer to invest their labour in plant food production; usually sheep and "goats are raised as an extra investment, without major labour input, and as an adjunct to a cropping system. The animals make use of natural vegetation, crop residues, roadside plants and tree leaves, which provide a sizable portion of the energy they consume.

Due to intensification of cropping, with irrigation and cultivation of large areas, there has been a progressive reduction in grazing land, resulting in high density of livestock. The grazing lands are thus over-utilized, and investment in their improvement is nil.

Population trends for sheep and goats have varied in the different Asian countries. China now has the largest sheep population (Table 1), followed by Turkey, India and Iran, while India has the largest goat population, followed by China, Pakistan and Turkey. Pakistan and China have shown the greatest recent increases in sheep numbers, while in Iran the numbers of both sheep and goats have declined. Trends in sheep numbers in India have varied from increases in the arid and north-western regions to a decline in the semi-arid southern, central and peninsular areas. Goat numbers in India have increased.

**Table 1 LAND USE, TOTAL LIVESTOCK (EXCLUDING POULTRY) AND SHEEP AND GOAT POPULATIONS IN ASIA (FAO, 1984)**

Countries	Land area (m ha)	Arable land (m ha)	Total livestock (m)	Total sheep (m)	% of the total livestock	Total goats (m)	% of the total livestock
1.	2.	3.	4.	5.	6.	7.	8.
Afghanistan	64.750	7.910	28.71	20.00	69.66	3.00	10.45
Bahrain	0.062	0.001	0.03	0.01	33.33	0.02	66.67
Bangladesh	13.391	8.917	52.14	2.00	3.84	12.05	22.89
Bhutan	4.700	0.092	0.55	0.04	7.27	0.05	9.09
Brunei	0.577	0.003	0.04	-	-	0.00	-
Burma	67.655	9.613	15.92	0.40	2.51	1.00	6.28
China	932.641	97.482	574.82	98.92	17.21	68.23	11.87
Cyprus	0.924	0.365	1.20	0.50	41.67	0.36	30.00
East Timor	1.487	0.070	0.26	0.01	3.85	0.06	23.08
Gaza Strip	0.038	0.005	0.05	0.02	40.00	0.03	60.00
Hongkong	0.099	0.007	0.51	-	-	0.00	0.00
India	297.319	164.850	379.58	40.89	10.77	80.80	21.29
Indonesia	190.457	15.000	26.04	4.79	18.39	7.91	30.38
Iran	163.600	13.100	58.65	34.30	58.48	13.60	23.19
Iraq	43.397	5.250	12.92	8.30	64.24	2.30	17.80

Israel	2.033	0.344	0.08	0.24	30.00	0.11	13.75
Japan	37.108	4.238	15.21	0.02	0.13	0.06	0.39
Jordan	9.718	0.378	1.61	1.00	61.11	0.53	32.92
Kampuchea (DM)	17.652	2.900	3.09	0.00	0.00	0.00	0.00
Korea (DPR)	12.041	2.200	4.37	0.34	7.78	0.26	5.95
Korea (REP)	9.819	2.032	6.22	0.01	0.16	0.35	5.63
Kuwait	1.782	0.002	1.00	0.60	60.00	0.31	31.00
Laos	23.080	0.870	2.86	-	-	0.06	2.10
Lebanon	1.028	0.210	0.65	0.13	20.00	0.44	67.69
Macau	0.002	-	0.01	-	-	-	-
Malaysia	32.855	1.020	3.29	0.07	2.13	0.34	10.33
Maldives	0.030	0.003	-	-	-	-	-
Mongolia	156.500	1.313	23.62	14.11	59.74	4.55	19.26
Nepal	13.680	2.318	16.91	2.52	14.90	2.60	15.37
Oman	21.246	0.015	1.23	0.30	24.39	0.70	56.91
Pakistan	77.872	20.150	86.21	24.27	28.15	28.70	33.29
Philippines	29.817	7.850	14.78	0.03	0.20	1.85	12.52
Qatar	1.100	0.003	0.13	0.05	38.46	0.06	46.15
Saudi Arabia	214.969	1.060	6.78	3.60	53.10	2.35	34.66
Singapore	0.058	0.002	1.32	-	-	0.00	00.00
Sri Lanka	6.474	1.064	3.34	0.03	0.90	0.53	15.87

Syria	18.405	5.087	16.09	14.00	87.01	1.00	6.22
Thailand	51.177	17.400	14.99	0.02	0.89	0.03	0.20
Turkey	77.076	23.468	85.59	48.70	56.90	16.73	19.55
UA Emirates	8.360	0.007	0.70	0.15	21.42	0.45	64.28
Vietnam	32.536	7.000	16.27	0.02	0.12	0.26	1.59
Yemen (AR)	19.500	2.740	5.58	1.82	32.62	2.23	91.96
Yemen (DEM)	33.297	0.192	2.78	1.00	35.97	1.38	49.64
Total	2 679.070	426.531	1 486.28	322.90	21.72	255.22	17.17

Table 2 MEAT, MILK AND WOOL PRODUCTION FROM SHEEP AND GOATS IN THE ASIAN COUNTRIES (FAO, 1984)

	Total Meat production (m kg)	Mutton production (m kg)	% of total meat	Chevon production (m kg)	% of total meat	Total milk production (m kg)	Milk from sheep (m kg)	% of total milk c	Milk from goats (m kg)	% of total milk	Total greasy wool (m kg)
1	2	3	4	5	6	7	8	9	10	11	12
Afghanistan	252	133	52.77	26	10.31	900	5	0.55	5	0.55	23.50
Bahrain	10	4	40.00	1	10.00	6	-	-	-	-	-
Bangladesh	353	2	0.56	48	13.59	1 632	17	1.04	517	31.69	1.32
Bhutan	3	-	-	-	-	13	-	-	-	-	0.04
Burma	287	2	0.69	5	1.74	507	5	0.98	6	1.18	0.40
China	18 335	322	1.75	306	1.67	4 498	525	11.67	150	3.33	187.00
Cyprus	51	6	11.76	4	7.84	119	26	21.84	40	33.61	1.20
India	1 006	133	13.22	305	30.31	35 855	-	-	955	2.66	38.00
Indonesia	537	24	4.47	38	7.07	153	-	-	-	-	-
Iran	703	230	32.71	45	6.40	2 617	705	26.93	223	8.52	16.20

Iraq	220	48	21.82	11	5.00	543	165	30.38	69	12.70	17.00
Israel	234	4	1.71	1	0.43	846	22	2.60	25	2.95	0.60
Jordan	53	6	11.32	7	13.20	45	26	57.77	170	37.77	2.50
Korea (DPR)	216	2	0.92	1	0.46	70	-	-	-	-	-
Korea (REP)	679	-	-	2	0.29	650	-	-	1	0.15	-
Kuwait	76	43	56.58	2	2.63	157	6	3.82	20	12.73	0.75
Lebanon	79	9	11.39	4	5.06	138	14	10.14	39	28.26	1.00
Malaysia	245	-	-	1	0.04	35	-	-	-	-	0.07
Mongolia	229	103	44.98	20	8.73	310	55	17.74	39	12.58	19.80
Nepal	80	12	15.00	13	16.25	793	-	-	33	4.16	4.50
Oman	14	2	14.28	4	28.57	29	-	-	9	31.03	-
Pakistan	973	180	18.49	240	24.66	9 805	35	0.35	390	3.97	45.13
Philippines	761	-	-	8	1.05	28	-	-	-	-	-
Qatar	5	3	60.00	-	-	18	2	11.11	9	50.00	-
Saudi Arabia	345	88	25.50	12	3.48	513	90	17.54	83	16.18	3.60
Singapore	105	2	1.90	-	-	1	-	-	-	-	-
Sri Lanka	35	-	-	1	2.85	270	-	-	6	2.22	-
Syria	201	80	39.80	7	3.48	1 133	525	46.33	79	6.97	25.00

Turkey	900	312	34.66	71	7.88	5 805	1 300	22.39	625	10.76	63.00
UA Emirates	20	5	25.00	4	20.00	17	4	23.52	8	47.05	-
Vietnam	835	-	-	2	0.24	87	-	-	-	-	-
Yemen AR	75	2	28.00	26	34.66	223	38	17.04	125	56.05	3.68
Yemen DEM	16	6	37.50	5	31.25	45	12	26.66	25	55.55	-

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## 2. GENETIC RESOURCES

### 2.1 Sheep

Almost all the reported data are from experiment stations and government farms; very few have been collected on producers' farms or in villages, and comparative data on crossbred and native contemporaries within the same flock or herd, run together in the villages, are rare. Such data should be collected in a planned manner, to encompass lifetime performance in relation to production, reproduction, survival and resistance to disease, so that valid comparisons can be made between native breeds, or between natives and crossbreds, run under the same field conditions.

Even the recorded information available from experiment stations is far from complete; there are few records of lifetime performance.

Table 3 gives a summary of general information on sheep breeds in various countries, while Tables 4-6 present production data, Table 4 for India and Tables 5-6 for some other Asian countries.

#### 2.1.1 India

Several authors have published extensive reviews of available data on Indian sheep breeds, including Bhat et al., (1980 and 1981), Acharya (1982), Acharya and Bhat (1984), and full details can be obtained from these. India is divided into four ecological zones, each with its own main product and different breeds - carpet wool in the Northwestern, meat in the Southern Peninsula and Eastern, apparel wool in the Northern Temperate.

One apparel wool breed not in Table 3, the Hissardale, occurs in the Northwestern Region, but it consists now of only one flock at Haryana University.

#### 2.1.2 Afghanistan

Yalçin (1979) defines 8 breeds in Afghanistan, the Karakul, bred for lamb pelts, being predominant. In general, white breeds occur in the eastern, southern and western parts of the country, and pigmented breeds in the central and northern regions.

### 2.1.3 Iraq

There is large diversity in the available sheep genetic resources, but the Awassi is the predominant breed. All grow carpet wool and meat, some also producing milk.

### 2.1.4 Iran

Various authors have identified different numbers of Iranian sheep breeds; Sohraby (1937) named 14, Ardalan (1938), 12, Jones (1964), 16 and Yalçin (1979), 16. Data in Table 3 are based mainly on Yalçin (1979).

### 2.1.5 Turkey

Turkey has 11 sheep breeds, 5 with fat tails, 1 with semi-fat, 1 with fat rump, and 4 with thin tails. The most numerous breed is the White Karaman. Two distinct strains of Turkish Merino have been developed over the last 5 decades, the Anatolian and the Karacabey, accounting now for 3 percent of the total sheep population.

Table 3 SHEEP GENETIC RESOURCES IN VARIOUS COUNTRIES

Country	Region	No. of breeds	Main products	Coat types	Colour range	Tail types	Range between breeds			Authors
							Field populations (m)	Flock sizes (head)	Adult body wt. (ewes) (kg)	
India	North western	11	Carpet wool Meat	Coarse wool, with varying degrees of medullation	Mostly white Some breeds have pigmented heads or faces	All thin	0.2-5.7	30-500	21-30	Bhat. et al., 1980 Acharya, 1982 Adharya and Bhat, 1984
	Southern Peninsula	14	Meat	Hair (no usable wool) to coarse highly medullated wool	Mostly pigmented; (a few white)	All thin	0.2-5.1(2 unknown)	25-330	20-30	Acharya, 1985

	Eastern	6	Tibetan- Wool Rea at meat	Tibetan relatively fine wool; rest not used	Tibetan white; others mixed	All thin	0.3-0.6 (2 unknown)	3-250 (1 unknown )	19-41 (poole d sexes)	
	Northern Temperat e	7	Apparel wool Carpet wool	Relatively fine and dense to coarse and highly medullate d wool	Mostly white	All thin	Unknown	Unknow n	25-35	
Afghanist an		8	Karakul (predomina nt) lamb pelts <u>Turki</u> - Meat, Rest - Meat, milk, carpet wool of varying quality	Coarse wool with varying degrees of medullati on	Some breeds white; others mainly pigmente d	6 fat- tail 2 fat- rump	0.2-6.6	not given	26-52	Yalçin, 1979
Iraq.	Central and North Western	1	Awassi - Carpet wool, meat and milk	Coarse wool With some medullati on	white; pigmente d head - may extend to fleoe	Fat	5.0	Not given	40-65	Karam et al., 1971 B hat, 1985
	Southern	1	Arabi - Carpet wool and meat	Coarse wool with some medullati on	White pigme nted head - may extend to fleece	Fat	5.0	Not given		
	Northern	1	<u>Karradi</u> (or Kurdi) - Carpet wool, meat and milk	Coarse wool with some medullati on	White pigmente d head - may extend to fleece	Fat	not given	not given		

	General	3	Strains developed from main 3 breeds		Many animals pigmented	Fat	Small numbers	not given	not given	
Iran	North and North-easter	6	Meat, milk, carpet wool Karakul - Sate lamb pelts also (black)	Coarse wool with varying degrees of medullation	Pigmented except one mainly white (Zel)	5 fat-tail 1 thin tail (Zel)	0.2-2.3	not given	30-50	Sohraby, 1937 Arde lan, 1938 Johns, 1964
	North-western	2	Meat, milk, carpet wool	Coarse wool with varying degrees of medullation	White; pigmented face and feet	Fat	1.2-3.4	not given	40-45	Yalçin, 1979
	Eastern	1 (Baluchi)	Carpet wool, meat and milk	Coarse wool with medullation	White, pigmented head and legs	Fat	10.3 (includes Baluchi and Kallakui from NE)	not given	35-40	
	Western	5	Meat, milk and carpet wool	Coarse wool with medullation	Some white with pigmented head and legs, some pigmented	Fat	0.04-3.5	not given	40-50	
	South-western	1 (Bakhtiari)	Meat, coarse carpet wool and milk	Coarse wool with medullation	Mainly white - pigmented head and feet	Fat	1.5	not given	45-50	
	Southern	1 (Grey Shiragi)	Lamb pelts, Meat and carpet wool	Coarse wool with medullation	Grey	Fat	3.2	not given	42-45	

Turkey	West and Northwest	3	Garpet wool, Me at and milk	Coarse wool with medullati on	Mostly white - pigmente d face and legs	1 Fat 2 Thin	0.06-0.32	50-300(2 unknow n)	35-40	Yalçin, 1979
	Center and Northwest	1 (Merino)	Wool	Apparel wool.	White	Thin	1.2	not given	50-55	
	Central West	1 (sekis)	Meat and Milk	Course Wool with medullati on	white some pigment	Semi-fat	0.01	2-4	40-45	
	Central North	1(karakul )	Lamb pelts, meat and carpet wool	Course wool with medullati on	Pigmente d (lamb black)	Fat	0.1	not given	35-45	
	Centre and east	1 (white and Karaman )	Carpet wool and meat	Course wool with medullati on	White black nose	Fat	17.9	not given	35-50	
	Northeast	3	Meat milk and carpet wool	Course wool with medullati on	2 white 1 pigmente d	1 thin-tailed 1 fat-tailed 1 fat-rump	0.1-8.1	5-200(2 unknow n)	35-55	
	Southeast	1 (Awassi)	Carpet wool, neat and milk	Coarse wool With medullati on	White-pig-mented head	Fat	0.8	not given	40-45	
Pakistan	Baluchista n	4	Carpet wool, neat and milk	Coarse wool with medullati on	Mostly white pigmente d heeds and feet	Fat	not given	40-1000	30-33	Hasnain , 1985
	Northwest Frontier Province	7	Meat, milk and carpet wool	Coarse wool I with medullati on	4 white, - pigmente d head 3 pigmente d	5 fat 2 thin	not given	22-150	22-70	

	Punjab	7	Carpet wool and meat, one milk also (Thalli)	Coarse wool with medullation	Mostly White pigmented head and legs	Thin	not given	20-300	23-45
	Sind	3	Meat and carpel Wool - 2 milk also	Coarse wool with medullation	Mostly white, pigmented head	1 fat 2 thin	not given	15-500	23-30
	Northern Areas	3	Meat and menure 1 also carpet wool and milk 1 also milk	1 no wool 2 coarse wool with medullation	Mixed	2 Small fat 1 thin	not given	5-90	25-33
	Azad Kashmir	4	Meat and carpet ore (Kail) apparel wool one (Pahari) milk	3 coarse with medullation 1 finer with less medullation	Mixed	Mostly thin	not given	10-250 (2 unknown)	29-35

China	Pastoral	7 (native)	Carpet wool and neat	Coarse wool with varying medullation	Mostly white; pigmented heads and necks	3 fat-tail 1 fat-rump 3 thin-tail	not given	not given	33-69	Cheng, 1985
		3 (developed)	Apparel wool and neat	Apparel wool	White	Thin	not given	not given	44-52	
	Mixed agricultural - pastoral	1 (Tan)	Lamb pelts carpet wool and meat	Coarse wool with medullation	White pigmented head	Fat	not given	not given	35	
	Agricultural	4	Lamb pelts and carpet wool	Coarse wool with medullation	Mostly white same pigmented heads and necks	Fat	not given	not given	31-41	

General reference - Ponting (1980).

**Table 4 BETWEEN-BREED RANGES OF IMPORTANT ECONOMIC TRAITS FOR INDIAN SHEEP BREEDS**  
(Acharya and Bhat, 1984)

Region	Body weight at: Greasy fleece weight								Survivability		
	No. of breeds recorded	3 mths kg	12 mths kg	6 mths kg	Adult kg	Medulation %	Staple length cm	Average fibre diameter $\mu$ m	0-3 mths %	3-12 mths %	Adult %
Northwestern	9	8-13	18-33	0.5-1.4	0.9-2.9	24-83	5-9	28-115	71-99	80-99	73-94
Southern Peninsula	11	7-14	14-24	0.3-0.9 (2 breeds only)	0.7-1.2 (3 breeds only)	24-43 (2 breeds only)	6-7 (2 breeds only)	27-59 (3 breeds only)	81-98 (6 breeds only)	95-97 (3 breeds only)	89-97 (3 breeds only)
Northern	3	8-22	16-18 (2 breeds only)	0.4 (1 breed only)	0.8-2.8	0-26	6-16	20-34	89 (1 breed only)	89 (1 breed only)	80-91 (2 breeds only)

**Table 5 PRODUCTION PERFORMANCE OF SHEEP OF THE ASIAN COUNTRIES**  
(Acharya, 1985)

Breed	Fleece Production			Lactation		Birth (%)	Twinning (%)
	Annual greasy fleece weight (kg)	Average fibre diameter ( $\mu$ m)	Percent medulation	Yield (kg)	Length (days)		
1	2	3	4	5	6	7	8
<b><u>AFGHANISTAN</u></b>							
Arabi	1.2-1.7	36	52	45-55	130-140	65-80	0-2
Baluchi	1.3-1.8	30	28	35-40	120-130	60-75	0-1
Gadik	0.6-0.9	24	19	30-35	120-130	65-75	0-1
Ghiljai or Ghilzai	1.5-2.0	34	45	35-45	120-130	70-75	0-2

Khandhari	1.2-1.6	35	42	35-40	120-130	65-75	0-2	
Karakul	2.0-2.6	38	57	40-45	120-130	70-85	5-8	
Turki	0.8-1.0	-	51	55-65	130-140	75-80	8-10	
<u>IRAQ</u>								
Awassi	2.0-2.5	32	2.4	156	-	-	-	
Arabi	1.5-2.0	31	2.5	-	-	-	-	
Karradi	2.3-3.0	47	3.9	-	-	-	-	
Hamdani	2.5-4.0	40	5.5	-	-	-	-	
Neimi	1.5-2.0	40	7.2	-	-	-	-	
<u>IRAN</u>								
Bakhtiari	1.5-1.8	-	-	35-40	130-140	70-85	2-7	
Baluchi	1.3-1.8	-	-	40-50	120-130	60-75	1-5	
Grey Dhirazi	1.5-1.8	-	-	45-55	140-150	90-95	1-2	
Karakul	1.6-2.5	-	-	40-50	120-150	90-95	2-10	
Kurdi	1.8-2.0	-	-	60-65	-	-	-	
Makui	1.5	-	-	60-65	-	-	-	
Mehraban	0.8-1.2	-	-	60-65	150-180	70-80	0.8	
Sangasari	1.0	-	-	35-40	-	-	-	

Sanjabi	1.5-2.0	-	-	54	180	80	3.0
Zol	1.0-2.2	-	-	35-40	130-140	70-80	3-5
<u>TURKEY</u>							
Awassi	1.8-2.2	32-35	-	100-155	200-210	-	12
Deglic	1.8-2.2	28-32	-	35-45	130-140	-	1-2
Imroz	1.6-2.0	32-40	-	70-100	150-170	-	10-20
Karakul	2.3-2.5	33-35	-	55-60	130-140	-	10-15
Kivirdik	1.3-1.7	27-30	-	60-90	150-160	-	10-20
Red Karman	1.2-1.5	30-34	-	45-55	140-150	75-80	0-5
Turkish Merino							
a) Karacabey Merino	3.0-3.4	22-33	-	50-70	130-140	85-95	10-20
b) Central Anatolian Merino	3.7	22	-	40-50	140-150	88-90	45
Knise Karaman	1.5-2.0	30-35	-	40-50	140-150	-	4-5

**Table 6a** BODY AND FLEECE WEIGHTS (KG), MILK PRODUCTION (KG), FERTILITY AND LAMBING PERCENTAGE IN VARIOUS IRAQI BREEDS OF SHEEP (Bhat, 1985)

	Awassi		Arabi		Karradi		Hamdani		Neimi	
	M	F	M	F	M	F	M	F	M	F
Weight kg at/c										
1. Birth	4.5	4.3	3.5	3.0	4.0	3.5	5.0	4.5	4.0	3.8

2. Weaning	28.0	25.0	20.0	18.0	24.0	22.0	30.0	27.0	25.0	23.0
3. Yearling	50.0	45.0	38.0	30.0	40.0	34.0	55.0	50.0	40.0	35.0
4. Maturity	65.0	55.0	50.0	40.0	50.0	42.0	80.0	65.0	55.0	45.0
5. Fleece	2.5	2.0	2.0	1.5	3.0	2.3	4.0	2.5	2.0	1.5
Milk Production (kg)		106		40		60		80		100
Lactation Period (days)		142		140		130		145		146
Staple Length (cms)		4-6		2-4		6-8		7-9		3-6
% ewes lambing		75		55		80		89		60
Lambing Percentage		120		104		104		124		105

Table 6b FIBRE DIAMETER (MICRONS), MEDULLATION PERCENTAGE AND KEMP PERCENTAGE IN WOOL SAMPLES

	Rams				Ewes			
	(n)	F.D.	Med.	Kemp	(n)	F.D.	Med	Kemp
Awassi	16	32.5	1.9	0.5	-	-	-	-
Arabi	10	31.2	2.4	0.1	3	29.1	1.2	0.6
Karradi	13	47.4	3.4	0.5	-	-	-	-
Hamdani	19	40.1	4.3	1.2	100	43.0	8.2	1.3
Ne'imi	9	40.1	4.6	2.6	22	38.4	6.4	2.7

#### 2.1.6 Pakistan

Hasnain (1985) described altogether 28 sheep breeds in Pakistan, grown mainly for carpet wool and meat; some are also milked, and one (Kail) produces apparel wool. About half have fat tails.

#### 2.1.7 China

Cheng (1985) described 12 native breeds, grown for carpet wool, lamb pelts and meat. Three new Merino types have been developed.

#### 2.1.8 Indonesia

Sheep breeds found in Java are of two main types, the Thin-tailed sheep (JTT) prevalent in the West and the Fat-tailed wool sheep (FTJ) found mostly in East Java (Hardjosubroto, 1980). Both types grow coarse, highly medullated fleeces which are not used; in fact, the FTJ are kept closely clipped. The JTT are pigmented and FTJ mostly white. Both are known to be highly fecund, but of low mature liveweight. Lamb mortality tends to be high, partly on account to low birth weights and partly because of unpredictable multiple births.

These sheep are known to be very prolific, with litters of 3 and 4 occurring with relatively high frequency, and litters of 5 and 6 on rare occasions (Sitorus and Subandriyo, 1982). However, they also show a much higher incidence of single births than expected for sheep which have 3 or more lambs at the frequencies observed, and are unusually variable in litter size. Mortality is very high in the larger litters. The overall mean number of lambs born in 131 lambings was 1.98, identifying the breed as above average but not of exceptional prolificacy. However, 11% of parturitions contained 4 or more lambs, a most unusual result for a group with a mean of 2 or less.

Documentation of the extreme variability in litter size indicates potential for very high production from the Javanese Thin-tail ewes, but also major management problems. Mortality rates of 16.7, 18.4, 35.5, 42.9 and 60.0% for lambs born in litters of 1, 2, 3, 4 and 5 respectively have been recorded. Applying these to the proportions of ewes producing the different litter sizes reported for JTT gives a mean of 133 lambs weaned per 100 ewes lambing, not a very outstanding record compared to other breeds of the region.

#### 2.1.9 Sri Lanka

According to Goonewardena et al. (1984) the native sheep are mostly concentrated in the northern and eastern regions of the island. The climate in these regions is hot and humid throughout the year. The native sheep are hairy and small in size. The mean heights at withers of adult rams and ewes are 52 and 49 cm respectively, and the mean adult body weights 24 and 19 kg. Ewes are capable of breeding all the year round, but management aims at a peak between the months of November and January.

It is believed the sheep were brought from South India several hundred years ago. The native flocks are generally closed, with some between-flock movement of rams.

The native sheep of Sri Lanka are a product of natural selection in a semi-arid environment, resulting in poor growth rate, later maturity and poor reproduction rate. They are impressive, however, in their ability to survive and reproduce in the harsh environment.

#### 2.1.10 Malaysia

There is only one breed of sheep in Malaysia. Lee et al. (1978), Vanselow (1978) and Mukherjee (1980), have described some production figures of this breed, which is only available in small numbers. The wool is not used. Current interest in these sheep has grown due to their capacity for harvesting weeds from the plantations.

### 2.2 Goats

#### 2.2.1 India

The origin of the Indian goat breeds is not clearly known. They are believed to have been derived from wild goats which inhabited the Asian mountains in antiquity, and to have been domesticated around the 7th century BC, much earlier than cattle (Allchin, 1969). There are at present 20 distinct goat breeds in India, of which several are economically useful, with distinct characteristics of productivity and adapted to the various agro-climatic regions. Eleven are in the Northwestern Region, 4 in the Southern Peninsular, 2 in the Eastern and 3 in the Northern Temperate.

The Jamnapari breed of the Chambal Ravines in Etah district (UP) has been extensively used for improvement of native breeds in several countries. The famous Anglo-Nubian breed is based on a cross of the Jamnapari. The dwarf goat breeds, such as Black Bengal, Barbari, Malabari and Assam Hill, are famous for high prolificacy (multiple births), early sexual maturity and generally give two kid crops in a period of 14 months. The Pashmina goats of Ladakh produce the finest quality of pashmina fibre (cashmere) in the world.

Many excellent reviews are available on the genetic resources of goats in India (Bhat et al., 1980; Acharya, 1982; Acharya and Bhat, 1984). Large inter- and intra-breed variability is indicated (Table 7) but most of the data reported are from experimental stations and Government farms. Very few reports are available from producers' flocks under village conditions. Comparative data on crossbreds and native contemporaries within the same flocks under village conditions are not available.

#### 2.2.2 Afghanistan

There are four goat breeds in Afghanistan. The Vatani and Asmari produce pashmina fibre from their undercoats. Generally information on them is scanty and evaluations are not available. The Asmari is generally used as a pack animal and for meat. Its long hair is used for making ropes and tents.

#### 2.2.3 Iraq

Iraq has a number of goat breeds. These are small triple-purpose animals. The Khurdi, found in the northern provinces, is similar to the Central Asiatic Pashmina. In the Dohak region Angora goats are found, which produce mohair in common with the Angoras of Turkey. Many colours are found in Angoras. The Iraqi is another important breed, which is generally black, but other colour types are known. This breed is the most numerous, and is found in all three agro-climatic zones; it is used generally for meat.

#### 2.2.4 Iran

Iran has a number of breeds, the most common being the Khurdi of northern Iran. The Nejdi is dual-purpose (milk and fleece), and the Lori is an Iranian milk goat. Morghose, Raini and Khurdi are pashmina-producing.

#### 2.2.5 Turkey

There are 6 breeds of goats. One fourth of the entire goat population, however, consists of Angoras and other fibre-producing breeds.

#### 2.2.6 Pakistan

Hasnain (1985) lists 25 breeds of goats, which are maintained for meat, milk, fibre and skins. Some of these are also used as pet animals. Four are able to produce fibre like pashmina. There are 3 breeds in Baluchistan, 3 in N.W. Frontier Province, 4 in Punjab, 4 in Sind, 4 in the Northern Areas and 7 in Azad Kashmir.

**Table 7 BETWEEN BREED RANGES OF IMPORTANT ECONOMIC TRAITS FOR INDIAN GOAT BREEDS**

(Acharrya, 1982; Acharya and Bhat, 1984; Acharya, 1985)

Region	No. of breeds	Body weight at:		Total yield kg	Lactation		Dry period days	Age at first kidding days	Kidding interval days	Service period days	Kidding %	litter size (% total kiddings)			
		3 mths kg	12 mths kg		Daily yield kg	Length days						1 %	2 %	3 %	4 %
North-Western	6	6-10	15-22	71-173	0.7-1.3	106-188	115-155 (3 breeds only)	525-776 (4 breeds only)	329-365 (3 breeds only)	124-170 (2 breeds only)	30-154 (4 breeds only)	41-100	7-52	0-7	0-0.2
Southern Peninsula	3	6-7	14-17 (2 breeds only)	54-83 (2 breeds only)	0.4 (1 breed only)	168-172 (2 breeds only)	145 (1 breed only)	491-610	290-357 (2 breeds only)	143-155 (2 breeds only)	187 (1 breed only)	44-62 (2 breeds only)	36-44 (2 breeds only)	0.6-6 (2 breeds only)	0-0.3 (2 breeds only)
Eastern	2	5 (1 breed only)	11-12	52 (1 breed only)	-	119 (1 breed only)	-	522-1067	282-376	90 (1 breed only)	85 (1 breed only)	22 (1 breed only)	54 (1 breed only)	20 (1 breed only)	3 (1 breed only)
Northern Temperate	2	7-9	17 (1 breed only)	69 (1 breed only)	-	187 (1 breed only)	-	628 (1 breed only)	280 (1 breed only)	-	-	-	-	-	-

### 2.2.7 China

Several authors have described Chinese goat breeds (Epstein, 1969, Devendra and Burns, 1970; Cheng 1985). Cheng lists 16, with 3 in the pastoral, 1 in the mixed agricultural-pastoral and 12 in the agricultural areas. They are used for meat, skins and pelts, with 8 producing cashmere; of these, the Liaoning Cashmere, in the agricultural areas, has the highest production.

### 2.2.8 Indonesia

The Katjang goat is the indigenous type and Katjan Etawah crosses are also common. The Etawah is actually a cross between the Jamnapari imported from India and better local Javanese goat varieties. Though essentially a milking goat, the Etawah is rarely used for milk in Indonesia. Both the Etawah and the Katjang types are valued almost exclusively for their meat. The Gambrong breed of East Bali is larger than the Indonesian Katjang, and has a special purpose in that the long coarse hair of the male is used to make fishing lures.

### 2.2.9 Malaysia

The Katjan breed has been described in a number of reviews (Devendra and Burns, 1970; Devendra and Nozawa, 1976; Mukherjee, 1980). This breed is supposed to have given rise to a large number of sub-types which are available throughout the South-Asian region, particularly in Malaysia, Indonesia and the Philippines. Mason (1969) considers the Sarawak breed of Malaysia and the Metiga of Indonesia small varieties of Katjan. The Philippines native goats are also of the same type, but with coarse hair. In both Malaysia and Indonesia these breeds have been crossed with the Jamnapari of India and crossbreeding has resulted in a breed called Peranakan Etawah in Indonesia.

#### 2.2.10 Korea

Korea has a medium-sized black goat which is not generally described as a breed type. It has been suggested that these goats are related to Chekiang and Kiangsu goats of Eastern China.

#### 2.2.11 Japan

The native Japanese goat, called Tokara, is generally found in Southern Tynkyu Island. It is believed to be an introduction from Taiwan around the 15th century AD. The Okinawa meat goat has been described by Shinjo et al., (1978). Nozawa et al., (1978) have suggested that 13% of the genes in this breed have been derived from the Saanen breed; their suggestion is based on blood protein polymorphism.

### **3. HUSBANDRY**

#### 3.1 Management Practices

##### 3.1.1 India

In arid and semi-arid regions sheep and goats are raised on permanent migration and the flocks follow well-established migratory routes according to the season. They are not brought to a homestead at any time of the year. Another group, generally from the western district of Rajasthan, migrate for 6-9 months and are brought to the homestead for the rest of the year. Goat flocks are normally non-migratory, except where they form part of mixed sheep and goat flocks. The animals are grazed on crop residues in harvested fields, in forests and in lean seasons on tree loppings. Only lactating animals get supplementary feeds, which may vary from concentrate mixture to hay or dry tree leaves. About 60% of flocks are penned in open fields away from the house and the rest are penned in temporary yards. Although the animals breed around the year, most breeding is linked with seasonal availability of grazing resources. The males stay with the flocks throughout the year, with copulation prevented as required.

In sub-tropical and temperate regions most flocks start migration in April, when they move to alpine pastures at high altitude, and start migration down in the month of October. During April-October they graze the alpine pastures, and during winter are fed dry fodder, tree leaves and concentrates. They are penned in closed houses as a protection against cold.

##### 3.1.2 Afghanistan

Eighty percent of the sheep population are kept in transhumant flocks and the remaining 20% are stationary. Grain feeding is practised on an extremely limited scale. Breeding begins about the middle of September. Most surplus lambs and kids are marketed at about 7-10 months of age. In the Karakul breed 95% of male lambs are killed for pelt within 24 hours of birth.

##### 3.1.3 Iran

Seventy percent of the sheep population is transhumant. Flocks migrate long distances following seasonal grass growth. The other 30% are stationary and are maintained on grazing lands around villages. During the cold and snowy winters sheep are often subjected to critical feed shortages, with high death rates and poor lamb crops.

#### 3.1.4 Iraq, Syria, South Arabia and Yemen

In most Middle East countries, sheep are kept in communal flocks. The flocks are either stationary, transhumant or fully nomadic. Transhumance is generally observed in mountainous areas.

#### 3.1.5 South Asia

Most flocks are with smallholders, 2-3 goats being tethered together and raised as part of the household. Very rarely is there special housing for either sheep or goats, except in Malaysia (goats) and Java (sheep).

### **4. IMPROVEMENT PROGRAMMES**

#### 4.1 Sheep

##### 4.1.1 India

###### i. Selection within indigenous breeds

Bhat et al. (1980), Acharya (1982) and Acharya and Bhat (1984) • have reviewed a large number of Indian experiments aimed at increasing either body weight or fleece quality in indigenous breeds. Most of these have had neither continuity in time nor consistency in purpose, and the main gains from the studies have been estimates of phenotypic and genetic parameters for the breeds used. From these estimates it has been concluded that selection on body weight at 6 months improves market weight, yearling body weight and ewe productivity, while an index based on body weight at 6 months and greasy fleece weight would improve fleece quality. Selection against medullation percentage would show a significant reduction, with a correlated decrease in average fibre diameter, body weight and fertility.

Improvement programmes through selection of indigenous breeds, using better pedigreed rams, have been undertaken in a number of Indian States: in Rajasthan with the Bikaneri and its derivatives, in Andhra Pradesh with the Nellore Mandya, in Uttar Pradesh with the Muzzafarnagri (in the western districts where sheep have been adapted to irrigated agriculture), and in Punjab and Haryana with the Nali and Lohi.

Although many programmes have been launched by various State Governments to improve the productivity of native village sheep flocks by the use of improved breeds, the results by and large have not been satisfactory.

###### ii. Use of tropical improver breeds

Crosses produced by grading up the Bellary and other coarse-wooled hairy breeds with the Bikaneri have shown improvement in greasy wool weight and wool quality, as indicated by a decline in medullation percentage and fibre diameter. Superior Indian carpet wool and mutton breeds have been extensively used for upgrading; for example, the Nali and Lohi of Punjab and Haryana have

been widely used on local populations in the Indo-Gangetic Plains, with some rewarding results, though not in the case of the cross between the Nali and the Muzzafarnagri in irrigated areas.

North Indian carpet wool breeds have also been used on South Indian woolless mutton breeds to introduce fleece cover; in most crossbreds there was an improvement in fleece quality and quantity, but none in body weight gain, dressing percentage or efficiency of feed conversion.

By and large these experiments have shown a marginal improvement in wool characteristics, but in the absence of any field recording system it is difficult to evaluate the impact of the improvement programmes on populations adapted to various ecological niches. The programmes have shown, however, that within breed selection is superior to the use of improver breeds.

### iii. Use of temperate breeds

Crossbreeding with superior temperate breeds to improve wool quality and mutton production has been extensively used, and the results have recently been reported by Acharya (1982) and Acharya and Bhat (1984). Most of these experiments were done to improve wool weight and quality; breeds of three fleece types (fine carpet wool, Chokla; medium carpet wool, Jaisalmeri and coarse carpet wool, Malpura) were crossed with Rambouillet and interbred at various levels of exotic genes (Acharya and Mohan, 1979). Fine wool (Avastara) and superior carpet wool strains (Avakalin) have been produced from these experiments (Tables 8, 9 and 10).

A classic example of success in introducing superior temperate inheritance into indigenous sheep with the objective of developing a fine wool breed is the Kashmir Merino, which is now a well recognized Indian breed, used for apparel wool. This breed is a result of crossing 4 breeds of sheep in the valley of Kashmir, initially with Australian Merino, then with Rambouillet and Russian Merino. About 75-82% of genes in the breed are now from the three exotics, the majority coming from Russian Merino. The present population of the Kashmir Merino exceeds 1 million.

Table 8 AVERAGES AND STANDARD ERRORS OF GREASY FLEECE WEIGHT AND WOOL QUALITY ATTRIBUTES OF INDIAN SHEEP BREEDS CHOKLA, NALI AND PATTANWADI AND THEIR CROSSES WITH RAMBOUILLET AND MERINO  
(Arora et al. , 1983; Acharya and Bhat, 1984)

Breed or cross		Average fibre diameter $\mu\text{m}$	Medullation %	First 6 monthly greasy fleece weight kg	Body weight at 6 months kg
Chokla		23.1 $\pm$ 0.35 (79)	25.1 $\pm$ 0.05 (79)	0.9 $\pm$ 0.02 (439)	13.3 $\pm$ 0.15 (315)
	F1	20.6 $\pm$ 0.19 (196)	19.0 $\pm$ 0.04 (196)	1.0 $\pm$ 0.03 (795)	15.2 $\pm$ 0.11 (749)
	F2	21.2 $\pm$ 0.38 (81)	19.0 $\pm$ 0.04 (80)	1.0 $\pm$ 0.03 (115)	16.2 $\pm$ 0.29 (124)
	5/8	20.8 $\pm$ 0.57 (33)	15.2 $\pm$ 0.06 (30)	1.1 $\pm$ 0.04 (39)	14.8 $\pm$ 0.45 (41)
	3/4	20.0 $\pm$ 0.42 (63)	11.9 $\pm$ 0.04 (62)	0.9 $\pm$ 0.07 (62)	15.8 $\pm$ 0.03 (104)
Nali		28.0 $\pm$ 0.45 (81)	62.8 $\pm$ 0.85 (81)	1.0 $\pm$ 0.37 (341)	13.8 $\pm$ 0.15 (314)
	F1	26.6 $\pm$ 0.18 (308)	28.1 $\pm$ 0.02 (308)	1.0 $\pm$ 0.03 (1028)	14.8 $\pm$ 0.09 (954)
	F2	21.8 $\pm$ 0.28 (159)	27.7 $\pm$ 0.03 (155)	1.1 $\pm$ 0.03 (191)	16.2 $\pm$ 1.9 (206)
	5/8	22.0 $\pm$ 0.51 (44)	23.8 $\pm$ 0.07 (43)	1.1 $\pm$ 0.03 (66)	16.6 $\pm$ 0.34 (67)
	3/4	19.3 $\pm$ 0.48 (61)	11.4 $\pm$ 0.05 (50)	1.0 $\pm$ 0.08 (125)	16.2 $\pm$ 0.26 (132)
Pattanwadi (P)		28.0 $\pm$ 0.46 (85)	35.0 $\pm$ 1.8 (85)	0.5 $\pm$ 0.61 (86)	16.8 $\pm$ 0.18 (144)
Rambouillet x P		21.9 $\pm$ 0.24 (191)	16.0 $\pm$ 0.76 (191)	0.6 $\pm$ 0.01 (191)	19.4 $\pm$ 0.23 (306)

Merino x P	22.4 ± 0.44 (54)	18.2 ± 1.6 (54)	0.7 ± 0.02 (55)	18.8 ± 0.21 (172)
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Numbers of observations in parentheses

The results of crossbreeding utilizing Dorset and Suffolk are given in Tables 11 and 12. Suffolk crosses were generally superior to Dorset crosses, but in many cases there was not much improvement in either cross. However, inter-breeding of Dorset and Suffolk crossbreds showed better results.

Similarly, Suffolk, Dorset and Corriedale have been used on large field populations to develop mutton type strains. In a number of cases this experience has not been rewarding. A number of crossbreds so produced have not survived when run together with the natives, particularly when the advantage of special care and management of the experimental farms was withdrawn. With most of the crossbreeding experiments, except where sustained efforts have been made as in the case of the Kashmir Merino, the results have not been successful. The general situation is that under the prevailing realities of sheep husbandry, it may not be possible for crossbreds run under village conditions of management and survival to outdo the native well adapted breed types on the basis of lifetime production. Since no data are available on such comparative lifetime production records it is difficult to make any positive recommendations, but by and large the results have not been satisfactory (Bhadula and Bhat, 1981; Bhat, Pran P. et al. 1978 and 1981).

**Table 9 AVERAGES AND STANDARD ERRORS OF GREASY FLEECE WEIGHT, WOOL QUALITY ATTRIBUTES AND SURVIVABILITY OF INDIGENOUS AND SYNTHETICS (Arora et al., 1983)**

Breed	Annual greasy wool production (kg)	Average fibre diameter ( $\mu\text{m}$ )	Medullation (%)	Six monthly body weight (kg)	Survivability (0-90 days) (%)	Lambing on the basis of ewes available (%)
Nali	2.9 $\pm$ 0.02 (879)	28.6 $\pm$ 0.71 (20)	42.8 $\pm$ 4.0 (20)	14.4 $\pm$ 0.14 (397)	84 (1072)	86.5 (104)
Chokla	2.5 $\pm$ 0.01 (879)	23.2 $\pm$ 0.79 (23)	18.4 $\pm$ 3.2 (23)	13.7 $\pm$ 0.13 (363)	83 (1235)	78.8 (85)
Nali synthetic	2.8 $\pm$ 0.02 (760)	22.9 $\pm$ 0.23 (132)	16.3 $\pm$ 3.4 (127)	16.4 $\pm$ 0.07 (1603)	92 (3502)	74.9 (315)
Chokla synthetic	2.7 $\pm$ 0.03 (543)	21.1 $\pm$ 0.26 (64)	8.8 $\pm$ 1.1 (54)	16.3 $\pm$ 0.09 (1157)	87 (3021)	82.3 (215)
Superiority percentage of new synthetics over indigenous						
Nali synthetic	(-) 0.8	18.3**	52.4	13.9**	9.4	(-)13.4
Chokla synthetic	7.9**	6.8**	21.8	19.2**	5.66	4.4

\*\* P <0.01

Number of observations in parentheses

Russian Karakul sheep have been imported into India and crossed with Indian coarse carpet wool breeds for lamb pelt production under both hot and cold arid climates. The performance of Karakuls in both cases with respect to growth, survivability, greasy fleece production, productive performance and pelt quality were highly satisfactory. The crosses of Karakul with coarse carpet wool breeds showed significant improvement in pelt quality over the natives. There was, however, a large variation in pelt quality, and if selection within the crossbred population is resorted to, it is bound to lead to significant improvement in Indian pelt sheep (Acharya et al., 1980).

#### 4.1.2 Afghanistan

Very little information is available concerning sheep production in Afghanistan. Studies were conducted for improving the productivity of Ghiljai, Hazargie and Gadik breeds through crossbreeding with Turkish

Table 10 AVERAGES AND STANDARD ERRORS OF GREASY FLEECE WEIGHT AND WOOL QUALITY ATTRIBUTES OF INDIAN SHEEP BREEDS MALPURA AND DECCANI AND THEIR CROSSES WITH RAMBOUILLET AND DECCANI (Arora et al., 1983; Acharya and Bhat, 1984)

Breed or cross		Average fibre diameter $\mu\text{m}$	Medullation %	First 6 monthly greasy fleece weight kg	Body weight at 6 months kg
Malpura		40.9 $\pm$ 0.54 (145)	82.9 $\pm$ 0.05 (145)	0.5 $\pm$ 0.03 (211)	14.0 $\pm$ 0.44 (190)
	F1	27.8 $\pm$ 0.55 (117)	41.3 $\pm$ 0.05 (117)	1.0 $\pm$ 0.04 (113)	19.9 $\pm$ 0.44 (113)
	F2	24.6 $\pm$ 0.64 (85)	24.2 $\pm$ 0.06 (85)	0.9 $\pm$ 0.03 (114)	20.5 $\pm$ 0.39 (114)
	5/8	21.2 $\pm$ 0.08 (53)	17.0 $\pm$ 0.11 (50)	0.9 $\pm$ 0.04 (84)	20.6 $\pm$ 0.42 (84)
	3/4	19.7 $\pm$ 0.78 (58)	14.3 $\pm$ 0.09 (58)	0.8 $\pm$ 0.04 (103)	19.3 $\pm$ 0.42 (103)
Deccani (D)		52.4	68.2	0.5 $\pm$ 0.02 (55)	17.4 $\pm$ 0.74 (58)
Merino x D		23.9	32.8	0.6 $\pm$ 0.03 (26)	17.5 $\pm$ 0.69 (27)

Numbers of observations in parentheses.

**Table 11 AVERAGES AND STANDARD ERRORS FOR CHARACTERS RELATED TO FEEDLOT PERFORMANCE OF INDIGENOUS AND CROSSBRED SHEEP BRED FOR MUTTON**  
(Arora et al., 1983)

Breed	Weaning weight (kg)	Feedlot gains (kg)	Efficiency of feed conversion (%)	Dressing percent on live weight (%)
Mandya	9.6±0.14 (885)	8.2 (45)	13.3 (81)	48.9 (42)
Dorset x Mandya	11.6±0.29 (463)	12.2 (91)	17.4 (84)	49.0 (49)
Suffolk x Mandya	11.9±0.49 (302)	11.4 (44)	17.8 (52)	48.8 (37)
Nellore	11.9±0.28 (562)	8.3 (44)	14.0 (79)	47.8 (38)
Dorset x Nellore	14.0±0.57 (395)	12.5 (60)	17.4 (59)	50.5 (9)
Suffolk x Nellore	13.9±0.40 (303)	10.9 (29)	15.6 (36)	49.5 (21)
Deccani	13.4±0.49 (47)	9.0	11.7	41.8 (10)
Dorset x Deccani	14.2±0.80 (12)	12.0	14.1	44.9 (15)

Number of observations in parentheses.

Merino, Russian Merino and Columbia. There was an improvement in crossbreds over indigenous breeds in wool weight and quality and in body weights at State farms. However, exotic breeds or their crosses could not survive under the conditions of nutrition existing in the villages. No trace of these crossbreds can be found today.

**Table 12 AVERAGES AND STANDARD ERRORS FOR CHARACTERS RELATED TO FEEDLOT PERFORMANCE OF INDIGENOUS AND CROSSBRED SHEEP GROWN FOR MUTTON (Bohra, 1984)**

Genetic group	Weaning weight (kg)	Feedlot gain (kg)	Total feed intake <sup>1/</sup> (kg)	Efficiency of feed conversion (%)	Dressing percentage live weight basis (%)
Malpura	11.4±0.20 (326)	9.1±0.45 (99)	69.9±2.22 (80)	13.1±0.38 (71)	47.4±0.40 (72)
Sonadi	11.3±0.19 (364)	8.6±0.45 (107)	67.1±2.30 (79)	12.4±0.40 (68)	46.0±0.38 (93)
Dorset x Malpura	12.8±0.17 (471)	11.7±0.41 (139)	75.1±1.89 (121)	15.7±0.32 (119)	48.4±0.36 (96)
Dorset x Sonadi	12.5±0.17 (486)	12.0±0.39 (147)	76.6±1.84 (118)	15.9±0.32 (117)	48.2±0.35 (102)
Suffolk x Malpura	13.1±0.20 (277)	12.6±0.44 (104)	73.7±2.10 (88)	16.2±0.36 (77)	47.5±0.38 (77)
Suffolk x Sonadi	13.3±0.19 (311)	12.9±0.44 (108)	75.9±2.12 (85)	16.0±0.36 (80)	47.2±0.38 (82)

<sup>1/</sup> Feed composition: *Zizyphus numularia* or cowpea hay 30 parts, maize 40 parts, groundnut cake 20 parts, molasses 7 parts, mineral mixture 2 parts and common salt 1 part.

Number of observation in parentheses.

The Karakul Institute in Afghanistan is providing facilities for grading and marketing of pelts. The efforts made by the Institute have increased the proportion of grey pelts from 30 to 70%, and the proportion of top grade pelts from 30 to 80%.

#### 4.1.3 Iraq

##### i. Body weights and growth rate

Hamdani sheep are the largest of all Iraqi breeds at all ages, followed by the Awassi and Ne'oimi. The smallest are Arabi and Karradi. Most sheep reach their mature weight between three and five years of age, the relatively fast growers such as Hamdani reaching it earlier. Some of them have reached a weight of 100 and 115 kg at Aski-Kalak Station at 18 months; males are always heavier than females and singles tend to be heavier than twins, differences decreasing after weaning (Table 6a).

## ii. Fleece weight

Fleece weights are heaviest in Hamdani, followed by Karradi and lowest in Arabi. It is the other way around with respect to fineness and length, where Arabi wool is finest and shortest and Hamdani and Karradi coarse and long (Table 6). Weight at the first shearing is always lower, since many farmers shear their sheep for the first time at 9 months of age (September); otherwise sheep are shorn in April or early May depending on the locality. The heaviest fleeces are produced when sheep are three to four years old. Most fleeces yield between 70 to 80% clean wool, depending on the breed.

## iii. Milk production

Ne'oimi and Awassi ewes are the best milk producers, followed by Hamdani. With better nutrition, several ewes have given up to one kilogramme of milk per day; individual records of 200 kg to 300 kg in a lactation period of 150 days are also known. The milking season usually lasts four to five months, while the fat percentage is between 5.5 and 7.5 and increases with age.

## iv. Fertility and lambing percentage

These traits are mostly dependent on environmental conditions, particularly feeding and health. Percent of ewes lambing ranged from 50 to 90, Hamdani and Karradi being the most fertile followed by Awassi and Ne'oimi. Lambing percentages (twinning) were highest among Hamdani and Awassi. The flock of the State Board of Agricultural Research at Sho'la has a twinning percent of 25, but in other breeds twinning is of little significance.

## v. Lamb mortality

Nothing is known about embryo losses in Iraqi breeds, and still births are quite rare. Lamb mortalities from birth to weaning are not very high in most experimental flocks, being less than 5-10%. The sheep are hardy and can withstand scarcity of feed and weather fluctuations except for the Hamdani and Karradi, which suffer from high summer temperatures.

## vi. Lamb fattening

Lamb fattening is an important traditional enterprise in Iraq and consumers show a marked preference for mutton. About one third of the 11.7 million sheep are fattened in the five Northern Mohafadas each year, with 2.3 million in Nineveh alone, more than 60% of the latter being raised in the village Kikjally near Mosul city. Most of the sheep fattened are shipped southward to Baghdad, the main consuming centre of Iraq, utilizing about 50 percent of all meat produced in the country. Almost all fattening yards use barley alone with some straw, salt being given occasionally, and green roughage by some farmers. Sometimes the sheep are allowed to graze during the day. Feed is offered twice daily.

## vii. Selection within Iraqi breeds

The development of the Hamadi breed has been one of the major results of selection within the Karradi. Experiments using body weight as a selection criterion have been conducted at the Abu-Ghraib Experimental Station and also under the UNDP sponsored project at Akisi Kalak, with varying degrees of success; by and large the experiments were successful in increasing body

weights both in Awassi and Hamdani breeds, with an increase of about 6 kg in one generation. Unfortunately no sustained efforts in this direction have been made.

#### viii. Crossing among Iraqi breeds

No sustained long range experiment has been done involving crossing among various Iraqi breeds. A small study on the preweaning weights of crosses of Awassi, Karradi and Arabi showed no significant difference among the purebreds in body weights at four months of age. There was some marginal increase in the crosses, particularly (A x K), which was also superior to all other genetic groups for ewe traits, but no definite recommendation could be made on the basis of these results since they were based on very few numbers, and the design of the experiment was not optimal.

#### ix. Crossing with temperate breeds for increased meat production

An experiment was conducted to increase prolificacy in the Hamdani breed, using purebred Hamdani and Finnish Landrace and their reciprocal crosses. The ewe progeny of Finn rams and Hamdani ewes showed a drastic reduction in body weights at weaning and first oestrus, compared with pure Hamdani, with no significant decrease in age at first oestrus. There was, however, a marked increase in prolificacy in the halfbreds, which produced 70% multiple births.

#### x. Crossing with temperate breeds for wool production

A number of attempts have been made to introduce temperate breeds either as possible replacer breeds or to produce crossbreds with fast growth rate and finer wool. Most of these attempts have not yielded the desired result. The introduction of Merino sheep in a breed replacement strategy has failed due to their non-adaptation to the harsh environment of North and Central Iraq. Crossbreds have generally done well both in introducing finer fleeces and faster growth, but in the absence of any national strategy to introduce crossbreds these investigations have not made any impact.

### 4.1.4 Iran

#### i. Crossing among Iranian breeds

A considerable body of information has become available on the performance of indigenous breeds under semi-intensive and intensive conditions of husbandry, but within breed selection has not been attempted. Crossbreeding among Karakul, Mehraban, Neini, Kizil and Bakhtiari breeds did not express any significant positive heterosis in terms of lamb production.

#### ii. Crossing with temperate breeds

Crosses of Karakul, Mehraban and Neini with Corriedale and Targhee have shown marginal improvement in pre-weaning and weaning gains and weights (Farid et al., 1977). Results of crossbreeding with Ile-de-France and various types of Merino rams on the ewes of indigenous breeds have given encouraging results (Yalcin, 1979) and a new fine wool sheep, Magbillet, has been evolved through crossing Moghani ewes with Rambouillet rams. Introduction of Israeli Awassi genes into local Baluchi and Shal breeds has improved fleece weight and milk yield of the crosses.

Crossbreeding involving Suffolk and Targhee sheep from USA, and Chios from Greece with indigenous sheep of Iran has not yielded any satisfactory results because of prevailing nutritional

and management conditions. The situation was further aggravated by difficulty in natural mating between thin-tailed exotic rams and fat-tailed indigenous ewes.

### iii. Feedlot performance

Studies on the feedlot performance and carcass yield of mature Bakhtiari, Baluchi, Kallakui and Kizil rams and ewes on different levels of nutrition for 120 days have indicated the consistent superiority of Kizil animals followed by Bakhtiari, Baluchi and Kallakui in descending order (Saleh et al. , 1972). The Baluchi and Kallakui differed little from each other. In carcass composition the breed differences were small and not consistent in various sex and treatment groups. Studies on the effects of castration and nutrition on fattening performance have shown highest daily gains for Kizil followed by Baluchi and Kallakui.

### iv. Reproductive performance

Studies on reproductive performance, breeding season, oestrus synchronization etc. for increasing lamb production (Demiruren et al., 1971 and International Sheep and Goat Institute Report, 1977) Have shown 25-27% twinning percentage in most breeds, and breeding season lengths of about 7 months. The effect of docking and castration on the weight and carcass growth of lambs has shown (Demiruren et al., 1971 and Saleh, 1976) that the tail fat was deposited as subcutaneous/intramuscular/internal fat with no change in lean to fat ratio.

### v. Future trends

The present sheep production and improvement will of necessity have to come from native breeds. There are no large within-breed selection programmes combined with field recording of performance in any of these breeds. There is, however, a tradition of ram rotation and the breeders themselves exercise a certain amount of selection on the basis of body weights and prolificacy. The action programmes are primarily directed to this end. From the results of experimental crossbreeding, it is not possible to extend to any large tracts in the country the few pockets available for crossbreeding.

## 4.1.5 Turkey

### i. Problems relating to selection

Of the 41.9 million sheep in Turkey, approximately 40.5 million are of native breeds. These sheep are not being subject to within-breed selection except at Government Experiment Stations and in organized flocks. Estimates of genetic and phenotypic parameters for different production characteristics are available for some breeds. Main limiting factors in initiating a programme of selection are the lack of stratification within the breeds, lack of recording in the field and the number of characteristics to be considered in selection. It would be desirable to establish nucleus flocks in the field, in addition to those at the State farms; this would be useful in creating stratification in the breeds, and in disseminating genetic improvement gained in the nucleus flocks to other flocks by the sale of rams. Such an arrangement is particularly important for Awassi, Kivircik and Merino breeds.

### ii. Crossing with temperate breeds for wool production

Crossbreeding of Kivircik and White Karaman sheep with mutton Merino rams since the 1930s has led to the formation of two Turkish-type Merinos, viz. Karacabey Merino and Central Anatolian Merino respectively (Yalcin, 1979).

### iii. Crossing with temperate breeds for meat and wool production

When White Karaman were crossed with Ile-de-France rams, the  $F_1$ s and  $F_2$ s showed significant improvement in body and fleece weights, milk yield and conception rate, while sheep with 60-70% Ile-de-France genes were considered adaptable.

### iv. Crossing for meat production

Crossbreds involving Rambouillet and Daglic have shown significant improvement in growth rate in  $F_1$  and  $F_2$  lambs over either of the parent breeds. Results of crossbreeding Daglic, Merino and Ile-de-France sheep have shown that the Ile-de-France as terminal rams gave considerable advantage in growth rate and carcass quality.

### v. Crossing for milk production

Introduction of Awassi genes into White Karaman has significantly improved milk production.

## 4.1.6 China

Improvement of sheep by crossing indigenous breeds with exotic fine wool breeds has made rapid progress, with reasonably good results. Three new fine wool strains viz., Xinjiang fine wool (now renamed Chinese Merino), Northeast fine wool and Gansu Alpine fine wool have been evolved. The average fleece of improved (crossbred) fine wool and medium wool sheep is two to three times heavier than that of indigenous coarse wool sheep. There is also improvement in wool quality (Cheng, 1984).

## 4.1 Goats

### 4.2.1 General

In the Asian region goat improvement programmes are organized only in the Indo-Pakistan sub-continent, Malaysia and the Philippines. In the Middle East, improvement programmes are concentrated on the Angora breed. Other breeds have been left alone by the development agencies and government initiatives, and are mostly looked after by the breeders themselves, who use traditional methods of improvement. These involve selection based on phenotype and the needs of the region, with some exchange of bucks. The major selection traits are body weight gains and prolificacy, with the aim of increasing meat production.

In the Indo-Pakistan sub-continent the development agencies have introduced exotic temperate breeds, mainly Saanen, Alpine, Toggenburg and German, to increase milk production in indigenous goats. Similar programmes are available in Thailand, the Philippines and Korea.

On Government farms and field stations and in research projects, the crossbreds have shown improvement in milk yield, age at first kidding and body weights. In some cases they have been produced in villages, where they have been given better nutrition; no data are available on their performance when run together with native breeds. So far, large crossbred field populations are not available on the basis of which conclusions could be drawn. Wherever attempts have been made to introduce exotic genes under village conditions the level has not exceeded 50%, and crossbreds have generally not survived as well as the natives. It is unlikely that crossbreds will successfully replace native goats except in small urban pockets. Improvement programmes should

concentrate on the native breeds; within-breed selection combined with field recording programmes should yield results.

#### 4.2.2 Selection within indigenous breeds

Selection for milk production in goats has been largely restricted to experimental flocks. Studies in India have shown selection in Beetal goats to be effective.

#### 4.2.3 Crossing among indigenous breeds

The Jamnapari and Beetal have been used extensively in the Asian region for upgrading local goat populations for meat and milk. While in the Indian sub-continent they have been used primarily as improver breeds for increasing size and milk production, in Indonesian villages and in other countries they have been used primarily for meat. Crossbreeding among indigenous breeds, especially Jamnapari, Beetal, Barbari, Black Bengal and Sirohi, reflected the usefulness of Jamnapari and Beetal as improver breeds for body size, body weight and milk production in smaller breeds.

#### 4.2.4 Crossing among indigenous breeds for chevon production

The wide range of variability in body weights and reproduction rates can be effectively utilized for improving meat production through crossbreeding/grading. The primary results of such experiments in India involving Jamnapari, Beetal, Barbari and Black Bengal showed that the crosses of Beetal x Jamnapari and Barbari x Jamnapari were inferior to purebred Jamnapari. The Barbari x Beetal crosses were, however, superior to Jamnapari x Beetal. The magnitude of improvement was 18% in carcass weight, 8% in dressing percentage and 18% in bone percentage over purebred Beetal.

The Beetal x Barbari crosses were superior to Jamnapari x Beetal and Barbari x Beetal. The magnitude of improvement in Beetal x Barbari was 33% in carcass weight, 2.5% in dressing percentage and 16% in bone percentage over purebred Barbari. The Beetal x Sirohi crossbreds were superior to Sirohi, the magnitude of improvement in carcass weight and dressing percentage being 13% and 1.4% respectively over purebred Sirohi. The results of indigenous crosses revealed specific combining ability for various indigenous breeds, but Jamnapari, the largest Indian breed, did not "nick" well with any other indigenous breeds.

#### 4.2.5 Crossing with exotic breeds for milk production

Crosses of indigenous breeds with exotic dairy breeds (viz. Alpine and Saanen) in India showed substantial improvement in Beetal and Malabari halfbreds. Milk production and lactation length improved greatly in both Alpine and Saanen halfbreds, Saanen halfbreds being superior to Alpine. Three-quarters Saanen with Beetal were superior to 1/2 Saanen x 1/2 Beetal. The crosses of Beetal with Alpine and Saanen showed marginal differences from the Beetal in age at first kidding, kidding interval and service period. The most commonly used exotic breeds are Alpine, Saanen and Anglo-Nubian. Results of Alpine and Saanen have shown that there was an improvement in milk yield of almost 100%. Anglo-Nubian crosses with Beetal showed maximum improvement in slaughter weight.

#### 4.2.6 Crossing with exotic breeds for fibre production

Chegu and Changthangi pashmina goats in India have an annual production of 132 g and 214 g of pashmina (cashmere) respectively, with an average fibre diameter of  $12.4 + 0.7 \mu\text{m}$ . There are no Angora goats in India, but crossing exotic Angoras onto indigenous Gaddi and Sangamneri Produced lower quantities of finer and shorter mohair.

## 5. CONCLUSIONS AND RECOMMENDATIONS

### 5.1 General Conclusions

- i. Among Asian countries, China, India and Iran have the largest populations of sheep and goats, and have the highest production levels. Information on the performance of Asian breeds is highly inadequate and largely unsatisfactory. While some of the breeds have not even been fully described, others are being indiscriminately crossed. Their improvement, even today, is entirely based on ram/buck exchange between breeders and distribution of rams/bucks from Government farms, with no provision for monitoring their performance and impact. Wherever improvement programmes are underway, the participation of farmers is virtually non-existent.
- ii. Most breeds of sheep are available in adequate numbers and there is no danger of extinction for any breed population. In goats, except for two breeds (Jamnapari and Barbari of India), whose numbers have declined to 5000 and 30 000, numbers are fairly adequate.
- iii. Most countries have been crossbreeding indigenous breeds with imported exotic rams/bucks/semens, in order to introduce gains in body weight and wool quality. Except for two cases (Turkey and India), these programmes have not been able to create any impact.
- iv. No system of recording performance in producers' flocks exists in the entire region except in Turkey. Crossbreeding is being extensively used under the impression that dramatic changes in the performance of these breeds will be obtained, without considering the realities of the environments in which these crossbreds are to survive and produce. It can be safely concluded that all these goals can be achieved if indigenous breeds are given proper nutrition and adequate health cover, combined with within-breed selection based on performance recording in farmers' flocks.

### 5.2 Gaps in Information

The information available from these countries on various aspects is scanty, and data need to be collected. Some aspects are detailed below:

#### 5.2.1 Reproductive cycle

It has been observed that most breeds in the region breed round the year, while some breeds show considerable variations in breeding season and frequency of lambing. This inconsistency needs to be examined.

#### 5.2.2 Lifetime performance

Data on sheep maintained in the experimental stations which have been reported in the literature refer to performance early in life. There are no data on lifetime performance. This vital aspect is not realized when comparing native breeds with crossbreds or new introductions. While some figures are available on lamb survival, the mortality figures over the years are not available. Changes in lambing percentage and wool production for native breeds with age are also not available.

#### 5.2.3 Performance under village conditions

Lifetime performance needs to be compared in villages as well as on experimental farms. This information is not available.

#### 5.2.4 Artificial management of crossbred and native

In most village conditions in Asia, whenever a crossbred is produced it is given special care, consequently the cost of production increases. The question which needs to be examined is whether a cost/benefit ratio on management would give this new crossbred introduction an advantage over the native if the special care did not

exist. This information is vital for making any general recommendation on crossbreeding as a method of improvement.

#### 5.2.5 Comparisons from available information

From the presently reported information, it is not always possible to decide whether the comparisons are contemporary or not. This is a basic defect with most of the data presented. Efforts need to be made to rectify this.

In most experiments native and crossbred have to be run concurrently, in the initial years of experiments. This comparison is available when crossbreds are being generated. Data on the natives are reduced as the crossbred groups are increased and the natives are eliminated, whatever the reasons, with the result that concurrent information on the natives is lost. This kind of design needs to be avoided if meaningful comparisons are to be made from which recommendations can be made to farmers.

#### 5.2.6 Valuable traits of native breeds

Lists of genetic traits which are available from the point of view of conservation are difficult to make, but a few can be identified:

Adaptation: Most native breeds are adapted to harsh environments. When purebred exotics are introduced into these environments they generally do not survive. Halfbreds with exotics have shown increased production, but when concurrently left under village conditions the marginal increase is not large enough to justify the costs under the harsh environment. The crossbred survival is also difficult without proportionate input, which is generally not forthcoming.

High ovulation rate: A number of breeds from the Asian regions show high ovulation rate; particularly Javanese thin tailed sheep (JTT) and Bengal goats.

### 5.3 Recommendations

- i. Evaluation of indigenous breeds needs to be undertaken, starting with those that are numerically more important and in keeping with local product needs, such as meat, milk and wool.
- ii. Evaluation of breeds for crossing with local breeds for increased meat, milk or wool production (quality and quantity) should be undertaken. This should include breeds from within and outside the region.
- iii. Most of the sheep and goat breeds in the region have long breeding seasons. In fact, some of the ewes continue to cycle even during the "non-breeding season". In some breeds, two peaks of breeding activity have been reported. This trait of sheep is not being fully exploited. There is now sufficient evidence under experiment station conditions that it is technically feasible to breed every eight months or three times in two years, but this concept has yet to be field-tested to identify practical problems under nomadic and transhumant situations.
- iv. There is interest in the use of hormones for synchronization of oestrus, superovulation and induction of early maturity. The physiology of reproduction and its modification through hormonal intervention is not sufficiently understood, however, to warrant immediate studies in the region. Instead, efforts are needed to understand the reproductive behaviour of the indigenous breeds in the regional environment. Hormonal interventions may be called for after the seasonal and lactational anoestrus are well understood.
- v. It is necessary to develop JTT strains homozygous for the "prolificacy" gene. These sheep show considerable variability in litter size, but on an average, to have a high litter size it is necessary to develop strains which have a uniform litter size.

- vi. It is also desirable to develop strains of JTT sheep which do not carry the "prolificacy" gene. Such ewes will have mostly singles and twins. This will be an adequate level of prolificacy for most currently existing management situations.
- vii. Most of the indigenous breeds have poor body weight gains and efficiency of feed conversion. Improvement through selection in body weight gain, which is highly heritable, is possible.
- viii. A critical evaluation of the current crossbreeding programmes must precede any recommendation for the future.
- ix. Most of the breeds in the region produce fleeces which have high average fibre diameter and medullation percentage. These are suitable for various grades of carpets. Some of the breeds have coarser and more hairy fleeces which are not usable even for low quality carpets. Selection against medullation results in improvement in fleece quality.
- x. Selection for the first six-monthly fleece weight and against medullation percentage in extremely coarse and hairy breeds improves greasy wool production and quality towards better carpet wool. Such a selection needs also to be undertaken in better carpet wool breeds.
- xi. It is recommended that for improving apparel wool production, crossing of better carpet wool breeds with exotic fine wool breeds can be attempted, stabilizing exotic inheritance at 50%. Further improvement may be brought about through selection in crossbred populations for greasy fleece weight and against medullation percentage.
- xii. It is recommended that for improving mutton production, especially under intensive feed management, crossbreeding of extremely coarse and hairy wool breeds with exotic mutton breeds be undertaken.
- xiii. Improvement of milk production in goats can be brought about through selection for first lactation milk yield and age at first kidding.
- xiv. The important goat breeds of India whose number have declined seriously are the Barbari and Jamnapari. It is reported that only 5000 animals of Jamnapari and 30 000 heads of Barbari exist at present. They need to be conserved.

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**PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN THE TROPICS - AFRICAN  
EXPERIENCES WITH SHEEP AND GOATS**

L.O. Ngere 1/

**1. INTRODUCTION**

The Inter African Bureau for Animal Resources (IBAR) estimated the cattle, sheep and goat population in Africa in 1981 as follows:

(in thousands)

Cattle	161 267
Sheep	166 684
Goats	142 665

These represent about 13% of total world cattle and about 25% each of its sheep and goat populations. Phenotypically, the African sheep and goats exhibit great variation in conformation, coat colour, size, height, length and size of tail, presence or absence of horns and their shape, and behaviour patterns, among others. The different breeds of sheep and goats appear well adapted to the various ecozones found in Africa within which they are widely distributed. The management system in most of Africa is extensive with most of the animals having the natural grasslands and browse, as available, to sustain themselves. The small ruminants also have a variety of use for the indigenous populations. The more conventional includes their utilization as a source of milk, meat, skin, wool; but there are also less conventional socio-economic uses: dowry, cash, sacrifices etc., especially in the rural communities.

## **2. IMPROVEMENT OF AFRICAN SHEEP AND GOATS**

The numbers of African sheep and goats are considerable and a first step in the rational use of such a large collection of animals would be to organize them into smaller manageable groups. This need has been recognized and attempts have been made (Epstein, 1953; Mason, 1951; Mason and Maule, 1960) using easily distinguishable phenotypes of body size and height as well as ear shape and length. Thus, with information from their works, Tables 1 and 2 have been built up showing over 48 breeds of sheep and 22 breeds of goat in Africa. Although the classifications were on a phenotypic basis, simplification of the African sheep and goat fauna was achieved and future studies may reveal even more important underlying genetic differences between the breeds.

In discussing any animal improvement scheme, the environment is important. Africa is a large continent and although the bulk of its area lies within the tropics, the southern and northern tips are within subtropical, and Mediterranean climates, respectively. And the tropics are not one uniform environment - though characterized by high ambient temperatures, trade winds and other geophysical factors influencing rainfall which in turn, being seasonal, affects vegetative cover on which the ruminant stock of sheep and goats largely subsist. This is particularly important in extensive systems under which most of the small ruminants are kept in Africa. The ecozones can be grouped into: Arid, Semi-arid, Sub-humid, Humid, Highlands, and Mediterranean. These zones offer differing opportunity for grazing/browse, can influence parasites which cause disease of the animals, and also affect the comfort of the animals themselves - all these are factors which influence animal productivity and so merit consideration.

Table 1 AFRICAN BREEDS OF SHEEP

Land Area	Main Breed Types	Varieties	Special Character	Country	
North Africa	Algerian Arab	Ouled Jellal	Coarse wooled, thin tailed	Algeria	
	Atlantic coast:				
		Beni Ahsen		Coarse wooled, medium fibre	Morocco
		Doukkala		Coarse wooled, thin tailed	
		Zemmour		Coarse wooled	
		Beni Guil/Petit Oranais, Hamyan	Harcha	Coarse wooled, thin tailed	Plateau of E. Morocco and W. Algeria
			Tounsint		
			Zoulay		
		Berber/Chleuh, Kabyle	Ait Barka	Coarse wooled, thin tailed earless	Mountains of Morocco
			Ait Haddidou		
			Ait Monad		
			Aknoul	Dwarf,	
			Mannoucha		
			Tounfite		
			South Moroccan		
			Zanan		
		Ausimi/Meraisi, Awsemy, Osemi, Ossimi, Ousimi		Coarse wooled, fat-tailed	Lower Egypt
		North African Barbary:		Coarse wooled, fat-tailed	N.W. Egypt
			Barki/Arab, Bedouin, Dermawi, Libyan b.		
	North Africa	Tunisian b./Tunisienne			
North East fat-tailed:					

	Barki			
	Fellahi			
	Rahmani	Jhalawani, Sarawani	Fat-tailed	Egypt
	Ibeidi			Morocco
	Saidi			
	Kurassi			
Middle Atlas:				
	Azrou		Mixed types with	
	Bekrit		Berber and Tadla blood	
	El Hammam		Coarse wooled	
	Timhadit			
	South Moroccan	Rehamma-Srarhna,		
		Zembrane		
	Tadla Beni Meskine	Tadla Beni Meskine	Mixed: Berber x South Moroccan x Zaian. Coarsed wooled	Morocco - Plateau of west
		Tadmit	Mixed (?) Algerian Arab x Merino	Algeria
			Medium fibre wool	Tunisia
		Tunisian milk		
		sheep/ Sardinian	Coarse wooled, milked	Tunisia
West Africa	Macina	Goundoun	Coarse wooled, long tailed	Mali
	West African Long-legged/			Niger
	Guinea Long- legged,		haired	North of West Africa
	Sahel:			

		Fulani			
		Maure			
		Tuareg			
	West African Dwarf/			haired	
		Cameroon Dwarf, Djallonke,			
		Fouta Jallon, Kirdi,			South of West
		Kirdimi/Lakka,			
		Nigerian Dwarf, Southern			
		West African maned			
Eastern and Southern Africa	Northern Sudan Sheep:				Areas in north of
					Sudan
			Sudanese Desert	Thin-tailed	East of Nile,
			Gezira		Eritrea
			Baraka		Northern riverine
			Wellega		Eritrea
					West Ethiopia
		West African:	Zaghawa	Thin-tailed	North-west Sudan
		Angola Thin-tailed	Fellata	Thin-tailed	West Sudan
		Dongola			Sudan
		Arrit			North Eritrea
		Southern Sudan Sheep			South Sudan
		Congo long-legged		Thin-tailed	East Congo
		Congo Dwarf		Thin-tailed	Katanga, Congo
	Angola Thin-tailed			Angola	
	Myasinian	Akele Guai	Fat-tailed	Eritrea	

Eastern and Southern Africa					
		Tucur	Fat-tailed	Ethiopia	
		Mens	Fat-tailed	Ethiopia	
		Arusi-Bale		Ethiopia	
		Rashaidi		Eritrea	
Arab			Fat-tailed	Somalia	
	Masai	Nandi, Samburu			
		E. Uganda		Kenya	
	East African Blackhead		Fat-tailed	Karamoja, Uganda	
	East African Long-tailed	Tanzania Long-tailed	Fat-tailed	W. Uganda	
		Raunda - Uruadi		Uganda	
	Rhodesian	North Rhodesian	Fat-tailed	Kenya and Tanzania	
		South Rhodesian		Burundi	
	Bo Tswana			Zambia, Zimbabwe	
	Mondombes			Malawi	
	Nguni				
		Swazi	Fat-tailed	Mozambique	
		Zulu		Swaziland	
		Landin			
		Bapedi		Bolswap	
	Africander	Namagua	Fat-tailed	South Africa	
		Ronderib			
		Transwaal			
		Damara			
	Madagascar		Fat-tailed		
	Somali		Fat rumped	Ogaden, Somalia	
		Adali		North-east Ethiopia	
	Topesa		South-east Sudan		

		Kenya		Kenya
Blackhead Persian				
Derivatives		Dorper	Fat-rumped	South Africa
		Van Rooy	Fat-rumped	
		Bezuidenhet		
		Africander		
		Wiltiper		South Africa

Sources: Mason,1951; Mason and Maule 1960.

Table 2 AFRICAN GOAT BREEDS

Land Area	Main Breed Types	Varieties	Special Character	Country
North Africa	Baladi/Bedouin, Egyptian	Sharkawi	Mohair, dairy	Lower Egypt
	Berber			Maghreb,
	Libyan		Meat, dairy	North Africa
	Nubian		Dairy, Roman nose	North-east Africa
	Mzabite/Algerian Red		Long ears, short hair	
	Touggourt			South Algeria
	Zaraibi			Upper Egypt
	Saidi		Bigger form of Baladi	
West Africa	West African Dwarf/:		Short-legged, haired	South of West Africa
	Cameroon Dwarf			
	Fouta Djalien			
	Kirdi/Kirdin (Chad)			
	Nigerian Dwarf			

	Guinea			
	West African Long-legged/		Long-legged, haired	North of West Africa
	Sahel			
	Arab (Chad)			
	Maure (Mauritania)			
	Nigerian	Red Sokoto (Maradi)		Noth-west Nigeria
East and Southern Africa	Sudnese Nubian		Long-eared	
	Sudanese Desert		Long-eared	
	Benadir	Bimal	Long-eared	
		Garre		
		Tuni		
	Southern Africa	Boer		
		Zambia		
		Zimbabwe		
		Botswana		
		Mozambique		
East and Southern Africa		Swazi		

		Zulu		
		Angola		
		South-west Africa		
	Madagascar		Long-eared	
	Southern Sudan		Short-eared	
	Eritrean and Abyssinian		Short-eared	
		Galla - Sidama		
		Arusi - Bale		
		Danakil		
	Somali	Abgal	Short-eared	
		Ogaden	Short-eared	
		Somali Land		
		Kenya		
	Arab		Short-eared	
	East African		Short-eared	
		Small East African		
		Mubende		
		Kigezi		
		Boran		
	Congo		Short-eared	
	Angola		Short-eared	
	Southern Africa	Zimbabwe	Short-eared	

		Malawi		
		Mozambique		
	Madagascar		Short-eared	Malagasy

Source: Mason, 1951; Mason and Maule, 1960.

From the foregoing, animal productivity can be improved either by ameliorating adverse environment, for example, through better nutrition (improving browse/grazing), shelter, health care management of these resources or through genetics. It is only the last mode of improvement that will be considered, in the context of course, of the African environment.

The general principles of animal improvement are well known and there is no reason why it should be different for the African continent. There are, however, some peculiarities of sheep and goat production circumstances in Africa that should be noted:

1. Large numbers of stock (or genetic material) and paucity of information.
2. Generally non-specialized/multiple use of these stock, i.e. for meat, milk, hides and skins.
3. Great range of the environment with the breeds appearing to be well adapted to their particular econiche.
4. Dominance of the extensive system of husbandry in which the animal feeds on whatever the environment provides, and when it can.
5. Poor control of the breeding animals.
6. Systems of flock rearing which may constrain the use of particular breeding plans.

Given such circumstances, plans for genetic improvement of sheep and goats should involve the following:

- a. Characterization/documentation of existing sheep and goat resources in Africa, as well as their econiche and management system.
- b. Selective breeding or within-breed selection.
- c. Crossbreeding of suitable breeds to optimize production.
- d. New breed development.

These are not new techniques, but the opportunities they hold for African sheep and goats and examples of their application as well as the problems of their use will be discussed further.

As regards information on sheep and goat resources, work has already begun. FAO and UNEP are collaborating with OAU/IBAR in the establishment of Regional Data Banks and lists of descriptors have been prepared and their methodology and problems discussed at an Expert Consultation meeting in Rome in June 1985. In supporting the establishment of such banks the OUA/IBAR Expert Committee group emphasized, among others:

- the need to identify and characterize breeds throughout the continent;
- identify these with high potential;
- help to encourage the development of good record keeping and centres for breed development;
- assemble performance data on prolific sheep and goats of Africa.

There are of course some problems with developing data banks not least of which are what information to record, and how to record so as to optimize usage. In Africa the situation is further complicated by the low literacy rates of the livestock farmers, the majority of whom cannot read or write, and the way the sheep and goats are more often left to fend for themselves or are bush grazed. Most of the information will, therefore, come from research scientists, and from fewer animals maintained under systems considerably different from what obtains for the bulk of the population.

Good records of performance form the bases of selective breeding since selection by sight will result in slow, if any, genetic progress. In recording performance, the economic traits need to be focussed upon. For the sheep and goats, these include:

- a. Measures of reproductive efficiency, including number of and weight of lambs/kids weaned per ewe/doe joined per year.
- b. Mortality at all ages especially from birth to weaning.
- c. Measures of growth: birth, weaning and later period weights.
- d. Milk yield, where appropriate.
- e. Wool quality and quantity, where applicable.
- f. Carcass quality.
- g. Disease data.

Mason and Buvanendran (1982) have detailed procedures and data that can give information on these economic traits for sheep and goats in the tropics. The close adaptation of African sheep and goats to their habitats would suggest that until more is known of their characteristics much emphasis should be placed on this avenue, i.e. within-breed selection for genetic improvement. Unfortunately, records of performance which form the basis of this technique are still not much developed in most African countries. However, there is an acute awareness of this deficiency and most countries have embarked on development of sheep and goat performance recording schemes at local and national levels, and are collaborating at international levels. Those records when analysed should help herd management, identify superior stock and generally lead to improvements in sheep and goat production in the African region. The data so far available show that African sheep and goats are valuable genetic resources. Thus:

- a. The West African dwarf (Mason, 1980) and the D'Man of Morocco (Lahlu-Kassi, 1983) have been identified as highly prolific breeds of sheep.
- b. The dwarf breed of sheep and goats of West and Central Africa have been noted to be trypanotolerant (FAO/ILCA/UNEP, 1980).
- c. Some goat breeds are reputed to be good producers (Devendra and Burns, 1970).

Milk - the Nubian

Meat - the Blackhead Persian derivatives (Boer)

Skin - Red Sokote (Maradi); Mubende

and more valuable breeds will be identified in the future. In addition records of performance can help identify constraints to productivity and suggest appropriate modes of intervention. But recording performance under the prevailing extensive management of large flocks or in small household flocks will not be easy. Therefore, cooperation between small herds or organization of larger herds probably by governments will enhance the use of this technique. Alternatively, improved breeds (e.g. males developed at breeding stations) can be used on traditional local flocks. The observation by Van Vlaenderen (1985) in northern Togo regarding improvements

in productivity in traditional herds using selected rams supports this view. Some improvement programmes in North Africa (Lahlu-Kassi, 1983) of sheep have been planned along such lines.

Crossbreeding is a valuable tool for livestock improvement when properly used. The present knowledge of African sheep and goats as well as the level of husbandry does not permit a general adoption of this technique at this time. When more is known about our breeds one can foresee the use of crossbreeding for systematic exploitation of heterosis in 2, 3 or 4 breed combinations or as a foundation for new breed development incorporating valuable genes from identified superior breeds.

South Africa, though subtropical, has evolved new breeds to meet specific needs:

Sheep: Dorper: (1942 - 50) Dorset Horn x Blackhead Persian Van Rooy: in 19th century  
(Rambouillet x Ronderib Africander x Blackhead Persian)  
Bezuidenhet Africander: (1918) Woolled Persian x Blackhead Persian  
Wiltiper: (1946) Wiltshire Horn x Blackhead Persian

Goats: Boer; from local goats x European, Angora and Indian types. Inasmuch as all these new breeds were evolved from inputs of indigenous African breeds, repeat of similar schemes is possible. Infact, Ngere (1973) and Ngere and Abeagye (1981) have described the Numgua Blackhead evolved from the West African dwarf x Blackhead Persian in Ghana.'

In conclusion, there is need for more detailed and extensive documentation on performance characteristics of African sheep and goats. Selective breeding (within breeds) would seem to be the most favourable method for the moment.

Any scheme to improve the small ruminants should take into account the habitat and flock sire. Crossbreeding and breed development also have a place under improved husbandry conditions and in the more developed countries of Africa.

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## **IMPROVEMENT OF ANDEAN CAMELIDS**

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In the last two decades, research has produced much knowledge about the biology of camelids and how to make better use of this resource.

Some erroneous concepts have been modified but many gaps in knowledge need further study. This paper contains a brief description of environment, farm characteristics and a summary of management practices recommended for increased production.

### **1. ENVIRONMENTAL CHARACTERISTICS OF PASTURE GRAZING LAND**

The central Andes "Puna" a natural zone for rearing camelids is composed of a series of mountain valleys and plateaux situated between 3600 to 5000 metres altitude. The area commences in the "Pampa de Junin" in the central region of Peru (latitude 11 south) and finishes in the south of Bolivia (latitude 21 south). Due to its diversity, the Puna is divided into three zones: humid, dry and arid.

The humid Puna is close to the eastern Cordillera and the dry Puna is close to the western Cordillera, both starting in the central region of Peru and extending as far as central Bolivia. The arid Puna is close to the Atacama desert in Chile and reaches as far south as Bolivia.

The typical climate of the Puna is characterized by low temperatures, frequent night frost and variability in rainfall. These characteristics are related to the altitude. The annual mean temperature is 8 C but improves from October to April, the rainy months. The greatest differences in temperature are during the day with a range of 20 C in the dry season, due to night frost. At 4500 metres night frost occurs throughout the year. To the north rainfall is about 500-850 mm decreasing to the south to 100-400 mm, being very irregular in the arid Puna. In general the soils are poor.

Owing to the factors described above, the main vegetation consists of graminea and herbaceous plants, with only a few trees found in specific microenvironments. However this geographical area has been of great importance to the local inhabitants. Alpacas and llamas were originally domesticated in this area creating a pastoral/agricultural economy (potatoes, quinoa (*Chenopodium guinea*) canihua (*Chenopodium pallidicaule*), etc., cultivation of the latter always being subject to the hazards of the environment. This "agro-pastoral" system is now used with sheep and cattle, introduced after the Spanish conquest.

### **2. CAMELID FARM CHARACTERISTICS**

Of the total world camelids Peru has 3.02 million, 90 percent alpacas, and Bolivia 2.5 million, 70 percent llamas (Table 1). In Peru farmers who are organized in "Ayullus" (communities) own 75 percent of the alpacas. They are small farmers with low production and management levels. The remainder (25 percent) are associated with large farm enterprises created by agrarian reform (Table 2). There is also a limited amount of middle-level

farmers who were not affected by agrarian reform. It must be pointed out that within the communities, some farmers are prosperous while others have no land and few animals.

**Table 1** ESTIMATED POPULATION OF SOUTH AMERICAN CAMELIDS ('000)

Country	Domestic		Wild	
	Llamas	Alpacas	Vicuñas	Guanacos
Peru	900	3 020	50	5
Bolivia	2 500	300	2	0.2
Argentina	75	0.2	2	100.2
Chile	85	0.5	1	10.0
Colombia	0.2	-	-	-
Ecuador	2.0	-	-	-
USA	2.5	-	-	-
	3 564.7	3 320.7	55	115.2

Table 2 ALPACA POPULATION IN PUNO STATE ACCORDING TO TYPE OF PRODUCTION

(Village)	Production Type				Total
	Big associated farmers	(%)	Small individual farmers	(%)	
Puno	35 509	(39.3)	54 923	(60.7)	90 432
Azangaro	49 442	(50.0)	49 456	(50.0)	98 898
Carabaya	24 106	(16.2)	124 675	(83.8)	148 781
Chucuito	15 077	(6.5)	215 587	(93.5)	230 664
Huancane	41 496	(33.5)	82 315	(66.5)	123 811
Lampa	81 179	(41.0)	117 201	(59.0)	198 200
Melgar	58 230	(37.4)	97 344	(62.6)	155 574
Sandia	–		43 995	(100.0)	43 995
San Roman	130	(2.4)	5 205	(97.6)	5 335
Total	305 169	(28.0)	790 521	(72.0)	1 095 690

Source: Anuario estadístico 1979, ORDEPUNO, Dirección Regional de Agricultura y Alimentación, Puno.

Both in Peru and Bolivia, llamas are in the hands of the community farmers. A distinction must be made between the large enterprise and the small community farmer, particularly as agrarian reform has not largely changed social relationships and production techniques even where land has changed ownership.

The big associated farmers in general have better soils, better pastures and are situated close to good roads. They also benefit from investment facilities. On the other hand, the small farmers with limited basic resources, overexploit and destroy the environment for themselves as well as for future generations.

It has been possible from various studies made of the Puna, one of the most important areas of camelid husbandry, to evaluate the main characteristics of raising these animals as well as their management (see appendix). There are different levels of organization. Sometimes all animals are put together with no distinction by age, sex or colour and no timetable is set for field operations. Other animals are classified according to age and sex and a timetable exists. In this case husbandry practices are the same as for sheep. In general, castrated males are kept for fibre production which limits the number of productive females.

This practice together with low fertility and high calf mortality produces small numbers for replacement and limits selection for productive characteristics.

Where animals are separated by age and sex mating is from December to April using 3-4 percent of the males during the whole period. In general, females are mated at about 2-3 years of age and their productive life is 10-12 years. Males start their first service at about 3 years old.

Where animals are not separated by sex and age mating takes place only in the rainy season (December-March) which indicates that it is not important to keep all animals together as mating is limited to one period. Birth rate is about 50 percent and calf mortality during the first three months is about 50 percent. Actual production rate is + 5 calves for 100 females in productive age. Because of these reasons take-off is low as only old animals are involved and meat production is not of good quality.

The shearing season is annual or biannual and takes place between October-November.

Technically annual shearing is better because of:

- a. Health: better parasite control;
- b. Economics: the fleece is less affected by the environment;
- c. Management: animal selection for production is possible at one year's old.

A great variation exists in individual production (1-8 lbs/animal/- year) which offers a great potential for improvement by selection.

### **3. MANAGEMENT PRACTICES RECOMMENDED FOR PRODUCTION IMPROVEMENT**

#### Reproduction

During the last two decades much information on reproductive biology has been collected which can be summarized as follows.

- a. Ovulation is induced by mating and comes 26 hours after service; ovulation can also be induced by hormonal treatment (LH, GNRH).
- b. Oestrus is continuous without the presence of a male (mating). After parturition oestrus reappears within 24 hours, but even if females are serviced ovulation takes place only 10 days postpartum.
- c. Twenty percent do not ovulate after service due to bad nutrition.
- d. Conception is + 95% but 40% of the foetuses die during the first month. These losses diminish as the females recover after parturition.
- e. There is no false pregnancy, which occurs in other animals with induced ovulation.
- f. Continuous association (for more than 15 days) of males and females inhibits male sexual activity.
- g. Females can be mated at 1 year of age only when they have achieved 50-60% of the adult weight (35-40 kg).
- h. Gestation is 342 days; births take place during the brighter hours (06.00-14.00 hrs in the tropical mountain zone).

The above information indicates that the biological principles governing reproduction in camelids are peculiar to the species and must be taken into account in applying techniques to improve birth rates.

Sexual activity should not take place for a minimum of 10 days after parturition as mating serves no purpose and can provoke uterine infections. Males should be maintained in sexual activity to service females in heat. This can simply be done by taking 6 percent of healthy males and dividing them into two groups and using them on alternative weeks. It has been shown under actual pastoral conditions that 50 to 60 percent of females are suitable for reproduction by servicing females of one year of age if they have reached a suitable liveweight.

### Health

Increased birth rate has no significance if causes of mortality are not recorded. Some diseases even if not fatal such as mange and gastrointestinal problems are important particularly for range animals. Information is available on the most important economic diseases. Intestinal parasites are the same as sheep but some ecto parasites are specific to camelids. Mange is caused by Sarcoptes scabiei var. ancheniae and Psoroptes aucheniae specific to camelids.

The main cause of calf mortality is enterotoxemia (Clostridium welchi types A-C).

### Feeding

Natural pasture is the principal feed for camelids; the most common feed consisting of gramminea, ciperacea and juncacea and in less quantity leguminosas. These pastures have poor soil which is phosphorous and nitrogen-deficient with overgrazing due to bad management. Quantitatively and qualitatively pasture production is better in the rainy season (November-March) and at its worst in the dry season.

However a good potential exists for pasture production improvement such as better water utilization according to the old indigenous irrigation system used in some communities.

Experimental work has shown not only the importance of irrigation but also the introduction of new plants to improve pasture production in the altiplano.

Further studies are required on efficient pasture use, for example, stocking rate throughout the year in association with sheep or separately.

## **4. GENETIC IMPROVEMENT BASED ON SELECTION**

Owing to low replacement rate, selection is limited. Farmers should therefore try to increase birth rates and reduce mortality, culling undesirable animals and retaining those with the most important economic characteristics such as colour of wool, weight of fleece and liveweight. According to Velasco (unpublished data) in alpacas a uniform colour is dominant over a mottled colour.

An animal of uniform colour is one without white hairs while a mottled animal has parts covered with white hair. White is the dominant colour in alpacas, while brown is dominant over black. Velasco, with 106 pairs of mother-daughters, using the regression factor of daughters, calculated the hereditary index by liveweight (.69 + .2) and by fleece weight (.35 + .2). These results show that alpacas can be selected with little error at 264 days.

PERCENTAGE OF ALPACAS BY AGE AND SEX IN ONE HERD. MEAN FROM  
227 185 HEAD FROM 13 BIG FARMS IN PUNO (1979)

Age	Female	Male	Castrated	Total
Calves (0-1 year)	9.7	11.4		21.1
Sub-adults (1-2 years)	8.4	8.9		17.3
Adults (2 years)	42.0	4.3	15.3	61.6
Total	60.1	24.6	15.3	100.0

AVERAGE YEARLY MORTALITY BY AGE IN EXPERIMENTAL FARM  
"LA RAYA" 1973-1979

Age	$\bar{X} \pm S$	Range
Calves (0-8 mths)	26.7 $\pm$ 19.5	9.3 - 56.6
Sub-adults (8-24 mths)	5.1 $\pm$ .3	4.1 - 6.6
Adults (>24 mths)	2.9 $\pm$ .7	2.0 - 3.6

ALPACA FERTILITY FROM SMALL FARMERS 1/

Farmers	Population Total	Females		Calves		
		Total	Mating	Born		Dead
				n	% 2/	
1	205	101	78	53	67.9	32.0
2	245	127	79	63	79.7	44.0
3	235	113	85	68	80.0	50.0
4	184	86	86	28	32.5	17.8
5	120	46	46	27	58.6	48.1

1/ 1980 enquiry in Puno.

2/ On serviced females.

ESTIMATES OF ALPACA FERTILITY IN SOME LARGE FARMS (1980) 1/

Farm	Mothers		Calves Born			Calf Deaths %
	Populations total	No. Services	n	%		
				a	b	
Tulapa	6 061	4 874	3 179	65.2	52.4	40.5
Giletamarca	1 224	1 014	515	50.7	42.0	15.3
Umachiri	2 978	2 550	1 643	64.0	55.0	68.4
Kunurana	2 562	2 100	433	20.6	16.9	18.0

Nuñoa	3 164	2 860	1 716	60.0	54.2	41.7
Alianza	6 756	6 509	4 195	64.0	62.0	9.0
Sais Vilque	3 167	3 167	1 815	57.3	57.3	47.4
Carumas	1 718	1 718	446	25.9	25.9	26.0

<sup>1/</sup> Based on records of the Ministry of Agriculture, Zona Agraria IX, Puno, Peru.

- a. On mothers served
- b. On total of mothers

#### WEIGHT MEAN OF ALPACA FLEECES

Biannual Shearing (lbs)	Author	Annual Shearing (lbs)	Author
4.5	Toledo y S. Martin 1980	3.5	Moro 1968
6.5	Calderón L. 1952	3.2	Bustinza 1970
7.7	Gallegos 1954	2.4	Calderon et al. 1972
7.7	Magagno 1956		
4.8	Moro 1968		
7.7	Cuadros 1971		

#### CROSSES OF BLACK AND BROWN ALPACAS

	Black x Black	Black x Brown	Brown x Brown
Black	5	3	4
Brown	0	5	27

Velasco J. (Unpublished data)

#### BIRTH RATE OF ALPACAS OF LA SAIS PICOTANI

Mating	Year	%
Traditional (Sheep system)	1966	53.1
	1967	59.0
	1968	51.2
	1969	55.4
	1970	63.2
	1971	61.5
IVITA <sup>1/</sup>	1972	81.0
	1973	80.0

<sup>1/</sup> 6% of males divided into two equal groups used alternately. Each group works one week replacing the other.

**EFFECT OF ALTERNATE MATING ON BIRTHS IN ALPACAS**  
(Sais Picotani 1972)

Class	No. Services	% Parturition
Adults	924	83
Primiparous <sup>1/</sup>	475	77
Total	1 399	81

<sup>1/</sup> One year of age.

NUTRITIVE VALUE OF NATURAL PASTURE BY OESOPHAGEAL FISTULA  
VS. HAND COLLECTED NATURAL PASTURE

Feed fraction	Alpacas			$\bar{X}$ (A)	Hand-collected (B)	Differences % A - B
	1	2	3			
Protein %	18.8	18.3	17.0	18.0	10.1	+ 78.6
FDN % <sup>1/</sup>	57.8	56.2	63.2	59.0	65.5	- 9.9
DIVMS % <sup>2/</sup>	59.9	54.5	72.2	50.0	43.9	+ 34.2

<sup>1/</sup> Natural detergent fibre.

<sup>2/</sup> In vitro digestibility of dry matter.

PRODUCTION OF INTRODUCED PASTURES  
(4 200 m above sea-level)

	Annual total of dry matter <sup>1/</sup>
<u>Gramineas</u>	kg/ha
<u>Lolium perenne</u> 5.23	12 821
<u>Lolium multiflorum tetraploide tetilla</u>	12 461
<u>Lolium perenne alemana</u>	12 745
<u>Leguminosas</u>	
<u>Trifolium pratense</u> K.	22 100
<u>Trifolium pratense alemana</u>	18 450
<u>Trifolium repens</u> L.	15 756

<sup>1/</sup> Four collections per year.

AVERAGE NUTRITIVE COMPOSITION OF ANDEAN ALTIPLANO NATURAL PASTURE IN TWO PERIODS OF THE YEAR

Period of the year	Protein %	CA %	P %	Cu %	Co PPM	DIVMS <sup>1/</sup> %
Rainy	8.5	.28	.21	4.78	.20	45
Dry	4.1	.28	.07	4.14	.18	35

<sup>1/</sup> DIVMS = In vitro digestibility of dry matter.

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**IMPROVEMENT OF PIGS IN THE TROPICS:  
GENERAL PRINCIPLES**

J.W.B. King <sup>1/</sup>

### 1. INTRODUCTION

The principles for the improvement of pigs do not differ around the world but the way in which they are implemented will depend on selection objectives and on the existing population of pigs and the way in which it is to be utilized for production to meet particular markets. Overlying all these considerations are likely to be requirements for adaptation to local climatic conditions and to diseases, and endo- and ecto-parasites. Much judgement will therefore be required in specifying programmes appropriate to particular circumstances and the purpose of the following review is to discuss some of the issues which arise.

### 2. NATURE OF THE INDIGENOUS PIG POPULATION

Populations of indigenous pigs will undoubtedly vary in their history and breeding structure. At the one extreme there may be large, ill-defined populations made up of individuals without any of the uniformity usually ascribed to breeds, but nevertheless filling a particular niche and performing a particular function. It is unlikely that more than fragmentary knowledge exists about the pedigree of individual animals and yet the population as a whole probably represents a valuable asset to the animal agriculture of the region. At the other extreme there may well be small pedigreed populations that have been carefully husbanded for several generations, recorded in detail and about which a great deal more is likely to be known. When both kinds of population are present in the same region, problems may well arise in defining distinctness and deciding whether performance levels between a small pedigreed nucleus and the population at large are genetic or merely environmental. If trials to establish this are needed, the general experimental principles described by Sellier (1980) are useful for planning appropriate designs.

### 3. USE OF THE INDIGENOUS POPULATION

The advantages of crossbreeding in the pig appear to be so great that it is most likely that the genetic resource of the indigenous breed would not be utilized in some form of crossbreeding. Although critical evidence is scanty,

the general principle is that the amount of heterosis observed is usually greater in unfavourable environments, thus giving a further incentive to some crossbreeding system for use in the tropics. To organize the crossbreeding that is required may present some organizational difficulties and at first crossbreeding may take the very simple form of crossing the females of the indigenous breed with males of an exotic breed as a means of producing pigs for meat production. This first crossing method does not use heterosis in the sow so that extending the crossing system to use first cross sows for breeding will probably be advantageous providing adaptability to the local environment is not lost. In the interests of simplicity, a backcross to boars of the parental exotic breed is the simplest method of using a crossbred sow and avoiding the necessity for having a third breed.

Because of organizational difficulties, attempts are frequently made to perpetuate the crossbred population from inter se matings, thus producing a synthetic population (or eventually a new breed) which may be multiplied for use in that environment. Although attractive from the administrative viewpoint, the serious loss of heterosis may well mitigate against the system, as well as requiring the use of breeding females not well adapted to the local conditions. Ingenuity in devising ways in which a discontinuous crossing system can be implemented may therefore be rewarding.

In later discussion, it is assumed that the indigenous breed will in fact be used as the mother of slaughter pigs, or as a contributor to a crossbred sow. The improvement of maternal performance is therefore of paramount importance in the indigenous population.

#### **4. SELECTION OBJECTIVES**

The potential number of characteristics in which genetic changes might be desired is great and some grouping and simplification may help the task.

##### 4.1 Female Reproduction

- Piglets weaned per litter (as a convenient integration of numbers born and viability).
- Weaning weight of the litter (particularly when weaned piglets are sold from one producer to another).
- Re-breeding interval (leading to a measure of piglets per sow per annum).
- Sow feed costs.
- Sow carcass value.

##### 4.2 Male Reproduction

Genetic changes may not be necessary but possibly the ability to produce fertile sperm at high ambient temperatures may be required.

##### 4.3 Slaughter Pig Production

- Growth rate
- Food conversion

- Viability to slaughter
- Carcass yield
- Carcass value

All the characteristics listed above may be dependent upon inbuilt genetic resistance to climatic stress, diseases and endo- and ectoparasites. The extent to which these adaptive characteristics show genetic variation will be unknown and the problem of whether or not to attempt selection for them will be considered later.

## **5. SELECTION METHODS**

To achieve the desired objectives, reliance is placed on various measured traits, not necessarily those listed as selection objectives. Nevertheless the more directly it is possible to reflect a selection objective in a measured trait, the greater the response is likely to be. Some indirect measures are valuable since they facilitate the employment of selection methods which would otherwise not be feasible. The prime example of this is the estimation of carcass merit from live animal fat measurements which makes it possible to carry out large scale performance testing and to dispense with progeny testing.

For the improvement of female reproductive traits which have a low heritability, the use of additional litter records on the same individual and of records from close relatives is valuable. Thus the device of keeping potential breeding stock from a first litter and retaining that sow for a second litter to record litter performance, will almost certainly be a valuable method. Using the records from relatives will require the calculation of selection indices with appropriate weights and, because of the varying numbers of relatives which will be available in any given case, the use of a computer becomes useful.

In measuring the performance of the growing pig, it is appropriate to use weight intervals rather than age intervals for record purposes since this avoids many non-genetic variables. Measurement of fat thickness as a predictor of leanness would also be best done at a fixed weight, but since this may be inconvenient, correction of the measurement to a fixed weight is appropriate. With the higher heritabilities observed for most traits observed on the growing pig, the additional benefits to be gained from use of information on relatives will be small and not a high priority in devising an appropriate selection method.

## **6. SELECTION METHODS FOR ADAPTIVE TRAITS**

Selection of individual animals for adaptation to climatic conditions will probably not be feasible and is probably not to be regarded as an essential feature of the selection procedure. In cattle, where climatic room exposures and body temperature measurements have been made in the selection of stock adapted to the tropics, the current tendency is for such tests to be dropped and reliance placed on natural exposures to climatic extremes. Similarly with pigs, Horst (1982) from his review of the literature could find no indicators of heat tolerance.

With resistance to diseases and parasites, although laboratory tests may be feasible, or can possibly be devised for the future, natural exposure will probably be all that can be achieved. For many diseases natural exposure is subject to drawbacks because of the complexities introduced by maternally acquired immunity. For the time being some hard decisions may be necessary in deciding upon those diseases which will be excluded by sanitary measures and those where endemic exposures will be the normal course of events. Realistic assessment of the diseases to which stock may be exposed during the production phase of their use will be needed to avoid undue optimism about veterinary measures which are unlikely to succeed in widespread practice. Selection can then be

practised in that environment using what Horst (1982) calls 'productive adaptability' where the performance of the animal is used indirectly as a measure of whether or not it is adapted to the stresses it has encountered.

For the future, great store is set on the possibilities of being able to detect genetic markers which can be used as indicators of resistance actors. Although in other animals a few useful associations have been found, this type of investigation must at this stage be regarded as speculative not a method which can be relied upon for solving present problems.

## **7. BREEDING PLANS**

Breeding plans can be assessed by computation of expected progress using the known dependencies on selection intensity, accuracy of selection, extent of genetic variation and on the inverse relationship to generation interval. The influence of some of these factors can now be noted.

Obtaining reasonable selection intensities can be a problem with, relatively small populations and to maximize the opportunities, it is desirable that all potential breeding animals born should be subject to the selection procedure. While some independent culling levels for particular traits may be necessary, they should be kept to a minimum and unnecessary selection of uniformity of colour or type avoided. Where there are requirements for special recording, as in the measurement of food conversion, then the allocation of pens should follow the principles laid down by Smith (1969).

The accuracy of selection will depend very much on the traits under consideration. As noted already, there may be scope for using records on relatives or characters with low heritability, but little to be gained where the heritabilities are higher. Weight given to different traits is best determined by the use of a selection index although uncertainties over the parameters to be used in such an index will often make it necessary to use values obtained from the literature. These can be combined with estimates of the variability of the local population to give procedures which will allow a start to be made on selection. For a discussion of these problems, see James (1982).

The extent of genetic variation available in the population will depend on the past history of selection, on past bottlenecks and on effective population sizes. If the indigenous population under improvement is a unique one, then it may be worthwhile devising some form of open breeding plan which allows the immigration of additional breeding animals from outside the nucleus on the basis of superior performance. As has been shown by James (1978), this measure can increase effective population size and reduce rates of inbreeding.

In many practical breeding schemes, the generation interval does not receive as close attention as other selection parameters. One reason for this is that the discard of comparatively young breeding animals may add considerably to the cost of the breeding operation. Arrangements to pass animals from the breeding nucleus to commercial crossing herds may therefore be useful in offsetting this cost. Optimum structures should be computed for alternative circumstances, using the general principles enunciated by Ollivier (1974). It is unlikely that sows should be maintained for more than two litters or boars for more than twenty matings if the generation interval is to be kept at an optimum level.

During the course of selection, unexpected and unwanted correlated responses may need to be monitored. For example, the tropical conditions are such that small body size is an adaptive characteristic, so large increases in adult size may have adverse effects as suggested by Horst (1982). Similarly, the reduction of fatness and increase of lean will not only lead to an animal with reduced energy stores, but may also produce increased heat production with consequent ill effects for climatic adaptability. Such adverse possibilities are not a recommendation for making no changes, but for measuring those that do occur so that some kind of genetic control seems particularly appropriate to monitor the value of selection procedures. The ability to deep freeze

sperm makes it possible to provide such controls at reasonable cost and further economies can be made by not taking controls from every generation but by introducing them after a period of selection.

## 8. RATES OF INBREEDING

The rate at which the improved population becomes inbred will be a major concern in the design of improvement plans. Although some indigenous populations, such as the Meishan from China, appear to have had a long history of inbreeding without serious consequences for fecundity, such isolated experiences are not a general recommendation for neglect of inbreeding. Intense selection will inevitably lead to high rates of inbreeding and some balance will need to be struck. Definitive advice is not possible but attempts to maintain rates of inbreeding at those found in major pig breeds at round 1/2 percent per generation would be a pragmatic choice and one which would certainly be tolerated for a long term programme. For shorter term programmes, high rates of inbreeding could be tolerated.

## 9. GENERAL REQUIRMENTS

Finally some general observations might be permitted. A major requirement for the success of pig breeding operations is the organizational one both in the conduct of breeding operations in the nucleus herd and in the dissemination of that improvement to the population at large. This requirement should be stressed and placed high on the list of priorities.

Some new technologies may have exciting prospects but probably have low priorities for implementation in many basic schemes of the kind described here. To take a statistical example, the use of BLUP methods will probably add little to a scheme if the breeding population has been well structured for improvement purposes. Similarly, reproductive techniques such as AI and embryo transfer would not appear to be essential ingredients. This is not to deny the value of existing and future research on indigenous populations but to counsel critical appraisal of priorities. Organization and structuring of pig breeding operations should be near the top of that list of priorities.

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## **EDUCATION AND TRAINING FOR ANIMAL GENETIC IMPROVEMENT IN THE TROPICS**

### **EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN AFRICA**

A. Lahlou-Kassi 1/

Improving the efficiency of livestock production is nowadays a very important issue in the world, especially in third world countries. Such programmes are based essentially on the improvement of indigenous breeds either through selection or cross-breeding. These can only be achieved if the programme is supervised by well-trained technicians. Education and training of these technicians should be organized to meet the needs of specific regions.

Training and education programmes should be based on the answers to the following questions.

1. What are the needs of the region in terms of animal genetic resources?
2. Who are the people that should be involved with evaluation or improvement programmes?
3. What are the subjects to be developed in the training programmes?
4. Where should training programmes be held and in what language?

i. What are the needs of the region in terms of animal genetic resources?

- evaluation and characterization of indigenous breeds: sheep, cattle, goats, camels and horses;
- preservation of superior local breeds;
- improvement through management, breeding and cross-breeding;
- socio-economic aspects of different animal production systems.

ii. Who are the key people in evaluation or improvement programmes?

Professional who are:

- a. Responsible for the formulation and conception of programmes:
  - animal breeder at the government level;
  - animal breeder at the university;
  - heads of animal breeding associations when they exist.
- b. Responsible for execution of the programmes:
  - middle level technicians;

- farm managers.

All these categories have to be trained.

iii. Subjects to be developed in a training programme:

a. Methodology and policies:

This point concerns mainly:

- the establishment and efficiency of breed societies;
- the design and evaluation of selection and cross-breeding programmes in experimental stations and in the field.

b. Science and technology:

- inventory of the main breeds and their performances;
- cryopreservation of semen and embryos;
- disease resistance and new approaches for vaccination and disease prevention.

c. Socio-economic topics:

iv. Location and language:

Three languages have to be considered for African countries:

- Arabic, English and French.

Location of the training programme can be:

- at a national level: each country having its own programme especially designed for middle level technicians and farm managers;
- at a subregional level: programme designed for high level technicians from different countries having the same interest;
- study tours for decision makers.

## EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN THE TROPICS

S. Sivarajasingam 1/

### 1. INTRODUCTION

Credits on genetic conservation of animal resources are seldom listed or available in most animal science or veterinary courses. Evaluation is an area related to conservation that is taught but usually in basic sciences including genetics. Although many people in animal production are aware of some of the advantages of genetic conservation, only a few attempts have so far been made towards that direction of implementation on the ground. One major reason for this is the sole desire to improve yields quickly through crossbreeding for which tools like artificial insemination are readily available. It is easy to use them and immediate results are fantastic. Another reason is the ignorance that costs to maintain local resources far exceed income. This is based without taking into consideration the value of these animals in the event of any breakdown of the improved breed in the unforeseeable future. Smith (1984), worked out economic values of preserving germplasm in the face of uncertain needs and opportunities, for use in the unknown future and concluded benefits greatly exceeded costs. Even if they are free of these myths, many do not have the time or knowledge or both to set off to conserve their genetic resource of domestic livestock species. In a number of countries, conservation herds are maintained. However initial collection was not representative of the breed with most of the animals derived from a single region due, to inaccessibility to other areas. In other cases, animals could be traced back to only a handful of parents.

Thus the importance of courses has been discussed ' in previous meetings of the FAO/UNEP Expert Consultations (Osman, 1984 and Bodó, 1984). A comprehensive course was also conducted in Hungary sponsored by FAO. The present paper highlights some aspects of the training course and interregional communication between countries.

### 2. PARTICIPANTS OF TRAINING COURSE

Trainees in genetic resource conservation should include:

- a. Professionals. Those who are actually responsible for the job of breed improvement at various levels within a country. This group could also include other professionals indirectly related to animal production such as farm managers.
- b. Technicians. These people include those who work closely with animal geneticists or breeders.

### 3. BRIEF SYLLABUS

The following is a brief list of special topics that need to be emphasized in addition to what has been presented in the two volumes of the manual prepared during the course held in Hungary.

- a. Evolution of our domesticated species.
- b. Sampling technique. This is perhaps one of the most critical stages of conservation. Whatever samples collected should truly represent all aspects of the population and be a true representative. Sample size, ratio of male to female etc. need to be calculated.
- c. Recognition of types or lines. Within several indigenous breeds we could recognize distinct lines. For instance, the Kedah-Kelantan cattle in Malaysia has distinct colour groups, brown, yellow and black, all within the same region. Another example is the swamp buffalo of various sizes and conformation in China, Southeast Asia and Sri Lanka.

- d. Characterization and documentation. The FAO/UNEP Expert Consultation on Methodology for Data Banks Finalized characterization lists and methodology in 1985 and a manual is currently being prepared. This will serve as a useful document for future creation of standardized data banks and course material.
- e. Utilization of data banks. An approach to the proper utilization of the information in the data banks needs to be introduced using the most appropriate statistical methods. Demonstration on the application of selected microcomputer software appropriate for data banks should also be included.
- f. Management of live resources. Should the animals be raised under average management and feeding standards exposing them to usual environmental stresses and diseases or should they be under the best available conditions? Should the excess animals be randomly culled or done selectively. If the latter, the options are single trait or multitrait selection; and if multitrait, which are the traits and are they weighted equally or otherwise.
- g. Genetics. The students need an appreciation of maintaining variability and its genetic basis in a population. Cytogenetics and quantitative genetics should be briefly covered.
- h. Breed society. The establishment and mode of function of breed societies are useful techniques in gaining interest in the breed among farmers and institutions.
- i. Cryogenic storage. Steps in the collection of eggs, embryos and sperm, their storage and retrieval need to be outlined.
- j. Blood parameters. Aspects of protein polymorphism, red cell antigen and enzyme variations within and between breeds should be included in the curriculum only to reinforce their value as measures of genetic distance, evolutionary relationship and to understand control and eradication of diseases.
- k. Genecology and production in relation to climate, disease and vector and parasite spectrum.

Details of embryo transfer and blood parameter techniques are specialized areas, only relevant points need to be studied. Practical exercises should be included wherever possible. The technical details in the above list should be limited in courses arranged for technicians with more emphasis on management techniques for them.

#### **4. COURSE DURATION**

The recommended period is two weeks for a generalized course.

#### **5. LOCATION**

The exact location in the tropics is not critical. However, existing centres for animal production within the tropics are preferred. Facilities for microcomputer (together with well documented software), cryogenic storage, cytogenetics and immunogenetics are essential. Farm facilities to examine and characterize breeds within various species of livestock are also essential prerequisites to the choice of location.

#### **6. RECOMMENDATION**

A two-week training programme is warranted in each of the Asian, South American and African regions. Regional emphasis is necessary because of the differences between these regions and similarities within, in the species utilized and production systems. Regional cooperation will also be more effective. Participating countries should be selected by FAO based on the existence of promising indigenous livestock. The responding country should be encouraged at the top management level so that they will pursue the national conservation programme after the trainee has completed the course. There is sufficient interest in East Asia and Southeast Asian countries on the characterization, and conservation of their buffalo and cattle besides other small ruminants.

## 7. ACKNOWLEDGEMENT

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## EDUCATION AND TRAINING ON ANIMAL GENETIC RESOURCES IN THE TROPICS

### South American Camelids

Cesar Novoa 1/

In the Andes human and environmental systems are experiencing irreversible deterioration.

Scientists and government officials know the problem exists but there is no consensus about the causative factors. In the past and at present these highland areas were considered marginal and have supplied camelid meat and wool for the people in the lowlands. There are systematic deficiencies of knowledge and the problems are not well understood.

Urban education on rural matters is limited, and knowledge on highland life is scanty.

In rural areas 80 percent of alpacas and 100 percent of llamas are in the hands of small farmer families, having a subsistence economy and cultural values different from the western world.

The camelids are complementary to the limited and risky agriculture which is due to climatic reasons.

Pasture use is based upon traditional knowledge, which though not always correct has permitted conservation of these animal resources since the future of these people depends upon them.

## EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN THE TROPICS - DEVELOPED COUNTRY VIEW

E.P. Cunningham 1/

The experience of recent decades in Europe and North America is that the development of livestock improvement programmes has not been limited by deficiencies or shortages in professionally trained manpower. In recent years, as aspects of the underlying sciences have become more sophisticated, a number of cooperative graduate training programmes have been established - in particular the Internordic Course in Scandinavia and the collaborative course in Germany. These have give additional benefit of creating international personal networks among research and development staff, which have served their respective countries very well. This idea is worth considering in other parts of the world.

One problem which has occurred in different ways in different countries has been that some of those with major responsibilities for livestock breeding policy and practice have not had an adequate knowledge of modern animal breeding methods. This has applied in some cases to key administrators in Ministries or breeders' organizations. In general, this problem has declined in recent years as governments have reduced their activities and control in livestock breeding practice. It is important that developing countries should be aware of the potential costs of excessive conservatism at the administrative level. Perhaps there is a case for special short courses specifically designed to keep key administrative personnel aware of recent technical developments and potential.

A further lesson from the experience of the developed countries is the extent to which the implementation of livestock improvement programmes has depended on appropriately trained technical staff. This applies in the areas of animal management, data management, and in the management of the infrastructure required for a modern breeding scheme. The new teaching medium of videodisc combined with microcomputer provides a new and powerful means of providing much of the training at this level which will be needed in developing countries.

Throughout the developed world, but particularly in Europe, much has been gained by 'lateral' transmission of information and experience, i.e. by each country learning from the experience of its neighbours. There are undoubted advantages in attempting to emulate that pattern elsewhere, e.g. in Africa. FAO's regional networks are perhaps the appropriate framework.

The social and administrative structures in developed countries have in general provided acknowledgement and reward for staff contributing effectively to livestock improvement activities - whether at the research, management or operational level. This has helped to ensure commitment of staff and success of the programmes. In order to strengthen motivation in developing countries, it could be worthwhile instituting some international system of recognition or awards to individuals making significant contributions to development in their own countries.

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## PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN THE TROPICS

### CONSERVATION OF ANIMAL GENETIC RESOURCES: BRAZIL NATIONAL PROGRAMME

Armando Teixeira Primo 1/

The Brazilian Agricultural Research Corporation (EMBRAPA) through the National Research Centre for Genetic Resources (CENARGEN), is concerned with a programme for the conservation and evaluation of livestock populations belonging to the "naturalized breeds" (genetic groups originated within animals introduced to the Americas by the colonists). These populations have been submitted to a long process of natural selection, having thus acquired adaptive and/or productive traits for the diverse ecological conditions found in Brazil. Most of these populations are in an advanced state of genetic dilution and/or in danger of extinction, as is the case for some groups of bovines of the Criollo type. These animals are being studied with the objective of conservation of the germplasm. Conservation is done either in situ (breeding units) or ex situ (cryopreservation of semen and embryos).

It should be pointed out that EMBRAPA was one of the first research institutions in Latin America which, following FAO/UNEP recommendations, established a programme for the conservation of animal genetic resources which was in an advanced state of disappearance (Table 1).

Table 1

FAO/UNEP Technical Consultation Recommendations 1980		Implementation of the Recommendations by EMBRAPA/CENARGEN
Surveys		1980
Characterization		1982
Evaluation Conservation		1983
<u>In Situ</u>	Germplasm nuclei	1981
<u>Ex Situ</u>	Gene bank	1984
Data bank		1985
Intercountry cooperation Exchange of germplasm		1985

In Brasilia, CENARGEN maintains a sperm and embryo bank with the objective of avoiding genetic dilution and irreplaceable gene losses of the valuable "naturalized breeds" germplasm. At present the gene bank stores frozen embryos and semen of Caracu, Crioulo Lageano and Mocho national cattle.

Techniques in cryopreservation, thawing and embryo transfer to recipient cows are wholly dominated. Through adaptation of foreign technology, freezing of bovine embryos for long-term storage became a reality in 1983. Together with the preservation and breeding in special reserves, the preservation of frozen semen or embryos is presently an alternative which permits formation of a gene bank to supply future research and breeding programmes. Biological stability, given by cold storage will also help in preventing genetic drift.

Micromanipulation has permitted the production of identical twins from a single embryo. Embryo halves can be frozen and stored for a long time, thus allowing evaluation of zootechnical traits of an individual or its progeny while maintaining a genocopy of the same in the embryo bank.

Genotype-environment interactions can be evaluated over time by allowing identical twins to develop in different years.

EMBRAPA/CENARGEN presently has the infrastructure and trained personnel required to begin research on embryo splitting.

The National Programme for Research on Genetic Resources includes, amongst its many components, both plant and animal projects in identification, characterization, evaluation and preservation of animal germplasm in danger of extinction belonging to naturalized breeds or types. Among the bovines, Caracu, Mocho Nacional, Pantaneiro, Crioulo Lageano or Franqueiro and Curraleiro or Pé-Duro merit special attention.

In collaboration with other research institutions cooperative conservation projects are being carried out with donkeys and Brazilian breeds of pigs and sheep.

## 1. ANIMAL GENETIC RESOURCES - BRAZILIAN NATIONAL PLAN

In 1980, a "Coordination of Animal Genetic Resources" was established at EMBRAPA/CENARGEN with the following duties:

- to implement activities to develop animal genetic resource conservation in Brazil;
- to consider the conclusions of the FAO/UNEP "Technical Consultation on Animal Genetic Resources Conservation and Management", held in Rome in 1980.

EMBRAPA, through CENARGEN, assumed the responsibility for the conservation of endangered Brazilian breeds through binding contracts with the remaining enthusiastic private owners.

With this contract, EMBRAPA/CENARGEN keeps 70 percent of the frozen embryos or calves produced, and the owner of the endangered stock will get 30 percent of the germplasm. It is expensive to conserve minority breeds, which are not economically profitable. Government financial assistance must always be given to ensure the breed's survival in the original environment or by means of genecryobanks in order to revive the vanishing and endangered animals in the future.

Before it was too late, EMBRAPA/CENARGEN began a nationwide programme to maintain locally adapted breeds. In certain regions of Brazil, these old breeds fit best in the given ecosystem (Table 2).

The conservation of animal breeds, having irreplaceable hereditary traits, is necessary for research education, general natural protection, and history, apart from breed improvement and economical and social reasons. With some breeds the problem was not so urgent, and the objective of EMBRAPA/CENARGEN was to arrest the

decline of the breed before it reached serious proportions. At the same time, it was necessary for CENARGEN to plan a long-term strategy, and, in this respect, the creation of the Semen and Embryo Bank was a most significant development. It will ensure that genes from the minor breeds can be stored against emergency or changing requirements in the future. At this time, semen and embryos are available from four breeds of cattle that are included on EMBRAPA'S priority lists, namely, Caracu, Mocho Nacional, Crioulo Lageano and Pantaneiro. With some breeds, which appear to have little relevance in current commercial systems, the role of the gene bank is limited mainly to preservation, but the Caracu is successfully establishing a relevant position within the cattle industry. The Caracu is demonstrating qualities unsuspected in the past. More recently, this breed has updated its image and it is noted now for its performance in feeding tests (Table 3 and (Table 4) and the high growth rate of its crossbred progeny (Table 5).

Table 2

## BRAZILIAN ENDANGERED CATTLE BREEDS

Breed	Location	Population	Main use	Main reason for being endangered	Specific trait(s) that might justify a conservation programme
Mocho Nacional	CENARGEN Brasilia-Federal District	20	Meat	Indiscriminate crossbreeding with zebu	One of the few bovines of the Criollo type expressing the "polled" trait and good adaptation to the breeding conditions of Central Brazil
Crioulo Lageano	Lages, State of Santa Catarina	250	Dual purpose	Crossbreeding with imported breeds	Adaptation to high plains environment. Easy calving and good maternal ability
Curraleiro or Pé-Duro	States of Piauí Maranhão, Goiás	Unknown	Dual purpose	Crossbreeding with zebu. Lack of attention by raisers because of small size	Adaptation to semi-arid zone. Thrives on low quality grazing.
Pantaneiro or Tucura	States of Mato Grosso and Mato Grosso do Sul. "Pantanal" ecosystem	Unknown	Meat	Small size. Crossbreeding with zebu	Heat tolerance and adaptation to seasonally flooded environments.
Caracu	South-central Brazil	>15 000	Dual purpose	Minority breed, but has updated its image demonstrating qualities unsuspected in the past.	Adaptation to several ecological zones in Brazil. Outstanding growth rate in feeding tests.

**Table 3** SUMMARY OF FOUR YEARS' PERFORMANCE FOR FOUR BREEDS OF CATTLE AT SERTAOZINHO-SAO PAULO, BRAZIL

Breed	1979		1980		1981		1982	
Chanchim	77	352.2 1/	51	344.2	77	366.2	42	350.0
(Zebu x Charolais)		92.2 2/		93.3		106.5		90.2
Caracu	6	330.5	17	281.3	12	353.5	19	328.8
(Criollo)		94.8		80.9		105.8		86.4
Guzerat	45	301.. 5	56	286.7	40	318.5	53	280.7
{Zebu)		79.7		81.4		97.9		75.8
Nellore	72	294.2	76	287.5	135	309.4	108	309.4
(Zebu)		79.1		78.2		90.3		77.8

<sup>1/</sup> Corrected final weight (w 392)

<sup>2/</sup> Gain in 112 days of test (G 112)

Source: Estação Experimental de Zootecnia-Sertãozinho - SP.

**Table 4** SUMMARY OF FOUR YEARS' PERFORMANCE FOR FOUR BREEDS OF CATTLE AT SERTAOZINHO-SAO PAULO, BRAZIL

Breed	1983		1984		1985	
Chanchim	33	345.1 1/	30	387.5	19	362.8
(Zebu x Charolais)		100.0 2/		103.6		96.6
Caracu	16	307.4	21	338.6	21	325.1
(Criollo)		87.9		99.4		98.8
Guzerat	41	284.6	45	297.4	47	301.2
{Zebu)		81.6		83.0		82.5
Nellore	91	293.1	128	293.4	146	293.9
(Zebu)		80.7		83.1		85.0

<sup>1/</sup> Corrected final weight (W 378).

<sup>2/</sup> Gain in 112 days of test (G 112)

Source: Estação Experimental de Zootecnia-Sertãozinho - SP.

**Table 5 PRODUCTION EFFICIENCY (P.E.) FOR WEIGHT AT 18 MONTHS (W18) IN AN EVALUATION OF NELLOR (N), CHANCHIM (C), SANTA GERTRUDIS (G), HOLSTEIN (H), BROWN SWISS (S) AND CARACU (K) AS SIRE BREEDS IN MATINGS WITH NELLORE COWS**

Crossbred Group	W 18	F 1/	P.E. 2/	I 3/	Class 4/
NN	243	.728	177	100	III
CN	276	.805	222	125	I
GN	271	.408	111	63	V
HN	304	.448	136	77	IV
SN	288	.474	137	77	IV
KN	280	.702	197	111	II

<sup>1/</sup> F = (Fertility) = calving rate corrected for mortality.

<sup>2/</sup> P.E. = Beef production at 18 months of the calves per cow exposed = F x W18.

<sup>3/</sup> I = Index in relation to control group NN = 100.

<sup>4/</sup> Class = Classification

Source: Instituto de Zootecnia-São Paulo, 1985.

### 1.1 Characterization

CENARGEN is carrying out studies in the area of characterization of germplasm in order to describe the genetic attributes of animal species or breeds covering the phenotypic and genetic parameters.

#### 1.1.1 Morphological characterization

Body measurements were taken in three Criollo cattle populations to characterize the germplasm in respect to conformation and size. Simple correlations between morphological measurements, in the Caracu breed, showed positive values ranging between 0.324 for height in the hindquarter and rump width and 0.825 for height in the hindquarter and height at withers (Trovo and Primo, 1984). Height at withers is shown in Table 6.

**Table 6 CRIOLLO CATTLE HEIGHT AT WITHERS (cm)**

Breed	Sex	
	Male	Female
Caracu	146	130
Crioulo Lageano	141	127
Curraleiro	116	108
Mocho Nacional	132	131

#### 1.1.2 Cytogenetic characterization

Systematic cytogenetic studies are being done in all the animals involved in the production of semen and embryos for long-term storage. No chromosomal abnormalities were found. The Y chromosome is

submetacentric in some of the animals and acrocentric in the majority of the Criollo cattle studied, suggesting influence of zebu blood. The Caracu and Curraleiro showed approximately 90 percent of acrocentrics while this percentage is 43 in the Crioulo Lageano cattle (Tambasco *et al.* 1985).

### 1.1.3 Characterization by blood typing

Up to the present, blood factors belonging to 10 genetic systems were analysed, and the number of factors per animal in the cattle populations of Pantaneiro, Curraleiro, Crioulo Lageano, Mocho Nacional and Caracu were studied.

Pantaneiro presented the highest genetic variability (12.61 factors per animal) and Caracu the lowest (10.91).

This preliminary analysis suggests a close relationship between two breeding populations (Mocho Nacional - Caracu) and (Pantaneiro - Crioulo Lageano). Curraleiro is associated with this last group at an intermediate genetic distance.

These preliminary results must be confirmed with the study of other genetic loci such as transferrins, haemoglobins, carbonic anhydrase and others (Mario Poli, Pers. Comm.).

## 1.2 Evaluation

Too often, breeds, strains and genetic types have been discarded for no valid reason. The evaluation of the existing genetic material in a number of environments and production systems is in the process of being implemented by EMBRAPA. This evaluation will involve pure breeding as well as crossbreeding. Frequently the superiority of the F<sub>1</sub> offspring in crosses has been ascribed solely to the introduced breed although it has later been shown to be due to heterosis. The expansion of the zebu at the expense of Criollos in Brazil is a clear example of such confounding interpretation of heterosis.

The adaptive and productive potential of Crioulo Lageano cattle, as purebred or in crossbreeding with Nellore and Charolais cows, is being studied through a cooperative project between EMBRAPA and the Federal University of the State of Santa Catarina. Based on these studies involving fertility, maternal ability, growth rate, milk production, resistance to parasites and carcass characteristics, it is expected to obtain indications on the rational use of this cattle as a source of genes, mainly associated with adaptive characteristics or traits.

A similar project is under way in the "Pantanal" region (a seasonally flooded area in the states of Mato Grosso and Mato Grosso do Sul) utilizing Pantaneiro cattle as purebred or in crossbreeding with zebu. These two projects have financial help from the Bank of Brazil.

## 1.3 Conservation of Animal Genetic Resources

EMBRAPA/CENARGEN utilizes three methods for the conservation of animal genetic resources:

- reproducing populations;
- freezing semen; and
- freezing embryos.

### 1.3.1 Reproducing populations

Until five years ago, animal germplasm was maintained in herds of a few individual breeders on the basis of expected economic returns or due to family tradition or personal interest. Just one herd (Caracu) was maintained, at the time, by a public institution (Instituto de Zootecnia - Sao Paulo) besides the private owners.

Nowadays, EMBRAPA/CENARGEN maintains small herds of animal germplasm which were on the verge of disappearing, or provides a small subsidy and technical assistance to encourage adequate population size in the remaining herds.

EMBRAPA is taking care of three endangered groups of bovines, namely, Mocho Nacional, Curraleiro or Pé-Duro and Pantaneiro in special conservation units.

### 1.3.2 Frozen semen

Storing germplasm in the form of frozen semen or frozen embryos could become a practical approach to conserving genetic stock whose survival is at risk.

FAO/UNEP (1983) provided information on methods and estimated costs of preserving gametes and embryos.

Smith (1984b) examined the efficiency of alternative methods for minimizing the loss of genetic variability. For periods of over five years, semen storage became the cheapest form of conservation (Smith, 1984a).

When possible, EMBRAPA/CENARGEN store 100 units of semen from each of 10 slightly related males. At present, CENARGEN has 10 000 doses of semen of one breed (Caracu) and of three local strains (Crioulo Lageano, Mocho Nacional and Pantaneiro), for long-term storage. As an urgent safeguard to protect endangered stock, semen was collected from some sires lacking performance data. Further testing and gradual substitution will be needed.

The rotational use of frozen semen from unrelated sires on each other's daughters would help to reduce inbreeding and drift in gene frequencies (Smith, 1977).

### 1.3.3 Frozen embryos

Storage of frozen embryos would be desirable where it is important to preserve the capability of reconstituting a breed or strain and maintaining it with low inbreeding. On the other hand, the genotype is intact in embryos, whereas at least three backcrosses are required to reconstitute the approximate genotype from semen. For frozen embryos, collection of 25 embryos each from 25 donors, would be sufficient for conservation purposes (Smith, 1984a).

Costs of frozen embryos are very high, but as for frozen semen the annual storage costs are low.

At present, CENARGEN, in Brasilia, maintains a gene bank with storage of embryos from Caracu, Crioulo Lageano and Mocho Nacional cattle. Through adaptation of foreign technology, freezing of bovine embryos for long-time storage became a reality in 1983.

## 1.4 Data Bank

It is necessary to obtain a comprehensive description of the characteristics of local breeds, together with a characterization of the environments to which they are adapted (Hodges, 1984).

EMBRAPA/CENARGEN just started work storing in a microcomputer the distinguishing physical features of local breeds in addition to reproductive traits. Semen and embryo collection data are already stored in a readable format. Changes in numbers and structure of the Crioulo Lageano cattle population is followed by close monitoring by CENARGEN data bank.

It is essential to have well defined Animal Descriptors.

## 1.5 Inter-country Cooperation

Many of the indigenous breeds are spread across many countries, so that genetic resource management requires cooperation between countries.

FAO/UNEP recommended that inter-country cooperation in the exchange of germplasm should be encouraged with due regard to quarantine precautions.

In Brazil, the Crioulo Lageano cattle are in danger of extinction (herd of 250) with a high inbreeding level and few bulls of related ancestry.

There are similarities between the Brazilian Crioulo Lageano and the Argentinian Criollo, possibly explained by the Iberic origin. Sal Paz (1977) demonstrated that the pure Criollo, in the Chaco ecosystem in Argentina, produces a greater weight of weaner calf per hectare per year than zebu, British beef breeds or zebu crosses.

In an effort to widen the genetic base and to arrest genetic dilution in the breeding unit of Crioulo Lageano cattle in Brazil, three Criollo bulls were imported from Argentina in 1985.

This exchange of germplasm was a donation from the Argentinian Instituto Nacional de Tecnologia Agropecuaria (INTA) to EMBRAPA.

The conservation of naturalized breeds is a matter of paramount importance in Brazil, not only for sentimental reasons, but to ensure the maintenance of genetic variability to meet future yet unforeseen requirements.

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### **INDIA'S EFFORT IN CONSERVATION AND MANAGEMENT OF INDIGENOUS LIVESTOCK AND POULTRY GENETIC RESOURCES AND CREATION OF DATA BASE**

R.M. Acharya 1/

#### **PART I: ANIMAL GENETIC RESOURCES**

The Indian sub-continent is known for the size and diversity of animal genetic resources and has been recognized as the home for many important breeds of livestock especially draught cattle, milch buffaloes, carpet wool sheep and highly prolific goat breeds. The Indian breeds are adapted to tropical heat and diseases and poor quality feeds. There are 26 breeds of cattle, 7 of buffaloes, 40 of sheep, 20 of goats, 4 of camels, 6 of horses, 3

of pigs and 18 of poultry. Due to the lack of any geographical barriers and little controlled breeding by Government/breed societies, there has been large inter-mixing of breeds contiguous to each other over the centuries resulting in dilution of breed characteristics making more than 75 percent of the populations nondescript. Added to this is the introduction of crossbreeding programmes involving superior exotic breeds, mostly from temperate ecologies to meet the economic needs of the changing society, which is further hastening the dilution and possibly extinction processes of the well established breeds. This in spite of the breeding policy which requires that the descript breeds be not involved in crossbreeding programmes.

The indigenous breeds have mostly evolved through natural selection primarily involving adaptation to ecological conditions of their home tract, management system and to a limited extent to meet the economic needs. However, in more recent years, improvement through selection, primarily based on physical conformation and to a very limited extent on production, has been emphasized.

On Indian breeds of livestock, a number of small and disjointed studies have been conducted by the Indian Council of Agricultural Research, Agricultural Universites, Animal Husbandry Department of the State and Central Governments.

Attempts have been made to compile information on indigenous breeds of livestock and poultry, more recently, by Acharya (1982) on breeds of sheep and goat, and by Acharya and Bhat (1984) for all species including poultry. These compilations stress the need for conservation of a number of breeds where numbers are seriously declining.

It is increasingly being realized that the indigenous breeds especially draught and dual purpose breeds of cattle, carpet wool breeds of sheep, more prolific breeds of goats and species like yak, mithun and camel need to be evaluated, conserved and further improved. This attempt should be preceded by a breedwise study covering their production, reproduction, adaptation and disease resistance characteristics especially in their native habitats and under existing management. Little emphasis on description of the existing breeds and their differentiation based on gene markers has been meaningfully laid.

## 1. SETTING UP THE NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES

To undertake studies on indigenous livestock genetic resources and to build a data bank, the Government of India (Indian Council of Agricultural Research) has set up a National Bureau of Animal Genetic Resources (Bureau) at Karnal (Haryana). The brief objectives of the Bureau are:

- To undertake systematic surveys for description, evaluation and cataloguing of livestock and poultry genetic resources and to establish a data bank and information service on these resources and to determine the need of and recommend steps for the conservation and management of these resources.

### 1.1 The Bureau's Activities

The first phase of the Bureau's activities will be directed at collecting and collating as much published and unpublished information as possible on the descript breeds and to conduct surveys to augment information on them in areas where there are deficiencies. Identification and description of a breed is to be approached in a multi-disciplinary manner and should involve the topography, soil and water resources, physical environment, feed resources and management systems. So far, largely the descriptions of breeds were on the bases of body conformation, coat colour and a few body measurements. Information on production and reproduction parameters was given on only a few breeds and that too based on limited data on animals maintained on Government farms. In a breed itself, sometimes subtypes have been delineated on the basis of physical conformation and performance characteristics. Modern scientific tools especially gene marker traits, e.g. blood

groups, biochemically polymorphic traits and variations in chromosomal structure and number would be applied in establishing breed identities and studying their evolution. Studies related to major histocompatibility complexes and DNA sequencing have not been evolved to the extent of applying to description of and differentiation among breeds but developments in these areas do hold tremendous promises for the future and would be ultimately employed.

Since breeds of domesticated livestock have been evolved to meet specific requirements and they have adapted well to their native environment and management it will be necessary that a description of a breed involves description of environment and management practices. The environmental factors such as monthly average temperature and range, relative humidity, rainfall, wind velocity, hours of daylight and possibly solar radiation and the management aspects covering feed resources and feeding, common disease problems, breed improvement programmes, breeding procedures etc. will give a meaningful description of a breed in its breeding tract. Above all, the interaction with man should be given due consideration especially so with the nomads, tribal and certain livestock breeding communities who seem to have provided a type of isolation for their livestock resulting in the emergence of recognizable breed characteristics.

The Bureau will advise the Government and possibly through cooperation with other agencies, undertake conservation of indigenous genetic resources (threatened with extinction) through both by in situ and ex situ methods, the former through maintenance of purebreds on the organized farms - in their home tract and the latter through cryopreservation of semen and fertilized embryos.

## 2. OTHER RESEARCH ACTIVITIES RELATED TO BREED EVALUATION AND IMPROVEMENT BEING UNDERTAKEN BY ICAR

In the recent past, livestock improvement in India has been attempted through the introduction of exotic breeds of different livestock for replacement of indigenous populations as in the case of poultry and fur animals and for evolving new breeds through crossbreeding, combining productivity of the exotic and adaptability of the native breeds in most other species. However, more recently the importance of indigenous breeds and need for their conservation through management have been realized.

The first task should, therefore, be to identify the existing genetic variants (breeds/strains) with respect to physical conformation, coat colour, size, performance and their adaptation to the physical environment and management practices in their home tract. The Indian Council of Agricultural Research is conducting extensive research work on the performance of important breeds of livestock and their genetic improvement through its species research institutions. It is planned to include in the network 79 farms for indigenous cattle and 56 for buffaloes belong to the animal husbandry departments of the central and state governments and also farms belonging to the Defence Organization maintaining Holstein x Sahiwal crossbred cattle and Murrah buffaloes, in addition to those in ICAR Research Institutes and State Agricultural Universities.

India was one of the first few countries to take up a Herd Registration Scheme. Herdbooks are being maintained for 8 breeds of cattle, viz. Sahiwal, Red Sindhi, Tharparkar, Hariana, Gir, Kanvary, Ongole and Kangayam and Murrah breeds of buffalo. These herdbooks serve as authoritative guides on the standard breeds. However, effective use of these herdbooks has not been made in genetic improvement of these breeds.

ICAR, in addition to the nine species institutes and National Research Centres, viz. National Dairy Research Institute for cattle, Central Institute for Research on Buffaloes for buffaloes, -Central Sheep and Wool Research Institute for sheep and fur animals, Central Institute for Research on Goats for goats, Central Avian Research Institute for avian species and the National Research Centres for yak, mithun, equine and camel for these respective species, has Directorates on cattle and poultry improvement and All India Coordinated Research Projects on buffalo, sheep, goat and pig breeding. All these Institutions and projects of the ICAR will cooperate

with the Bureau in undertaking studies on the indigenous genetic resources. Also, the Bureau will enter into collaborative studies with the State Agricultural Universities through ad hoc research schemes funded by ICAR wherever required. The National Institute of Animal Genetics, a sister institute and located on the same campus and sharing common facilities with the Bureau will conduct basic research studies on cytogenetic and immunogenetic aspects both as a guide to such studies to be conducted elsewhere and as a support to studies taken directly by the Bureau.

## **PART II: DATA MANAGEMENT SYSTEM FOR ANIMAL GENETIC RESOURCES BEING DEVELOPED AT THE NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES**

### **1. INTRODUCTION**

The success of the management of a system depends mainly on the quick transformation of the available data into information helping in timely and right decisions. At the basic level, every organization generates and processes data to produce limited information. Usually, once an objective is met, the data serve no further purpose. Often, when some information is needed for the existing data, the information is obtained with delay which is proportional to the volume of data and the efficiency of storage and retrieval system. The problem becomes severe when inter-departmental or inter-organization data are concerned. But, whatever the cost may be, flow of the data to a central place is a necessity because information for managing an organization cannot be obtained without processing the data from the various sources. Managing a huge data bank and deriving information from it is a stupendous task with the conventional system, but the arrival of computers and the database management software systems make it a realizable target.

### **2. NATIONAL BUREAU OF ANIMAL GENETIC RESOURCES**

The data on the livestock resources of India are not currently available in a central place, but scattered in different departments of the State and Central Government, Autonomous organizations and universities. Little has been done to bring such data or information on the genetic resources that can be compiled into a publication except on sheep and goat breeds by Acharya (1982) and subsequently on all species, though in much less detail, by Acharya and Bhat (1984). The National Bureau of Animal Genetic Resources (Bureau, Karnal, Haryana) has been set up by the Government of India/Indian Council of Agricultural Research (ICAR) to collect, compile and computerize the Animal Genetic Resource data currently available and to be collected through surveys. The following tasks are *inter alia* to be taken up by the Bureau in a phased manner in creating and maintaining a computer-oriented database for the generation of information on genetic resources of livestock in India:

1. Identification of data sources and collection of existing data.
2. Designing data and information formats for easy storage retrieval of data in a computer.
3. Design of a rational database and development of support software.
4. Routine updating, report generation and monitoring.

### **3 DATA SOURCE, COLLECTION AND COMPILATION**

Table 1 gives the source of data required for a model proforma given in Appendix 1.

More than 75 percent of the Indian livestock are nondescript. But within the remaining 25 percent, 26 cattle, 7 buffalo, 40 sheep, 20 goat, 4 camel, 6 horse, 3 pig and 18 poultry breeds have been well defined and established. Therefore, the data relevant to these breeds will be initially collected and compiled. In most of the cases, adequate information covering all the aspects may not be available and survey work will have to be undertaken to bridge the gap.

Table 1 DATA SOURCE FOR LIVESTOCK GENETIC RESOURCES AND THEIR ENVIRONMENT

Title of data and source code (within parentheses)		Source	
1. Livestock data (a,b,c)		a)	ICAR Institutes
		b)	AICRP on livestock breeding
2. Environment of the breeding tract (d,e)			
a)	Farming practices and water resources for irrigation (d)	c)	Central and State Departments of Animal Husbandry
b)	Soil composition (a and d)	d)	Central and State Departments of Agriculture
c)	Fodder and vegetation (a and d)	e)	Indian Metereological Dept.
d)	Weather condition (e)		

In the available census, data information on breed-wise population is not available and as such it is not possible to monitor the population changes in the different breeds. However, this aspect will be taken up for inclusion in the ensuing National Survey to be undertaken by the Bureau through the cooperation of different agencies.

#### 4. COMPUTER FACILITY

As the first phase of developing the data bank, a microcomputer, with Motorola 68000 processor, UNIX Operating System, 640 KB RAM, 72 MB Winchester disks, tape and floppy drives and a printer, has been procured by the Bureau. Along with the system, a rational Database Management System (DBMS) has also been obtained as it was felt that this would suit better than the other DBMS softwares. The system supports report generation and computer languages such as C, COBOL and FORTRAN. These languages will be used to develop support softwares for pre and post-processing of the data in the DBMS as well as in statistical computations.

#### 5. DATABASE

All the data available for a breed will be collected from the individual records of the animals in various organized farms and population characteristics will be derived from them. Wherever survey data are available, they will be included. The data on environmental and manage-mental aspects will also be gathered from the available sources and Processed to incorporate in the database.

The processed data on various breeds will be stored in a rational DBMS. From the census data giving population of different species and a Prior knowledge of the home tract of the breed, population size of various breeds will be generated and added to the database. Once the database is fully implemented, it is expected to give the following information:

1. Population number and compositional (age and sex) trends and possible factors affecting such trends.
2. Whether the present population size in an area (home tract/new area where a breed has been introduced) can be supported by the available feed resources and what is the optimum population size in relation to the existing feed resources.
3. Conformation, physical measurements, performance (production and reproduction), cytological biochemical and serologically polymorphic traits and special characters especially related to the adaptation, disease resistance, prolificacy etc. of different breeds.

4. What are the prevalent diseases and other management problems related to individual breeds and what measures will be effective to tackle them.

## 6. FUTURE PROSPECTS

The National Herd registration scheme being carried out by the Government of India has done commendable work in identifying elite animals of 8 descript cattle and 11 buffalo breeds.

The information regarding the registered animals could be kept in a database for use in possible future development programmes of the breeds especially in selection of mothers and possibly for use in multiplication of elite stock and conservation through cryo-preservation of semen and fertilized embryos. The availability of bulls, facilities for collection, processing, freezing and storage of semen in various organizations throughout the country would be kept in the data bank along with the pedigree and progeny evaluation results of the bulls, wherever available, so that possible central coordination can be effected by the Bureau in identifying and recommending exploit of superior germplasm.

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## **PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN THE TROPICS**

Sheep and Goats

Helen Newton Turner 1/

### 1. INTRODUCTION

The reasons for preservation, frequently discussed, can be summarized in one sentence - the need to maintain genetic variation. This need will govern the principles of preservation, which are similar for all livestock, though their application will vary with species and type of husbandry.

The principles will be discussed under five main headings:

- Which to preserve?
- In what numbers?
- By which technique?
- By whom?
- How to maintain a preserved group?

The characteristics of sheep and goat husbandry in the tropics which influence the application of principles for preservation are:

- Flocks and herds are often small.
- There are seldom flock or herdbooks laying down breed characteristics; the organization of breed societies is, however, being encouraged in some countries {e.g. OAU 1983 p.103}.
- Censuses by breed are rare.
- Type of management varies (stationary, transhumant or nomadic).
- Stud structures, with sires supplied from specialized breeding nuclei, are rare, though government farms frequently fulfil the role, distributing improved sires (indigenous, exotic or crossbred). This practice is more common with sheep than. goats.
- In some countries there has already been indiscriminate crossing with exotic breeds.
- Techniques using frozen semen or embryos are not yet as useful with sheep and goats as with cattle, though this position will undoubtedly change.

## 2. WHICH TO PRESERVE

Interest lies in genetically distinct groups. The FAO/UNEP Technical Consultation on Animal Genetic Resources which met in Rome in 1980, and which recommended the establishment of this Expert Panel, discussed work on breed documentation which had already been done, and urged that more was needed (FAO, 1981). Documentation of breeds in tropical countries had already started (e.g. Bhat et al, 1979), and there has been more since (Acharya, 1982; OAU, 1983; Cheng, 1985; Hasnain, 1985).

Much more needs to be done, and in particular more detailed information is required on the degree of relationship between the breeds, and the genetic differentiation of strains within them, but the work is long-term; enough data are already available for urgent decisions. These decisions will be based on numbers (present and future, predicted through rates of decline) and on performance (which includes other things besides production). Circumstances will decide whether the observer should look first at breeds under threat and then decide which to preserve, or rank the breeds in order on performance, then see if any near the top of the list are threatened.

### 2.1 Declining Numbers

Wildlife conservationists use five "status" categories (IUCNN Red Data Book, Brooke and Ryder, 1978), based on current numbers and rates of decline, and have suggested the same should be used for domestic species. The categories are:

- I. Endangered
- II. Vulnerable
- III. Rare
- IV. Not threatened at present
- V. Indeterminate (insufficient data)

Where should the borderlines for sheep and goats be drawn? It is a simple matter to calculate what a population will be in year  $y$  if it is decreasing at  $x$  percent per annum (Figure 1). Figures of 500 breeding females for the vulnerable category, and 300 for the endangered, were suggested, but the meeting reached no conclusion.

What is not so simple is to obtain the necessary estimates of current populations and rates of decline. Census data in many countries do not differentiate breeds; this lack was recognized in recommendation 5 of the Second OAU Expert Committee Meeting on Animal Genetic Resources in Africa (OAU, 1983), which read that national governments should be encouraged by the Organization of African Unity and the Interafrican Bureau for Animal Resources "to conduct a regular census of their livestock and poultry population classified according to the various breeds, types and strains, and in terms of sex, age, distribution and location".

Such censuses do not always exist, and though some assumptions about breed numbers can be made from regional numbers, these are by no means accurate, as pointed out by Acharya (1982). A conscious effort must therefore often be made to estimate present numbers and rates of decline, the most common causes of the latter being crossing (leading sometimes to complete breed replacement) and alienation of land (expansion of cities, roads etc.). A full survey such as that by Brooke and Ryder (1978) is expensive, but information can be obtained through extension officers, working to a planned questionnaire, and making records with an interval of (say) 3 years of the numbers and breeds (including crosses) of:

- Mature females and males (noting which of the latter are to be used for mating).
  
- Female and male lambs (or kids) and young animals prior to mating.

This information could be collected from a number of flocks in a number of regions. Where the animals are transhumant or nomadic, check points can be established at points through which they normally pass.

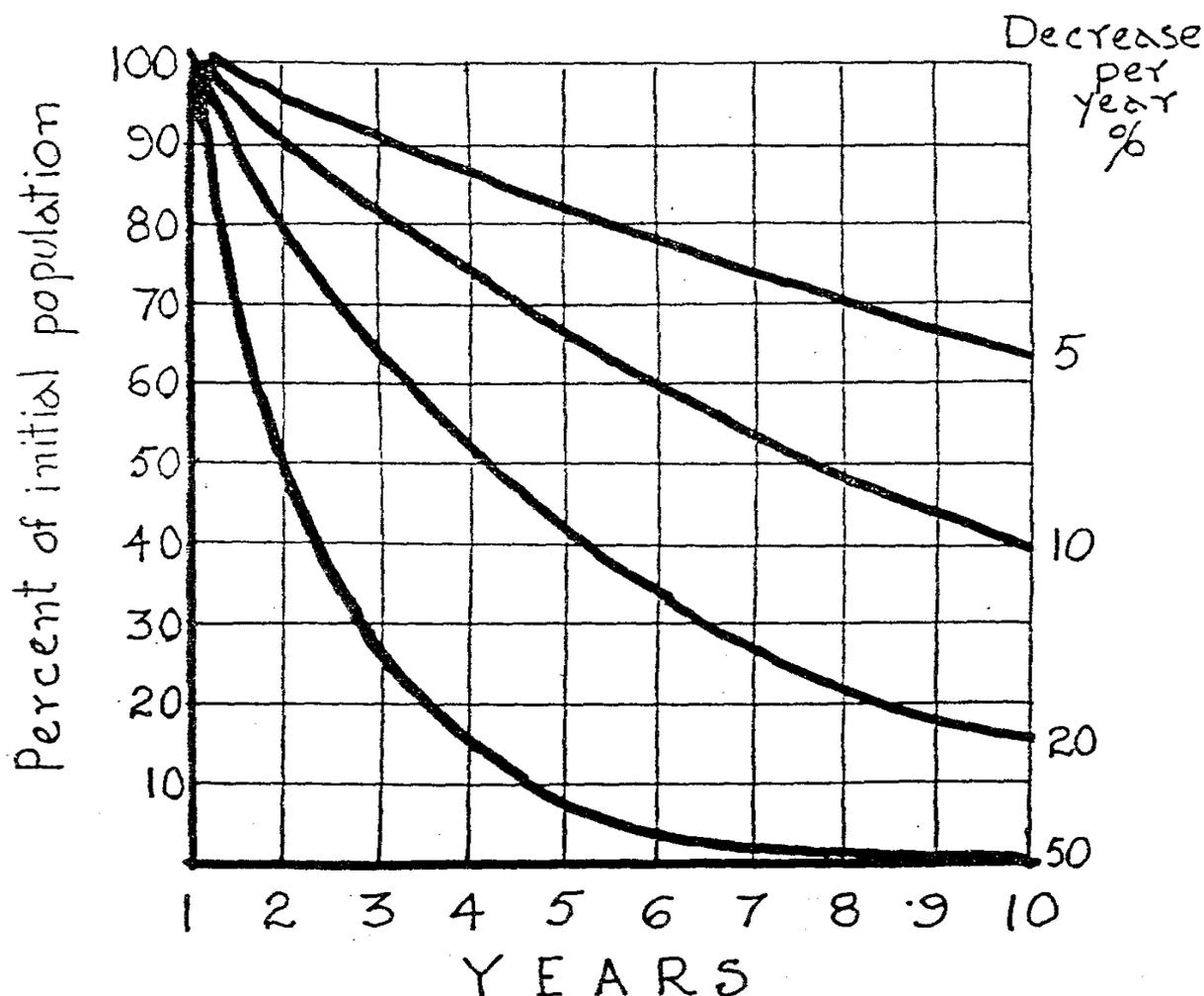


Figure 1 Populations with different rates of annual decrease.

At the first such census, crossbred animals could in many cases be identified visually and planned matings with different males recorded. Information on likely declines through crossing would then be immediately available.

In dealing with crossing, a decision has to be made about the level of "foreign" genes which will be permitted before an animal is rejected as a "purebred". Britain's Rare Breeds Survival Trust accepts animals with up to 20 percent of "foreign" genes. It is suggested that 25 percent might be taken as a limit. This would permit the progeny of first-cross males (between breed A and breed B) and A females to be classed as A. They are 75 percent A, and two back-crosses to pure A males would give 93.75 percent A.

If males of breed B are mated to females of breed A, all offspring are 50 percent A and would be disqualified. The rate at which the A breeding females are replaced by AB, however, depends on the number of age groups of breeding females. Figure 2 shows the decline in percent of A ewes after 5 years when different percentages of A females are mated to other than A males, for 5 and 8 age groups of females.

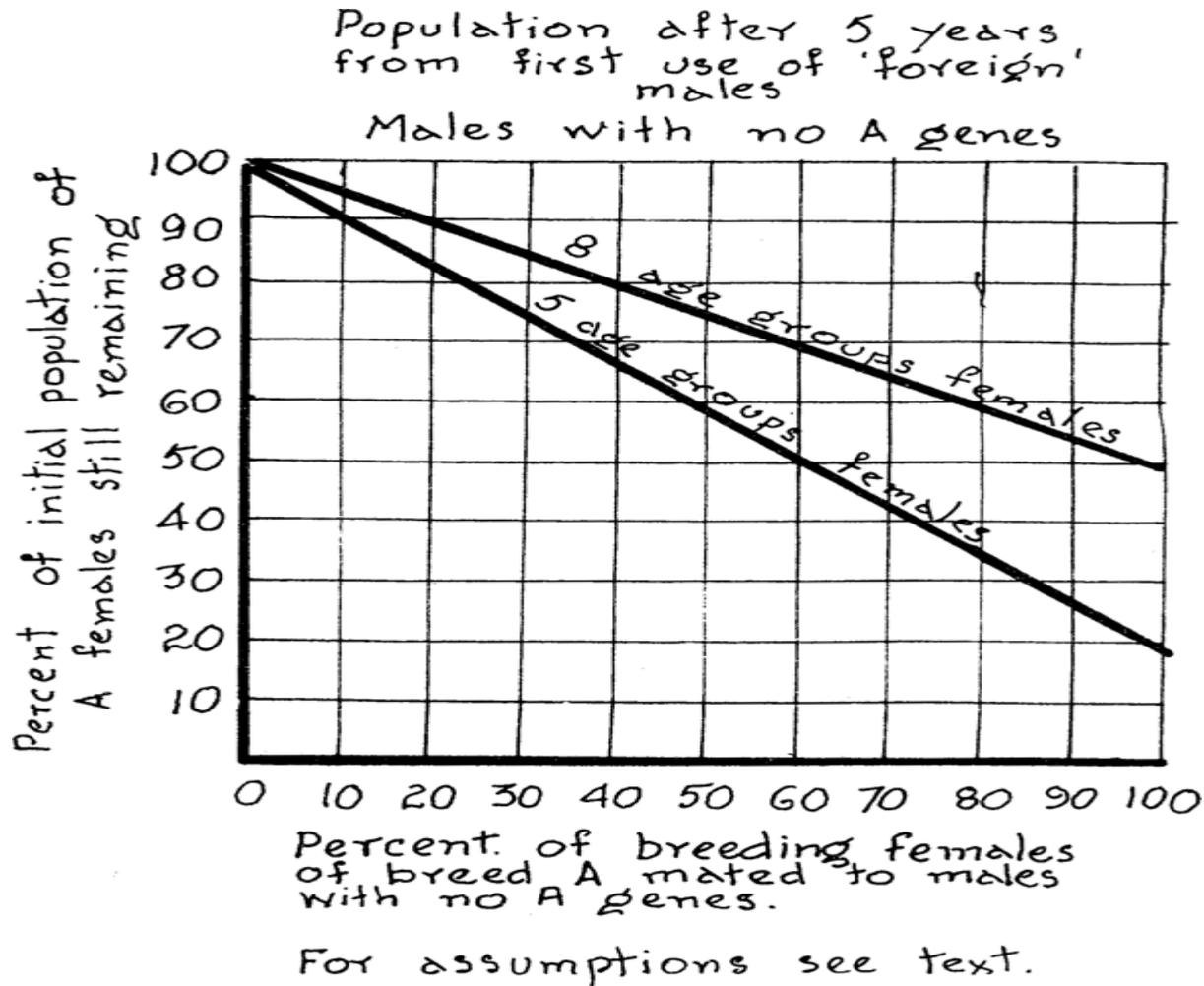


Figure 2 Reduction in purebreds with crossing.

When males which are half A are used, the decline in pure A is slower if 25 percent A is accepted. Figure 3 shows the decline in "acceptable" A females after 5 and after 10 years when half A males are used on various percentages of the A females (5 age-groups of females assumed).

The assumptions used in calculating these figures are:

1. Annual mating.
2. Females enter the breeding flock 2 years after the mating which produced them.
3. If there are 5 age groups of breeding females, one-fifth are replaced annually (no death rates allowed for).

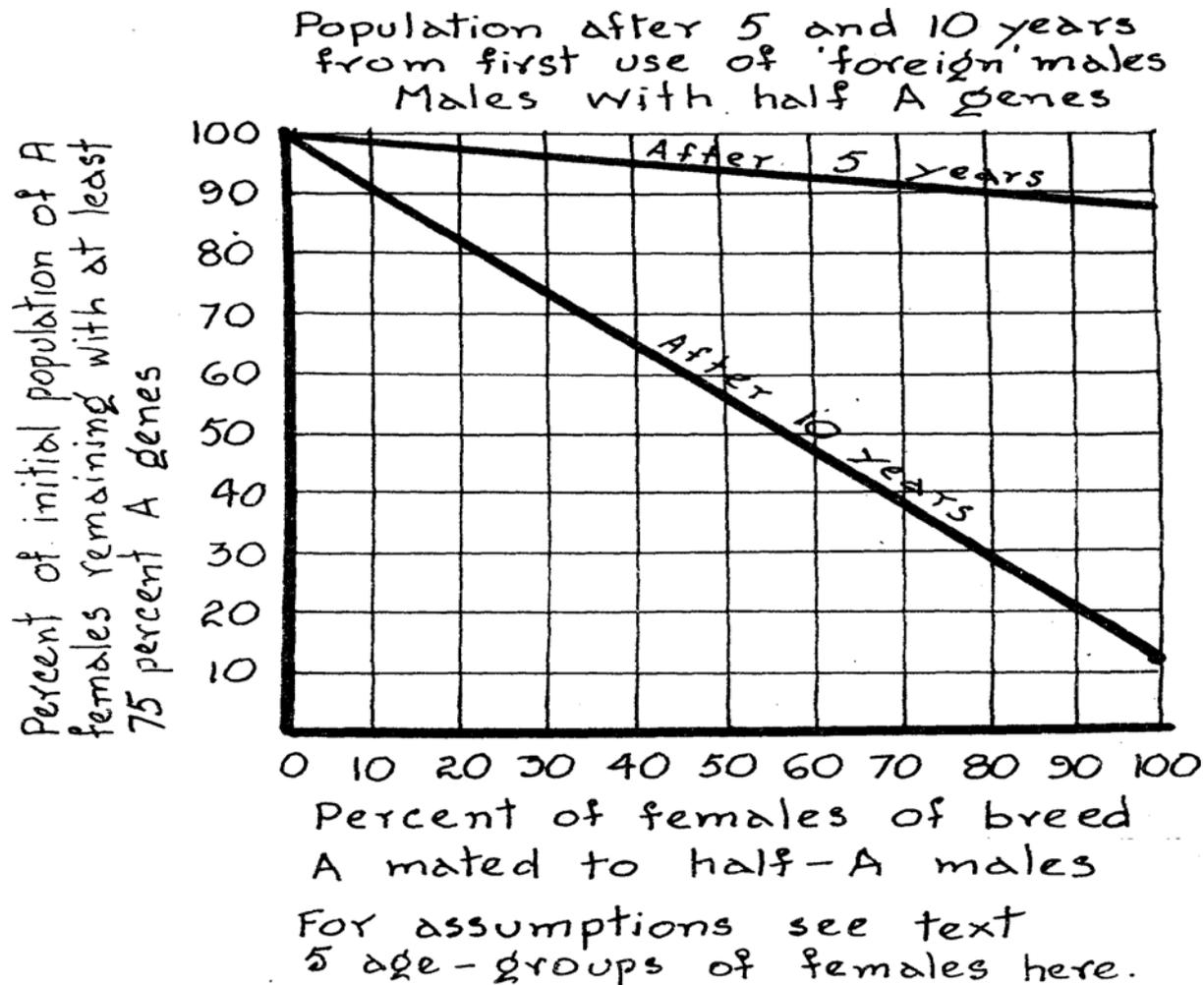


Figure 3. Reduction in purebreds with crossing.

Figure 2 and Figure 3 can be used in conjunction with the type of spot census suggested above. If a count of 1500 breeding females of Breed A has been made, of which 80 percent are to be mated to males with no A genes, then after 5 years the number of A females will be only just above the 500 level if there are 5 female age groups, and down to 900 with 8 age groups (Figure 2). If half-A males are to be used, the number of ewes with at least 75 percent A genes will be 1350 after 5 years, but only 450 after 10 years. Somewhere in that period preservation action would need to be taken.

## 2.2 Performance

What makes a breed worth preserving? More features than production have to be considered, and questions to be asked include:

- What are the main sheep (or goat) products required, in different parts of the country?
- Are any existing breeds outstanding for production of that commodity?
- How do the breeds rank for other traits such as reproduction rate, age at puberty, lambing

frequency, mothering ability, resistance to disease, adaptation?

- Has any breed an outstanding single feature, such as high prolificacy, short post-partum anoestrus, etc?

Decisions will be helped by FAO/UNEP's proposed data banks, which will cover records of all aspects of performance as well as descriptions of the environment. The need for more breed identification and performance figures must always be stressed, but in the meantime much data are already available, even though not always uniformly recorded, usually collected on experiment stations rather than in the field, and without direct breed comparisons. The figures are nevertheless a guide when urgent decisions are needed.

### 3. IN WHAT NUMBERS?

In an emergency, the only action possible may be to preserve all members of a single flock or herd, but ideally a preserved group should be a sample drawn from a number of flocks (or herds) of the breed, and be large enough to minimize inbreeding.

Technique will influence the number stored. One of the recommendations of the " Joint FAO/UNEP Expert Panel meeting in 1983 (FAG, 1984) was that "the preferred preservation 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". The recommendation, went on to urge that FAO/UNEP should set up an International Cryogenic Animal Gene Bank.

Since freezing of sperm means continued back-crossing to recover a breed, embryos rather than sperm seem a more profitable source for storage. Eventually the frozen embryos will have to be retrieved as live animals, so in deciding on numbers to be stored, allowance has to be made for losses between storage and animals-on-the-ground. This loss will depend on when and where storage is made. The following discussion refers to the final count of animals-on-the-ground, and to the numbers required for maintenance; larger groups may be preferable if there is to be selection for genetic improvement.

#### 3.1 Representative Sample

This is formed by collecting both males and females from a number of flocks and herds.

#### 3.2 Size of Preserved Flock or Herd

One of the main problems is to limit inbreeding. Smith (1984) chose to limit the annual rise (F) to 0.2 percent. If we accept this, we can use the following approximate formula (Turner and Young, 1969) to estimate sire numbers:

$$\Delta F = \frac{1}{8ML^2} \quad (1)$$

where  $\Delta F$  = annual rise in inbreeding %

M = number of sires added per year

L = generation length

The L value will depend on age at first mating and numbers of age groups of males and females. For first mating age 1 1/2 years, with 2 age groups of males and 5 of females, we arrive at  $M = 6$ , or a total of 12 males. With 10 females per male, the number of breeding females becomes 120.

At 10 females per male Formula (1) gives an underestimate of F, the discrepancy decreasing as the sex ratio increases. The formula can be used, however, to give approximate numbers. As a working figure, 150 breeding females with 20 breeding males is suggested, the males being unrelated as far as possible.

#### 4. BY WHICH TECHNIQUE

The available techniques are:

- Breeding flocks of live animals
- Frozen embryos
- Frozen semen

Smith (1984) discussed the relative costs, and concluded that, although initial costs were far higher for cryogenic storage than for animals, maintenance costs were lower. His maintenance costs for animals were based on British conditions, and in countries where animals can be continually grazed, with low shepherding costs, it is likely that collection of a breeding flock might be the initial choice of techniques, at least until the International Cryogenic Gene Bank has been established. This point will be discussed more fully by other speakers.

#### 5. BY WHOM?

The recommendation from the OAU Expert Committee, discussed above, was directed to national governments, and it is clear that in all countries, tropical or otherwise, the task of identifying the threatened livestock breeds is likely to fall on governments or their agencies. Most tropical countries have government farms or research institutes which maintain breeding flocks of sheep, though goats have been somewhat neglected. Such institutions are obvious starting-points for undertaking the collection and maintenance of preserved groups; some, in fact, already have indigenous breeds, though there needs to be a planned effort to ensure that all required breeds are included, and that more attention is paid to goats.

There are alternative ways of spending the money needed to maintain preserved groups:

- Extending existing facilities on government farms and research institutes, particularly to include goats as well as sheep.
- Helping universities with animal husbandry faculties to establish or expand farm facilities; the preserved groups would be valuable student training material.
- Paying private owners to retain a flock/herd; the necessary negotiations between extension officers and owners would help to strengthen links between them.

#### 6. MAINTENANCE OF PRESERVED GROUP

With cryogenic storage, genes are maintained without change, except for the possible risk of mutations induced by the technique. With live animals, the question arises - should an attempt be made to preserve the status quo, or should the preserved group be subjected to a genetic improvement programme?

The apparent conflict between these options was discussed at the FAO/UNEP Technical Consultation in 1980, and Professor King produced the outline given in Table 1 (FAO, 1980, p.17).

The general opinion of the meeting was that the second option was more likely to be adopted, though if and when International Cryogenic Gene Banks are established both methods may be possible.

Numbers required if genetic improvement is sought will depend on general breeding plans. The main aim of a central nucleus would be to distribute sires (or semen); available facilities, the size of the target population and reproduction rates would be influencing factors.

## 7. CONCLUSION

The aim of this paper is to outline suggestions and promote discussion, not to offer firm recommendations. Those will come later in the light of circumstances in different countries.

Table 1 CONSERVATION VERSUS GENETIC IMPROVEMENT PROS AND CONS

	Involves preservation of	Provides insurance against	Methods	Population Size
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:	Loss of adaptation to:	Live animals with selection	Large enough to carry out useful improvement programme
	a. distinct	a. disease		
	b. show evidence of adaptation	b. climate		
	c. reasonable prospects for a production system	c. nutritional deficiencies		

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## **PRINCIPLES IN USE OF LIVE ANIMALS**

### I. Bodó 1/

#### **1. INTRODUCTION**

There are two basic methods to preserve pure breeds or pure animal genetic material:

- a. in situ methods;
- b. ex situ methods.

The first one is the preservation of live animals mostly under the original environmental conditions (in situ).

The second is the conservation by several cryogenic methods.

The topic of this short paper cover some aspects of only preservation in living herds.

#### **2. ADVANTAGES AND DISADVANTAGES OF KEEPING LIVE ANIMALS IN A PRESERVATION POLICY**

The goal of a preservation policy is to preserve the animal population for future use, so that the structure of genes of the population in question remains unchanged as far as possible.

In this sense the efficiency of keeping live animals, i.e. the preservation by management, is very difficult.

To breed a domestic animal herd for many generations in the same gene structure is nearly impossible, because of several reasons:

- we do not know or see the genes but only some effects of them;

- the selection made by nature is sometimes very effective even against our wish;
- the sex ratio used in domestic animals requires selection, therefore many males are eliminated, according to the breeder's decision every year;
- the number of animals is mostly limited. When culling a cow or bull it is impossible to substitute it by another with the same gene structure even when this second animal is his son or her daughter.

Considering these aspects, the cryogenic method is advantageous when deep-frozen embryos are stored. In this case the next generation, the embryos, can be preserved for the future and remain nearly unchanged compared with the preserved stock which will show more genetic changes in all new generations.

If cryogenic storage is carried out using deep frozen semen (as is usual today), one can restore the breed in the future only by upgrading. In this case the advantage of unchanged genetic material does not exist.

There are other aspects as well. The conditions in some countries make it impossible to organize the cryogenic storage of genetic material. There are some domestic animal species whose semen cannot yet be deep-frozen without lethal damage (horse, pig).

Thus, a preservation policy cannot be planned without the management of live animals.

Another theoretical danger can be presumed when restoring a cryogenic stored breed or population in the future. In such a long period of many hundred years a considerable change of bacteria or other pathogens cannot be ignored. The live animals can accommodate to the small changes from one generation to the other but this is quite impossible for the cryogenically stored animals, because the change is very brutal for them. This is a theory but by accident there can also be other important changes in the environment conditions, when one considers a period of many hundred years.

An advantage of living herds compared to the cryogenic method is observation, because of two important reasons:

- from an aesthetic point of view the cryogenic storage affords nothing, while generations of men are highly delighted at the sight of living herds of unusual, pleasant-looking animals;
- the preserved genetic material has also a professional value; because it possesses important characteristics for possible future use. When the embryos are preserved in containers, nobody will think of the ancient breed and after a long period all the valuable traits of a breed in question can be forgotten.

This is also an argument in favour of living herds.

Domestic animals portray our culture as do buildings and other products of men's creative activity. Therefore it is desirable for future generations to see also the product of their ancestors in this field. Good cooperation is possible with National Parks, because the rare old breeds and the ancient method of keeping animals belong to the protected regions as well.

Nowadays there are many domestic animal breeds the characteristics of which are not yet evaluated. Thus, for evaluation live animals are essential (Maijala, 1984).

Cryogenic storage is expensive, while costs of maintenance of living herds can be more or less compensated by their products under given economic conditions.

As a conclusion one can state that both cryogenic storage and management of live animals are necessary for a complete system.

### 3. PROBLEM OF INBREEDING

When preserving valuable genetic material sometimes effective preservation starts only at the last moment when the number of animals is very small. On the other hand it is very difficult to verify the minimum number for such a breeding goal, when the costs of maintenance of a non-commercial herd have also to be taken into consideration.

Because of the ambition to minimize the number of animals preserved, the danger of inbreeding is a very important point in preservation policy.

May I mention here two opinions on the minimum number of several species which is necessary to avoid the endangered status (i.e. the breed in question is in danger of extinction):

Species	Number of breeding females	
	Cattle	750
Sheep	1500	500
Pigs	150	200
Horses	1000	-
Goats	500	200

Regarding livestock size the critical status of the populations is under that of the endangered ones and is estimated to lie in the range of 10-15.

Smith (1984) calculated small numbers and narrow sex ratio which can only be kept in research conditions:

Species	Male	Female	Number of breeding animals entering/year	
			Cattle	10
Sheep	22	60	22	12
Pigs	44	44	44	18
Poultry	72	72	72	72

We can speak about a "natural" preservation strategy in conventional herds and about an "artificial" one which is carried out in a laboratory yard or cages, under scientific control.

For the latter, a better and proven example is the Cornell Control White Leghorn population. They have a breeding scheme designed to minimize inbreeding and to maintain genetic variability. Fifty sires and 250 dams constitute the breeding population in each generation. Parents are chosen so that only one male and one female parent originate from each sire and dam of the previous generation (Bodó *et al.*, 1984).

Spanish workers keep 50-400 females and 10-100 males in poultry stocks that are conserved (Campo and Orozco, 1982).

The damage by inbreeding can be grouped according to the traits in question:

- a. Qualitative traits.
  - b. Quantitative traits.
- a. The problem is the diminishing variation of the characteristics of qualitative inheritance, the most spectacular of which is the colour.

It is very important to prevent this diminishing variation when the breed decreases in number and loses its territory.

More important are however the defects caused by major genes. The frequency of noxious genes can increase and some genetic defects appear (lack of hair, lack of tail, atresia ani, shortened legs etc.)

One has to use a special mating system to discover the carriers and a very severe elimination of them is necessary.

These are very obvious signs of inbreeding, but not as dangerous as they might appear. The elimination of such disadvantageous characteristics is relatively easy, in spite of the fact that they may last sometimes for many years.

Inbreeding can be considered in this sense as an advantageous method for discovering the hidden genetic defects of populations.

- b. The situation is certainly more dangerous if the signs of inbreeding appear in quantitative traits. These characteristics are fertility, calving difficulties, increased mortality of young animals, decrease of mothering ability of dams, degeneration of constitution, lack of growth etc.

These problems appear only slowly and not easily because of the considerable influence of environment and the human factor.

It is true that the effect of inbreeding is exaggerated because it is a well known danger in small populations, also in relation to human life, and is a subject pursued by many.

In an investigation in a Hungarian Grey Cattle herd the correlation between Wright's coefficient and the reproductive ability of cows was  $r = 0.134$ .

The difference between the reproductive results of inbred and non-inbred cows was 5 percent in favour of the non-inbred. The whole herd was under blood group control and the difference was not significant. Such a difference in reproductive performance of inbred and non-inbred bulls could not be observed (Bodó et al. , 1982).

For measuring the degrees of inbreeding Wright's coefficient is used. It is very good to judge the individual inbreeding rate when pedigree data are available.

The simple average of Wright's coefficient of individuals cannot characterize the degree of inbreeding of a population because it is possible that not all the inbred animals have the same common ancestor in their pedigree and the number of common ancestors can vary in several herds.

Therefore when using the coefficient of Wright for characterizing the inbreeding rate of a population the number of common ancestors should also be given.

Instead of Wright's coefficient the blood groups and other blood polymorphisms can be used to characterize the level of inbreeding in a given breed. Pedigree data are not necessary and from the frequency and the existence of possible factors and alleles one can conclude the degree of inbreeding in the given population (Bodó et al., 1982; Bodó, 1984).

How can we avoid the damage affected by inbreeding? There are many well known methods.

- a. First of all increasing the number of animals is the way to stabilize the preservation strategy, because the loss of heterozygosity is proportional to the decreasing effective population size.

The increasing number of breeding animals can be the only basis for all possible manipulations. It is the simplest and most important action but in some cases realization is very difficult.

- b. Rotational mating system. It needs pedigree data. It can be carried out by keeping the population as one unit or forming several subpopulations which will be crossed only after some generations.

It was believed that division of a population into several sublimes and using a circular group mating system reduces the inbreeding rate more than the simple rotational mating in one random population (Yamada, 1981). However, more recent studies by Yamada and Kimura (1984) have shown both the probability of fixation of a rare gene, and the chances get dangerous enhancement of inbreeding rate within sublimes are greater when using subpopulations in the mating system.

It can be concluded, that in the "natural" preservation form with an endangered population size, e.g. 500 cows, the division into subpopulations is very useful in discovering noxious genes in accordance with Yamada's first opinion. On the other hand under artificial conditions the small population can only be treated as a single random unit.

- c. Keep the sex ratio as narrow as possible. The best effective population size can be obtained by a ratio of 1:1. Such management cannot be used under natural circumstances, but in laboratory yards. Often changing the males instead of using the best ones for a long period is a possible solution.
- d. If some possibilities exist to control the blood of groups or other polymorphisms, these data can be used as an aid for mating and culling the dams and for selection of the future sires.
- e. To introduce an extraneous/similar breed is a very dangerous method and is only admissible in the last resort of evident genetic degeneration, because this intervention threatens with extreme peril all the genetic merit of the population in question.

#### **4. REMARKS ON MANAGEMENT SYSTEMS IN A PRESERVATION POLICY**

In a preservation strategy it is also very important to preserve the original environmental conditions for the animals. This ensures the effect of natural selection in the same way as it was before. On the other hand it is sometimes even more difficult to preserve the original conditions for a breed is than the preservation of the breed itself.

In the course of history natural and artificial selection kept the balance against degeneration of the population (and selection for improving production was not effective). For this reason in situ preservation seems to be the most authentic form for preservation. The other solutions can lead to falsification to some extent, because their goal is to obtain some genetic equilibrium which was never the situation in practice.

A real danger exists, that a population can lose its valuable traits when no selection is made over more generations even when it is theoretically attempted by scientific methods to keep the frequency of genes on the same unchanged level.

The "natural" and "artificial" system of management has already been mentioned. It is important to acknowledge that these two methods can also be used together.

When one wants to establish the technology for maintenance of a threatened herd, the first task is to choose the system of mating and to subordinate all the other elements of technology used to this system.

When speaking of management systems, some disease problems must also be mentioned.

A very important threat exists for endangered breeds, namely infectious diseases. The usual method adopted for commercial populations is to eradicate the population infected with a contagious disease and replace it with a new set of animals after a period of time. This is not possible when rare non-commercial breeds or populations are affected. In this case it is necessary to find other veterinary solutions to guarantee the survival of the animals (for example, by separation of the offspring from the dam or even by embryo transfer).

Another veterinary aspect in management is the presence of facultative pathogenic organisms. They can afflict animals when their natural resistance is reduced by underfeeding, poor management etc. Usually the local endangered breeds are kept under harsh conditions and therefore run a greater risk of breakdown in resistance. To change these conditions would be not only expensive but also undesirable if preservation strategy is involved. Therefore a compromise is necessary. The environment should be constantly monitored to ensure that it does not pose a threat to maintenance of good health in the animals (Bodó *et al.*, 1984).

Thus the most authentic method is the in situ maintenance of the threatened rare breed's or populations under the original unchanged harsh environmental conditions and it can be complemented by scientific solutions in order to conserve the unchanged status of the genes. In some cases one of these methods can/must substitute the other.

## **5. IMPORTANCE OF TYPE WITHIN BREEDS IN CONSERVATION AND PRESERVATION**

Essentially animal traits represent a great value for mankind and the gene structure of a population or breed is the basis for these traits.

When we are speaking about preservation we always think of endangered breeds or the diminishing variability in single purpose breeds etc. Thus, the category for the population which has the merit to be preserved is the breed

In so doing, breed variation is neglected for some traits in the interest, of high production. For example, in British breeds body size is acre and more increased using American and Canadian sires. In North America it is very difficult to distinguish among such different breeds as Hereford and Charolais and Simmental on the basis of body form.

The Hannoverian horse breed was a relatively heavy draught horse, and now it is a real sport horse because of the use of Thoroughbred stallions without changing the name of the breed.

When breeders' associations wanted to develop their breed in a modern direction (which is quite understandable), they increasingly eliminated the rare and commercially non-valuable traits and genes from the breed. The breed thus changes drastically and valuable genes are being lost for the future use of humanity.

If it is desired to establish a crossbred suckler cow herd of medium size out of dairy cows of big size (Holstein) it is possible by using original British beef breeds (e.g. Aberdeen Angus), but it is impossible when one has to use the modernized type of these breeds (e.g. Wye Angus with bulls of 1 200 kg).

In reality the value for mankind is represented by the genes and by traits based upon them and not by the breeds!

In this sense the activity and ambitions of breeders' associations and efforts of FAO are in contrary directions.

The topic of this short paper is preservation therefore the possible role of types in conservation of animal genetic resources, i.e. the profit heterosis, is only mentioned here.

In the future the different types within breeds must increasingly be taken into consideration.

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**EXPERIENCE IN APPLICATION OF EMBRYO AND SEMEN FREEZING  
TO ESTABLISH A RESERVE OF GENETIC MATERIAL**

Stefan Wierzbowski 1/

Practical work started in 1984 at the Institute of Zootechnics, Department of Animal Reproduction and covered one cattle and two sheep breeds.

Red Polish cattle are diminishing rapidly due to crossbreeding. As a result only a limited number of purebred animals exist. Red Polish cattle are a dual purpose animal previously also used for draught. This breed now exists only in the hilly area of southern Poland numbering about 300 000 animals. Although the number of animals is still quite convincing, the policy of crossbreeding is diminishing the number of pure bred animals. The programme to establish a gene bank reserve executed is in two parallel activities: one by establishing three government farms with 300 cows, and the second by collecting semen and embryos from selected animals.

Bulls used for natural mating at the end of their breeding careers were selected as semen donors. Up to now 39 bulls have been chosen. Depending on the period of time available, condition of collection, transportation etc. 170 to 1200 doses of semen were produced from a semen donor. On the average 320 doses per bull are collected and kept in store. It is planned to select 15 more bulls and round off the number to 45 animals. Semen was frozen in pellets as this method is commonly used in Poland. For collection of embryos, so far 20 cows have been used. To qualify a cow as a donor the following conditions had to be fulfilled: over 3800 kg of milk per lactation, 4.2 percent fat, a calf per year for at least six years, easy calvings, complete recovery of genital organs after last calving, not yet served or inseminated after last calving. Uterus and ovaries in normal condition. Generally, good health (negative TBC, Bruc, EBL tests) and acceptable condition were also demanded.

Superovulation was induced by a single injection of 2000-3000 i.u. of PMSG on day 8 to 11 followed by administration of 500-750  $\mu$  g of cloprostenol (ICI) 2 days later. The donors were inseminated usually twice, starting 8-12 hours after oestrus onset. On day seven of post-oestrus, the uteri of donors were flushed non-surgically. A total of 52 attempts were made to induce superovulation. Treatments were repeated in 60.3 day intervals on the average. In 42 cases (80.7 percent) one or more embryos were recovered after flushing and in 10 (19.2 percent) cases the response for superovulatory treatment was missing (Table 1). Three cows did not respond at all although 9 treatments were applied.

**Table 1 RESULTS OF EMBRYO COLLECTION IN SUPEROVULATED POLISH RED COWS**

Donor cows	Superovulatory treatments	Embryo yield per flushing													
		0	1	2	3	4	5	6	7	8	9	10	11	12	13
20	52	10	9	6	1	7	8	2	3	3	1	1			1

On the average 4.3 embryos per treatment were obtained (Table 2). The best donor was a 12-year-old cow which in three flushings gave 23 embryos, with 12 of freezable quality. No age difference was found in efficiency of cows as embryo donors (Table 3). A total of 181 embryos were recovered and 92 were qualified for freezing. 2.1 embryos of freezable quality were obtained per induced superovulation. According to our experience 2 1/2-3 frozen embryos are needed to obtain one pregnancy.

**Table 2 EFFECTIVENESS OF SUPEROVULATORY TREATMENT AND EMBRYO RECOVERY RATE IN POLISH RED CATTLE**

Donor cows	20
Superovulatory treatments	52
Induced superovulations	42
Recovered embryos	181
Recovered embryos per superovulatory response	4.3
Embryos of freezable quality	89
Embryos of non-freezable quality and non-fertilized ova	92
Embryos of freezable quality per induced superovulation	2.1
Stored embryos	51

**Table 3** EFFECTIVENESS OF SUPEROVULATORY TREATMENT IN POLISH RED CATTLE DONORS ACCORDING TO AGE OF ANIMALS

Donors in age groups (years)	Number of animals	Treatments (total)	Induced superovulations	Recovered embryos freezable embryos	Embryos of freezable quality per flushing
10 and less	9	32	25	103/46	1.8
10-15	4	11	10	59/28	2.8
Over 15	7	9	7	19/15	2.1

Also natural heats were used for embryo recovery. In 7 donors 25 flushings were performed and 6 embryos of freezable quality were recovered.

In sheep two breeds, were selected to create a gene reserve. The Swiniarka breed no longer exists. It was only a flock of animals resembling more closely the original type of the breed. The Olkusz breed, or rather type, is a sheep still under consolidation as a breed. The idea behind the creation of a gene reserve was just to establish a basis for future comparison and evaluation of the breeding progress made in this sheep. However, the procedure of establishing a gene reserve is the same as in the case of endangered breeds.

Creation of a semen bank in sheep is much more difficult than in cattle. Of the Swiniarka breed only 5 and of the Olkusz breed 6 rams were available. Of the Swiniarka rams, 683 semen doses in 40 days were produced and in Olkusz sheep 1628 semen doses in 34 days were collected (Table 4).

**Table 4** EFFECTIVENESS OF FROZEN SEMEN PRODUCTION IN RAMS

Breed	Swiniarka	Olkusz
Number of rams	5	6
Collection period (days)	40	34
Produced semen doses	643	1628
Average per ram	136	271
	(84-168)	(151-411)

In Swiniarka sheep 37 ewes were used as donors. For superovulatory treatment 30 i.u. (kg) 800-100 i.u.(PMSG) on day 8 after oestrus was administrated, and 48 hours later 100  $\mu$ g cloprostenol (ICI) was given. Nearly all ewes were used twice in one breeding season. On day 7 surgery was performed in midline and uterus was flushed applying retrograde technique. Ovulatory response was found in 65.2 percent of the cases and 1.9 embryos were flushed out on the average. Sixty-nine embryos were qualified for freezing with the average of 1.5 per induced superovulation (Table 5).

**Table 5 EFFECTIVENESS OF SUPEROVULATORY TREATMENT AND EMBRYO RECOVERY RATE IN SWINIARKA BREED**

Donor ewes	37
Superovulatory treatments	72
Induced superovulation	47
Ovulatory response (CL+unovulated follicles)	255
Ovulatory response per successful treatment (CL+unovulated follicles)	5.4
Recovered embryos	91
Recovered embryos per superovulatory response	1.9
Embryos of freezable quality	69
Embryos of freezable quality per superovulatory response	1.5
Stored embryos	69

In Olkusz sheep 36 ewes were superovulated only once. Treatment and recovery procedure was the same as used in Swiniarka sheep. Seventy-five percent of donors responded to the stimulation and 2.6 embryos, on the average, were flushed out. Thirty-four embryos qualified for freezing, giving 1.3 per superovulation (Table 6).

**Table 6 EFFECTIVENESS OF SUPEROVULATORY TREATMENT AND EMBRYO RECOVERY RATE IN OLKUSZ BREED**

Donor ewes	36
Superovulatory treatments	36
Induced superovulation	27
Ovulatory response (CL+unovulated follicles)	143
Ovulatory response per successful treatment (CL+unovulated follicles)	5.3
Recovered embryos	72
Recovered embryos per superovulatory response	2.6
Embryos of freezable quality	34
Embryos of freezable quality per superovulatory response	1.3

## CONCLUSIONS

Collection, processing and storage of semen is a reasonably easy and inexpensive procedure in comparison with collection of embryos. In bulls planned bulk collection of 300 semen doses was usually established in 2 to 5 collections during one or two weeks. It may also be assumed, that out of 300 doses of semen nearly 200 calves may be produced.

Rams are less efficient due to the lower freezability of ram semen and higher number of sperm needed for one semen dose. It is also the reason why in rams a much lower number of semen doses per ram was collected. Rams were collected in 40 days (Swiniarka) and 34 days (Olkusz), but only on average, 210 semen doses per

ram were acquired. to achieve one pregnancy 2.5 to 3 doses of frozen semen are needed. In this case it may be expected to produce some 30 to 40 lambs from each hundred semen doses only.

To establish cattle or sheep embryo reserves decidedly more efforts are needed. Females are less efficient producers of gametes which requires consideration in every plan to establish an embryo reserve. Some aspects which may have influenced the results received to be taken into consideration. Superovulatory effect of PMSG according to our experience may be irregular. Also it is possible to have very good results, as some PMSG products may have a limited effect. Also cows were selected for fertility since there was really no efficient donor available. In sheep there was no selection as records were unavailable.

It has also to be considered that all used breeds were of rather primitive type where also fertility is very satisfactory, especially in Polish Red cattle, less in both sheep breeds, but the prolificacy is rather limited, and this may also be the reason for generally low susceptibility for superovulatory treatment.

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**PAPERS PRESENTED AT EAAP/PSAP SYMPOSIUM ON  
SMALL POPULATIONS OF DOMESTIC ANIMALS IN EUROPE**

**GENERAL  
CATTLE  
BISON  
SHEEP/GOATS  
EQUINES**

## **POSSIBLE ROLE OF ANIMAL GENE RESOURCE IN PRODUCTION, NATURAL ENVIRONMENT CONSERVATION, HUMAN PLEASURE AND RECREATION**

K. Maijala 1/

### **1. INTRODUCTION**

Genetic variation in animals has developed during millions of years. In the course of time the usefulness of different genes and gene combinations has been under severe tests, especially concerning adaptability to different conditions and resistance to diseases and parasites.

During the last ten thousand years man has partly influenced this evolution, and many breeds adapted to local needs and environments have been developed. The possibilities of making changes in the genetic make-up of farm animals and of concentrating on the utilization of the breeds considered to be the best, have increased in recent decades, thanks to the availability of modern reproduction, computer and communication techniques.

The increased rate of changes and parallelization of breeding goals have awakened concerns about losses of genetic variation both within and between breeds. Many breeds have disappeared or are threatened. A recent survey showed that 81, 51, 67 and 12 European breeds of cattle horses, sheep and goats, respectively, were considered endangered (Maijala *et al.*, 1984).

Activities for preventing gene and breed losses have been started in different parts of the world (FAO, 1981), in order to maintain the possibility of adjusting animals to future, unpredictable needs. In many countries the emphasis is on conserving breeds, and hence it is topical to discuss whether this could be done economically, when the current competing ability of the breed is unsatisfactory and the population is small.

### **2. REASONS FOR CONSERVING SMALL POPULATIONS**

Before discussing the possibilities and ways of maintaining small populations or so-called rare breeds it is important to make clear why they should be conserved. In Europe, the reasons for conserving genetic variation have been discussed among others by Maijala (1970), Mason (1974), Simon (1984) and Maijala *et al.* (1984). On the basis of these and other papers, the following list of arguments for conservation can be made:

#### A. Economic-biological reasons

1. The production conditions for farm animals are changing. This concerns especially feeding, since one has to find new economic feedstuffs, and to utilize various kinds of wastes from agriculture and industry. It may also become topical to return to extensive pastures in case the intensively cultivated areas will be needed for direct production of human food or energy crops. Changes in management of animals may also continue to change (e.g. mechanization, milking frequencies and methods, densities, etc.). Similarly, the housing conditions (regulation of temperature, moisture, light etc.) may change. Changes are possible also in the hygienic conditions of animals (new kinds of disease agents, new vaccines and medicines) and in climatic conditions (temperature, humidity, altitude).
2. The demands for products and services desired from animals may change for many reasons, e.g. with opinions and knowledge concerning wholesome food, with increased standard of living and leisure time or with new fashions in eating and clothing. Changes in international trade and trade blocs influence costs of materials and prices of products. The increased human population may increase the need of quantities, and it is important to combat hunger. The need of compensating exhausted natural reserves of fuels, minerals, etc., with renewable plant and animal materials may become more and more topical. The competition between animal species in production costs and services, as well as that between animals

and plants as food producers may affect the usefulness of various kinds of animals. The need of finding new ways of utilizing agricultural plant products in case of surplus problems may also increase.

3. Experiences of crossbreeding in utilizing heterosis and complementarity speak in favour of maintaining the possibility of systematic crossbreeding also in the future.
4. In order to satisfy the rapidly changing needs it is important to make rapid, one-sided progress in some populations without losing the possibility of starting again in another direction if needed.
5. There is an increasing need of being able to adjust the breeding work to the new biotechniques such as embryo transfer, splitting and sexing, or gene technology.
6. There may appear needs to overcome selection limits and antagonisms.

#### B. Scientific reasons

1. For the measurement of genetic progress and correlated responses control populations or frozen stocks are very useful.
2. Research in genetics, physiology, biochemistry, immunology, morphology, etc., benefits from maintenance of a large variety of animal materials.
3. Many different populations are valuable for research in evolution, ontogeny, behaviour, etc.
4. They are also useful as teaching material in animal sciences.

#### C. Cultural-historical reasons

1. Conserved breeds can be considered to be valuable memorials of nature and culture (living cultural heritage).
2. They can be used as research and teaching material in history and ethnography.
3. There are ethical-moral grounds to take care of the existence of different creations of nature.

In many points (e.g. A.1, 2, 4) it is a question of maintaining the possibility of changing breeding objectives according to unpredictable changes in needs. Even negative changes in the production conditions of ruminants are possible, if grains are needed directly for human consumption or for fuel. In Italy it has already been necessary to return to the original local breeds in utilization of dry mountain pastures (Rognoni, 1980).

The arguments A.3, B.1-4 and C.1-3 require conservation of entire breeds. Availability of distinct and different kinds of breeds or lines makes the utilization of conserved variation more rapid and effective in the case of need, both in pure- and crossbreeding. Gene combinations are conserved besides genes, and both the cultural-historical and emotional interest are satisfied, which is not the case in storing material in frozen form or as gene pools. On the other hand, both the initial and maintenance costs are high, and there are risks for diseases, accidents, genetic drift, inbreeding and contamination from other breeds. Because of the smallness of population, genetic improvement by selection is slow, and hence the gap in current breeds or selection lines increases (Maijala *et al.*, 1984).

These disadvantages can be considerably lessened with the aid of simultaneous conservation of frozen semen and embryos, which also makes it possible to manage with rather small numbers of live animals (e.g. 20-300 females). These are needed for evaluation purposes as well as for cultural-historical reasons even if frozen semen and embryos were satisfactory for the conservation of the genetic variation itself. It is also very probable that the frozen material would be forgotten in store by our descendants, if no live animals could be seen and studied.

Additional arguments for maintaining many breeds as pure were given by Land (1981), who suggested a planned development of strains with divergent biological traits, since some old local breeds have proved themselves useful in many countries, because of their special traits for the modern market (e.g. lean carcasses,

double-muscling, high fertility). Their maintenance would increase genetic flexibility and the rate of progress and ensure the availability of desired genetic variation at the time of need.

Bowman (1981) considered that "the conservation of a wide range of genetic variation coupled with the development of a capability to reproduce and multiply quickly and cheaply desirable types of animals, are far more important to the future of animal production than the development of over sophisticated forms of within-population selection".

### 3. COSTS AND PROFITS

An idea of the relative costs for maintaining purebred populations for the purpose of genetic conservation can be obtained from Table 1, based on the studies by Brem *et al.* (1984) and by Smith (1984).

In both calculations, maintenance of live animals as pure breeds was many times as expensive as frozen semen, even though the number of animals was assumed to be very low, allowing no selection in the population during storage and not even in the first years after starting its reuse. In the study by Brem *et al.* (1984) the conservation as frozen embryos was also considerably cheaper than as live animals, while there were very little differences in the study by Smith (1984). In the latter study, conservation of sheep breeds was not essentially cheaper than that of cattle breeds.

Availability of many-sided semen stores makes it possible to conserve a breed without big risks for genetic drift and inbreeding depression. Frozen embryos offer the additional advantage that the breed can be regenerated and used for crossbreeding within a generation, even if the number of live animals of the breed is zero or minimized to show only its type and colours to our descendants. In addition, frozen embryos conserve better than frozen semen gene combinations and frequencies. It is likely that the costs of preparing embryos for frozen stores will decrease, especially if it becomes possible to make embryos by taking ova from the ovaries of slaughtered females and by using in vitro culture and fertilization.

**Table 1** ESTIMATED ANNUAL COSTS FOR CONSERVING CATTLE AND SHEEP BREEDS IN THREE DIFFERENT WAYS, WHEN STORAGE TIME IS 20 YEARS AND INVESTMENT COSTS AND INTERESTS ARE NOT CONSIDERED

Species	Author	Live animals		Frozen semen 1/		Frozen embryos 2/	
		Establ.	Remarks	Establ.	Remarks	Establ.	Remarks
		+storage		+storage		+storage	
		cost/yr.		cost/yr.		cost/yr.	
Cattle	B 3/	4 860 £5/	5m,25f	174 £5/	25mx20d	694 £5/	25f x 4e
Cattle	S 4/	5 000 £	10m,26f	600 £	25mx50d	4 250 £	25f x 25e
Sheep	S 4/	3 000 £	22m,60f	635 £	25mx30d	3 000 £	25f x 25e

<sup>1/</sup> Requires at least 10 additional years to regenerate the breed.

<sup>2/</sup> Requires about one generation (3 yrs in cattle) to regenerate the breed

<sup>3/</sup> Brem *et al.*, (1984)

<sup>4/</sup> Smith (1984)

<sup>5/</sup> 1 £ = 3.6 DM

m = males, f = females, d = doses, e = embryos

The returns from breed maintenance are still more difficult to estimate than the costs, because of the difficulties in predicting the future. However, Smith (1984) tried to calculate the probabilities of future uses of stocks to justify conservation from the national viewpoint. He based his calculations on the following factors: (1) total value of market, (2) cost of conservation, (3) proportion of the stock used in future commercial production, (4) proportional gain in economic efficiency over current stocks, (5) number of years until commercial use, and (6) length of the utilization period. Table 2 shows the estimated probabilities for the market volume in the U.K.

The general conclusion of Smith (1984) from the probability-values was that even small gains in efficiency and low proportions of the genes from a conserved stock would bring profit for the nation. Thus, it would be worthwhile to maintain a stock, even if there is a very small chance that the stock would be useful in the future. The costs of conservation appear to be small relative to possible future gains in national production. The required probabilities were the lowest for frozen semen, while those for live purebred animals and for frozen embryos were 5 to 10 times higher. In small countries with a limited market the probabilities required are, of course, higher. It has to be stressed also that the profits can be harvested only on the national level, not by individual enterprises.

In his extended studies Smith (1985) calculated the reduction in uncertainty about the permanence of breeding objectives by selecting alternative stocks for different sets of objectives. The size of each line was 5 males and 150 females, of which 50 were selected per year. The national return/cost ratio (in U.K.) in one year of one year's genetic improvement was 1900 in dairy cattle, 940 in beef cattle, 500 for meat production traits in sheep, and 200 for sex-limited traits in sheep. Even if these values might not be entirely realized in practice, there appears to be sense in developing alternative selection stocks for reducing the uncertainty with regard to the future needs and breeding objectives. The longer the time horizon, the higher number of stocks one could develop profitably. The high R/C values can be applied on the national level, while smaller investors have to apply lower values (e.g. 10), where the maximum benefit is sensitive to the number of stocks selected.

**Table 2 PROBABILITIES NEEDED FOR THE USE OF CONSERVED CATTLE AND SHEEP STOCKS IN U.K. TO JUSTIFY THEIR CONSERVATION, ACCORDING TO SMITH (1984). USE MADE AFTER 20 YEARS FOR 20 FURTHER YEARS. REQUIRED ECONOMIC EFFICIENCY OVER THEN CURRENT STOCKS 5%**

Species	Products	Method of conserv.	Probability (%) needed with different degrees of substitution		
			100%	50%	10%
Cattle	Milk 1/	Live	0.021	0.042	0.211
Cattle	Milk	Semen	0.003	0.006	0.027
Cattle	Milk	Embryos	0.018	0.035	0.177
Cattle	Beef 2/	Live	0.027	0.053	0.267
Cattle	Beef	Semen	0.004	0.007	0.035
Cattle	Beef	Embryos	0.023	0.045	0.226
Sheep	Meat&Wool 3/	Live	0.060	0.120	0.600
Sheep	Meat&Wool	Semen	0.013	0.025	0.127
Sheep	Meat&Wool	Embryos	0.060	0.120	0.600

100% = complete substitution

50% = 2-breed cross or synthetic

10% = specialized use

<sup>1/</sup> Total annual value of production in U.K. 1900 mill. £.

<sup>2/</sup> Total annual value of production in U.K. 1500 mill. £.

<sup>3/</sup> Total annual value of production in U.K. 400 mill. £.

Smith concluded from his calculations that there is scope and many benefits from creating and manipulating genetic diversity to maximize the future economic efficiency of our livestock.

#### **4. WHICH BREEDS DESERVE TO BE MAINTAINED?**

In spite of the many motives for maintaining several breeds and of the obvious national economic profitability of their maintenance in the long term it may not be possible or realistic to maintain all breeds. A choice is often made necessary by the fact that the number of people understanding the motives is limited, and hence also the resources available are limited. The criteria for choosing breeds for maintenance have been discussed by many authors (e.g. Mason, 1974, Simon and Schulte-Coern, 1979, Simon, 1934, Maijala *et al.*, 1984, Bodó *et al.*, 1984). They are closely connected with the motives and partly with the methods of conservation.

An important question is whether there is time to evaluate a breed before deciding to conserve it. Provisional maintenance may often be well-founded. Evaluation is even impossible for unknown traits, which may-become important in future. Compromises are needed between ideals and possibilities, between motives and methods and among different objectives. Both practical experience and theoretical knowledge from different sectors are important in the decision making, which thus may sometimes become complicated. The main viewpoints to be considered can be listed as follows:

1. Value of the breed as a biological material
  - a. performance (overall or in some special trait)
  - b. adaptation (climate, feed, management system, local tastes)
  - c. resistance (infection, parasites)
  - d. special characteristics (major genes, biochemical traits)
  - e. heterosis or complementarity expectations in crosses
2. Genetic status and distinctiveness of the breed
  - a. history and age as a separate breed
  - b. breed purity and relationships within breed
  - c. relationships to other breeds and evolutionary origin
  - d. population size and its trends (vulnerability)
3. Ecological aspects (e.g. landscape management)
4. Cultural-historical and aesthetical importance
5. Social importance (e.g. in leisure time)
6. Possibilities of evaluation and maintenance, and availability of adequate information.

It is important to consider whether the breed should be preserved without selection or maintained with simultaneous selection. For some breeds which occur in several countries, international cooperation is desirable in both decision making and action.

## **5. UTILIZATION OF RARE BREEDS IN PRODUCTION**

The economic-biological reasons mentioned above for maintaining minority populations referred to possible future needs. However, changes in needs and production conditions do not vary only with time but also with geographical and agricultural location within a certain era. Considering the whole world, some places are now living the stage of development which in some other places occurred hundreds of years ago. An interesting feature of history is that it often repeats itself even at the same location. Taking into account the wide spectrum of environmental and economic circumstances and the versatility of many farm animal species, it should be possible to find good economic niches for many minority breeds. Examples of special uses for cattle, goats, horses and sheep are listed in Table 3.

There are several alternative uses for each species, and it is likely that different breeds suit differently for them. It is also probable that some minority breeds can be utilized many-sidedly, while the popular majority breeds often are specialized to just one or two tasks. An idea of the many-sided uses and of special qualifications of farm animal breeds can be obtained from a recent working party report (Maijala *et al.* , 1985). An effective utilization of the many-sidedness may be the key to the profitability. The production conditions may vary even in the same village or community, and in the era of A.I. it is possible to use males of different breeds within the village, even within a farm. For some products, marketing may cause problems, if all neighbouring farmers do not produce the same product, but for some' products it is advantageous to be the only producer in the community. A creative imagination has often given good results in finding new ways for production and marketing, and its importance is obviously increasing in the era of surpluses concerning conventional products.

**Table 3 POSSIBLE SPECIAL USES IN ECONOMIC PRODUCTION FOR BREEDS OF SOME FARM ANIMAL SPECIES**

	Possible in breeds of			
	Cattle	Goats	Horses	Sheep
Tractive power in difficult conditions	X		X	
Production of "biological" food	X	X		X
Production in prison farms	X	X	X	X
Production at school farms	X	X	X	X
Pasture and lawn management	X		X	X
Forest management, underbrush-clearing				X
Production of sera for research & health	X		X	
Production of unallergenic milk				
Production of other medicines		X		X
Dam line in crossbreeding for meat	X	X	X	X
Utilization of harsh environments	X			X
Utilization of marginal areas	X	X		X
Experimental animals in research	X	X		X
Production of luxury furs	X	X	X	X
Production of wool for handicraft				X
Animals in part-time farming		X	X	X

Utilization of marginal areas or otherwise harsh environments deserves special attention, since ruminants do not have competitors in that field, the importance of which may increase. It is important that some breeds are continuously kept and selected in those conditions, in order to have suitable animals available at the time of need. Especially beef cattle, whose feed efficiency is poor, should be kept under extensive conditions, in order to minimize the costs of calf production. The adaptation and hardiness of local breeds can be exploited now by using them in commercial crossing for meat production with specialized meat breeds. Mason (1989) considered that a commercial crossbreeding system serves breed conservation because of the need of continuous supply of local adapted breed as foundation stock, giving financial inducement for maintaining such breeds.

The utilization of prison farms for breed conservation turned out to be possible in Finland, when it was realized that animals on these farms serve largely the psychological care and employment of prisoners so that top yields are not necessary and not even possible.

## **6. USE OF RARE BREEDS IN CONSERVATION OF NATURAL ENVIRONMENT**

Animals are part of nature, and hence native breeds of farm animals are often kept in natural parks. In France, at least two breeds of cattle, two breeds of 'sheep and one goat breed are kept in that way (Mason, 1982). The Rove goats graze the fire-breaks and keep them clear of scrub. In Hungary, flocks of indigenous breeds of cattle (Hungarian Grey) and of sheep (Racka and Cigaya) are kept in two big national parks (Hortobágy, Kiskunság), which were established in 1972 and 1974 (Salamon, 1982, Szabo, 1982). Bodó *et al.* (1984) considered that "the

costs in maintenance of cattle can be minimized by keeping them in national parks, where they can also help to maintain the biological balance by grazing the tall grasses".

Small numbers of indigenous farm animals are also kept in ecological museums in different countries.

## 7. UTILIZATION OF RARE BREEDS FOR HUMAN PLEASURE AND RECREATION

An important way of decreasing the costs for conservation of breeds is to use them for leisure time activities, the demand for which is increasing with shortening working time and increasing standard of living. Examples of such activities are given in Table 4.

Table 4 POSSIBLE USES OF FARM ANIMAL BREEDS FOR PLEASURE AND RECREATION

Kind of use	Possible in breeds of				
		Cattle	Goats	Horses	Sheep
Animals in national parks	X			X	
Farm animal parks and museums	X	X	X	X	
Trotting-matches			X		
Riding for hobby and racing			X		
Agricultural and native place museums	X	X	X	X	
Social company of humans, pet-keeping		X	X	X	
Aid in bringing up children, 4 H-farms	X	X	X	X	
Maintenance of local culture & tradition	X	X	X	X	
Exhibition in zoos	X	X	X	X	
Tourist attraction	X	X	X	X	
Folk art			X		
Ceremonial purposes	X		X	X	

The use for pleasure has been especially important for horses, where trotting and riding competitions bring in considerable amounts of money, not only to the successful enterprises but also to the states, which thus can support maintenance of working horses, too. At least in Finland it has been compulsory to arrange a certain proportion of starts in trotting matches for Finnhorses, and so the decrease in the number of Finnhorses has stopped many years ago, and the number of foals has been increasing in the 1980s. A working party set up by the Ministry of Agriculture and Forestry suggested in 1982 that the prize level of Finnhorses should be developed in proportion to that of warm-blooded trotters, in order to safeguard the continuation of the positive development in numbers. Whether this secures the maintenance of the right horse type for working is another question.

Finnhorse has also been found to be a suitable riding horse for beginners. Here the working type suits the purpose rather well. In order to increase this type of use of Finnhorses, the working party suggested that opportunities to participate in horse-racing should be arranged for Finnhorses in their own classes.

In some countries, there are farm animal parks, which have importance in creating interest in the old breeds among people and help in getting money for conservation activities through tourism. The best examples can be

found in the United Kingdom, where Cotswold Farm Park has representatives of 22 old breeds and attracts over 100 000 visitors per year (Henson & Henson, 1982). A Finnish animal park also has a farm animal section, and Norway has plans to establish such a farm for conservation purposes. The numbers of animals per breed in those farms are small, and hence one should have animals also elsewhere, in order to conserve enough variation and to avoid inbreeding.

The latter concerns also zoos, in which representatives of old farm animal breeds are sometimes kept. It is generally thought among animal geneticists that the role of zoos is to maintain wild ancestors of domestic breeds. The wild types would be valuable sources of genes and should thus be conserved. In 1975 there were altogether 244 Przewalski horses in 58 zoos in the world (Mason, 1980).

Mason (1980) considered pet keeping important in the sense that the close relationship between human and animal gives a motive for breeding rare or disappearing breeds. On this basis large groups of people become interested in visiting animal parks and in supporting conservation activities. Private societies for conservation purposes have been established among others in France in 1971, in the United Kingdom in 1973, in the Netherlands and in North America in 1977, in Denmark in 1981, in Austria, FRG and Switzerland in 1982. These have already increased the interest in conservation in their countries and in many cases prevented endangered breeds from disappearing.

## **8. MISCELLANEOUS PROBLEMS IN MAINTAINING SMALL POPULATIONS**

Besides the direct economic problems, for which finding other uses for the breeds is important, there are genetic, hygienic, organizational and safety problems making the conservation of breeds more difficult.

The genetic ones are mainly of two kinds:

1. One should try to minimize the risk of inbreeding and genetic drift with the aid of sufficient effective population size, appropriate mating systems and as equal sex ratios as possible.
2. One cannot make rapid genetic progress in a small population. In spite of this, some undesired natural selection may take place. Some one-sided selection could be applied in populations of 150 females, and utilization of embryo transfer techniques would give additional possibilities, but this would cause costs.

The hygienic problems are also of two kinds:

1. The animals should be protected from destroying diseases.
2. The stored material should not be a risk to other materials at the time of reuse.

An appropriate organization is needed for collecting and disseminating information, preparing mating plans, exchanging animals, etc.

In order to avoid risks of accidents (e.g. fires) the stored material should be placed in several locations.

These different kinds of problems are inclined to increase the costs of conservation. In addition, investments have to be made much before the returns, which for their part are uncertain and may be harvested by another group of people than by those who made the investment. Therefore, it is important to find and utilize various alternatives for getting immediate incomes for the material and that the society (state) takes at least partial responsibility for the costs as a national insurance fee.

## **9. SUMMARY**

The possibilities of conserving breeds of cattle, horses, sheep and goats for future needs were discussed, especially from the economic viewpoint. At first, several economic-biological, scientific and cultural-historical

motives for conservation were presented. Many of them spoke in favour of conserving entire breeds, but it was realized that simultaneous conservation of frozen semen and embryos makes the conservation cheaper or better.

Referring to the calculations by Smith (1984, 1985) it was stated that even small gains in efficiency and low proportions of the genes from a conserved stock would bring profit for the nation and that it pays to create genetic diversity to maximize the future economic efficiency of livestock.

The main viewpoints to be considered in choosing breeds for conservation were presented.

Several alternative ways for utilizing rare breeds in economic production were listed. Special attention was directed to the utilization of marginal feed resources and of local breeds as dam lines in commercial crossing-for meat production. Keeping indigenous breeds as a part of the natural environment in natural parks was also noted, as well as utilizing them for leisure time activities. These have been especially important in horses, which are used for riding and trotting. Attention was paid also to tourism, farm animal parks, zoos and hobby organizations. In spite of these possibilities, the state has to assume a partial responsibility for the costs of conservation, since the main returns from it can only be harvested in the future and not by those who invested the money.

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## **THE USE OF NATIVE HARE BREEDS IN MANAGEMENT OF AREAS OF IMPORTANCE FOR NATURE CONSERVATION IN SWEDEN**

C. Matzon 1/

### **1. THE ACREAGE OF AGRICULTURAL LAND HAS DECREASED IN A RADICAL WAY**

As a result of the improvement in and intensification of agricultural production in Sweden, the acreage of natural grazing land decreased from nearly 1 million ha to 200 000 ha from the time between the two world wars up to today.

The importance of well managed natural grazing land has been discussed in Sweden especially during the last years. In these areas, there are several endangered species of wild fauna and flora.

Agricultural policy in Sweden today is to reduce the overproduction of agricultural products and this will affect the total number of farmers and acreage of both arable land and grazing land. The number of grazing animals will probably diminish in a radical way.

### **2. NATURE CONSERVATION AUTHORITIES HAVE INSTRUMENTS FOR LAND USE REGULATIONS**

It is of great importance for Swedish nature conservation to ensure that areas of agricultural land - from the scientific and cultural point of view - will be managed in the right way to conserve fauna and flora. But it is also of vital importance for the understanding of the cultural background to use indigenous, local breeds in the management of the reserves for research and education.

Therefore, the Environment Protection Board already supports and in the future intends to support further the maintenance of native breeds.

Out of a total acreage of well over 1.5 million ha of national parks and nature reserves about 10 000 ha is agricultural land. A great portion of this land is owned by the government but also local communities and individuals are landowners. Restrictions through e.g. management plans makes it possible for the authorities to regulate land use.

The most significant instrument to keep adapted native breeds in reserves is through subsidies to tenants. A tenant can, if he keeps indigenous grazing animals in a traditional way, get support in the form of a lower rent

and in some cases, acreage allowances or head payment. Governmental funding can also be done for bushclearing, fencing, transport and support for farm buildings.

### **3. AN EXAMPLE OF SUPPORT FOR KEEPING NATIVE BREEDS IN SWEDEN**

Just recently, the Environment Protection Board, in cooperation with local authorities, started a scheme for the management of chalets (mountain pastures) in Dalarna county in Sweden. These chalets are not nature reserves. Chalets are a traditional, very specific type of agricultural system in the mid parts of Sweden. Cattle, sheep and goats are for about 2-3 months taken to grazing areas up in the woodlands far away from the villages in the valleys.

For each dairy cow of local breed (SKB) the farmer gets a yearly subsidy of SKr 500 (about \$75.00). If the cow is of lowland type or a crossbreed the subsidy is SKr 300. Subsidies are also available for heifers, goats and sheep.

The main reason for the Board to release funds for these activities is to get the farmers interested in this traditional form of production and by that keep the cultural landscape open. By allowing higher subsidies for native breeds the authorities emphasize the importance to preserve native breeds in the areas from where they originate, not least from the educational point of view.

### **BREEDING SCHEME AND GENETIC PROGRESS IN A SMALL CATTLE POPULATION (Tyrolean Grey)**

F. Pirchner and J. Aumann 1/

#### **1. INTRODUCTION**

Population size has received much attention both in population genetics and in applied animal improvement. Official recognition of a group of breeders as a herd book society depends in some countries, e.g. in the Federal Republic of Germany, on the number of animals deemed sufficient to carry on an effective breeding plan. Size of a population can be viewed from the genetic and economic aspects. The genetic aspect concerns prospects of genetic improvement without consideration of costs incurred by the breeding work. On the other hand, population size may reflect on the economy of the breed improvement.

Common sense would lead one to expect more genetic progress in large populations - selection intensity can be greater and outstanding and rare individuals are more likely to be found there than in small populations. However, the reproductive rate is by and large independent of population size which implies that selection differences are roughly equal in populations of different size. High selection intensity in small populations will lead to a high rate of inbreeding in much shorter time than in large populations. It can be shown theoretically (Robertson, 1960) that long-term selection response will be greater in larger populations simply because they harbour more genetic variability.

In populations with normally distributed traits, selection intensity increases somewhat with size. This increment is relatively modest and may have little impact on breed improvement except in well 'planned and precisely executed breeding schemes. Robertson (1960) has developed a theory which predicts that the total selection gain should be  $2 N_e$  times the genetic improvement of one generation selection. The half-time of the total genetic advance should be reached after roughly  $1.4 M$  generations ( $N_e$  = effective population size). However, in practical breed improvement, longterm time scales barely matter apart from the fact that the predictions were only partly substantiated by experiments. In breed improvement where changing market requirements etc. are

important, short term and medium term considerations would appear to be of overriding importance, i.e. selection gain over, say, a dozen or two dozen generations at the most.

The importance of population size on medium and long term genetic progress has been investigated in a number of experiments. Roberts (1966) reports from mouse experiments that the half-life of genetic progress is of the order of  $N/2$  generations. This indicates that genes with large effects are responsible for a large part of the genetic advance. The Australian group (Frankham *et al.*, 1968) reports rather large scale *Drosophila* experiments. They did find the expected connection between size of the population and selection intensity.

However, there was little change in the magnitude of realized heritability even though it increased slightly with increasing population size. On the long term, i.e. over 40-50 generations, large populations showed more progress but in the short and medium term the advantage of larger populations was rather modest. However, it must be emphasized that mass selection only was employed in the experiments.

An investigation by Hanrahan *et al.* (1973), employing mice, revealed clear advantages of larger populations. Effective population size was greater and the rate of inbreeding clearly lower in populations with 16 mating pairs than in those with 4 mating pairs. Genetic progress was greater in the larger population which is a consequence of a greater realized heritability. Selection intensity showed little difference which was to be expected due to within family selection.

Summarizing experimental investigations, larger populations permit greater selection gain, even on short term and medium term scale, partly due to greater selection intensity but mainly, however, due to greater realized heritability. The cause of the greater realized heritability in larger populations may be genetic drift which in smaller populations soon leads to increased homozygosity and thus to loss of genetic variability. A number of investigations indicate this in addition to theoretical expectations.

The other aspect of population size and genetic improvement concerns economics. Improvement work in large populations can be much more economical if one succeeds in spreading the genes of superior animals widely. Nowadays this may be accomplished by A.I. The advantages of large populations is great in particular if selection is very expensive as it is when progeny testing is used. A number of investigations indicate these advantages (Comberg, 1980).

The experimental investigations were performed with populations of comparatively small numbers. So the next question concerns the size of domestic animal populations and whether these are comparable with those mentioned above. The effective population size in respect -to inbreeding and drift of the latter is surprisingly small and comprises but a fraction of the real numbers.

We have investigated three Bavarian horse populations (Fehlings *et al.*, 1983). The Haflinger has an effective size of about 80, the Bavarian draught horse about 120 and the German trotter a little more. The figures are comparable to  $N_e$ 's from other horse and cattle populations. The inbreeding increment of U.S. Holsteins indicated, before introduction of A.I., an  $N_e$  of about 120 (Lush *et al.*, 1936) and that of the Bavarian Fleckvieh is not very different. Some populations have lower effective numbers and one may pose the question whether breed improvement work can be effective in such populations. However it can be stated that respect to effective population size, smaller breeds have numbers which are not much bigger than those of the largest experimental population investigated by Frankham *et al.* (1968) and others.

Another question concerns the connection between population size of domestic breeds and their genetic progress. Hintz *et al.* (1978) have published the estimates of yearly genetic progress of the five major U.S. dairy breeds over a period of about 15 years from the early 1960s to the middle 1970s. A perusal of the figures of [Table 1](#) indicates no connection between size and genetic progress of these five breeds - Brown Swiss have a

greater genetic trend than Holstein-Friesians even though their real numbers are but a fraction of the Holsteins and their effective size is also somewhat, though only little, smaller. The conclusion from this comparison must be that genetic progress depends on several things, possibly also on population size but that the latter's effect is overshadowed by other factors and that it is not discernible in the published figures. This may be due to the flattening of the curve relating genetic progress to population size when this curve approaches the asymptote. This flattening appears to occur at relatively low numbers ( $N_e < 100$ ) and other factors become much more important. At any rate, as can be judged from the figures published by Hintz *et al.* (1978) under practical circumstances population size appears to be a minor factor with regard to genetic progress.

**Table 1 GENETIC CHANGE IN YEARLY MILK YIELD OF U.S. DAIRY BREEDS**  
(Hintz *et al.*, 1978)

Breed	kg milk			Approximate number of yearly herd book registrations
	A.I. cows	Non-A.I. cows	A.I. bulls	
Ayrshire	36	36	24	11 400
Guernsey	25	35	15	24 500
Holstein	26	31	18	330 000
Jersey	25	13	18	38 100
Brown Swiss	38	36	35	13 100

In closed populations increase of the rate of inbreeding is unavoidable. However, the increase can be effectively postponed as has been found by Vangen (1983) in Norwegian horses or by Strom (1982) and Fehlings *et al.* (1983) who found inbreeding to be less than expected from inter se relationship. However, increase in inbreeding cannot be postponed indefinitely and at a later point inbreeding in such a population will even overshoot the level which would have arisen by continued panmixis (Robertson, 1964). Of course, any immigration will drastically reduce the level of inbreeding.

One must assume that populations of domestic animals are not closed to the same extent as laboratory populations are - in Central Europe herd books were never closed and only recently herd book societies on the continent have started to follow the Anglo-Saxon tradition in this respect.

Another question concerns the maximum intensity of selection compatible with a tolerable rate of inbreeding. The latter may be taken as the rate of inbreeding which is found in successful populations. In Holstein-Friesians this is roughly 0.4 percent F per generation. If one surmises that the inbreeding is largely caused by sires one arrives at a minimum number of about 30 sires per generation. The generation interval in cattle is about 5 years, therefore 6 bulls should be taken in every year, on average. This presupposes random mating after breeding animals have been chosen. If one would take one son from each sire and one daughter from each dam - not a realistic assumption if selection is to succeed - then the effective population size is roughly  $16 N_m / 3$  ( $N_m = n$  sires/generation). Again if 0.4 percent inbreeding increment is tolerated, 23 to 24 bulls should be used per generation, about 5 per year. These numbers are easily met by most breed societies.

## **2. BREEDING PROGRAMMES AND RESULTS IN TYROLEAN GREY**

The Tyrolean grey cattle number about 30 000 - 35 000 cows of which 4 000 - 5 000 are recorded each in North and South Tyrol. Insemination is Practised on about 40-50 percent but since herd size is small, the use of community bulls is the rule.

The practical genetic improvement via A.I. breeding programmes would appear to be severely hampered in such small populations. In many papers, the size of populations which permits sustained progress is in the order of several 10 000 and to become profitable the numbers should still be larger (Comberg, 1980).

The bottleneck in breed improvement lies in the selection of A.I. bulls which must be progeny tested and which would require testing of some 4 to 5 x as many bulls as are eventually desired. Furthermore, a certain number of selected bulls is required to avoid inbreeding to increase too rapidly.

In conventional A.I. breeding programmes (Comberg, 1980; Schmidt and Van Vleck, 1973) young bulls are testmated to produce 50 - 100 daughters which are tested for dairy performance which provides the criterion for selection of the bulls. About 1/5 to 1/3 of tested bulls are retained for general use while the future bull sires are chosen from the top 1/20 to 1/10 of all tested bulls. A programme such as this supplemented by efficient selection on the female side permits an increase in genetic merit for dairy performance of up to 2 percent of the average per year. However, the realized genetic advance is considerably less, more of the order of 1.0 to 1.5 percent.

The advantage of A.I. over natural service lies in the much greater numbers possible but also in the fact that daughters are distributed over many herds and preferential treatment or the prevalence of single herd effects in the progeny are unlikely.

Therefore, the fairly widespread use of community bulls and the fact that their progeny are distributed over many herds - not unlike the progeny of A.I. bulls - can result in some 15-20 daughters and thus permits a fairly accurate estimation of their breeding values. Naturally, the accuracy will be lower than that of A.I. bulls on account of the smaller number, but apart from this, the accuracy is comparable to that of A.I. progeny.

The bulls can and should be slaughtered after sufficient progeny - some 15-25 recorded heifers - can be expected. Before slaughter sufficient semen must be collected to permit their use as elite sires for producing young bulls. The procedure is fairly economical since it does not involve a waiting period of bulls or the storage of large quantities of semen. Rather the semen is collected after their use for natural service and the additional cost of the programme consists only of collection and storage of fairly limited quantities of semen. Therefore, many bulls can be tested and a fairly intense selection of bull sires is possible.

In Table 2 the theoretical genetic superiority of bulls selected in a conventional A.I. improvement scheme is juxtaposed to that of bulls from a young bull system as outlined. The differences are negligible but the loss of heterozygosity is less in the latter scheme and the costs would be much less than in the aforementioned "classical" A.I. scheme.

This "natural service" progeny testing scheme has been applied in the North Tyrolean Grey population beginning in 1977. In Table 3 bull numbers and selection intensity as well as progeny group size and age of bulls are outlined.

From 31 bulls whose semen was deposited in the 4 years 7 were selected. During this period the scheme had some difficulties as can be seen from Table 3. The numbers of progeny were uneven and the age of bulls at the time of semen collection became progressively older (the trend was reversed meanwhile).

The genetic progress in the North Tyrolean Grey population was estimated for the period 1977 to 1985. All the bulls were included which had progeny in at least 2 years. They numbered 98 with altogether 240 sire year averages (i.e. 2,4 per bull). The genetic progress was estimated via the regression of progeny average on year. The results given in Table 4 indicate considerable genetic improvement in the segment of the population which participated in the programme. In the case of milk fat-kg the genetic change amounts to more than 1.2 percent of the population average.

**Table 2 GENETIC SUPERIORITY OF BULLS SELECTED IN A.I. AND IN NATURAL SERVICE IMPROVEMENT SCHEME**

	Progeny Tested			r 1/	n 2/
	Testbulls	Bull sires	Cow sires		
AI	10	2	4	0.85	45
Δ G, kg milk/year		360	205		
Natural Service	30	3	8	0.71	15
Δ G, kg milk/year		370	260		

<sup>1/</sup> Correlation between breeding value and progeny average.

<sup>2/</sup> Size of progeny groups.

**Table 3 PROGENY TESTING OF NATURAL SERVICE BULLS IN NORTH TYROLEAN GREY CATTLE**

Year of semen collection	Tested/selected	n	Age of bulls in 1983
1977	5/2	33 (20-51)	9 ys
1978	15/5	22 (1-52)	8.5
1979	5/-	13 (3-17)	8
1980	6/-	9 (3-18)	7

The figures given in Table 4 indicate the natural service - progeny testing scheme was effective. It has been pointed out elsewhere that use of young bulls in A.I. and the use of progeny tested bulls mainly for production of the young bulls should give a high rate of genetic advance (Bar Anan, 1973). However, this was investigated for an A.I. population while the thrust of this paper is the procurement of progeny tests from natural service community bulls and selection of future bull sires from among these; The economy of this approach affords the possibility of progeny testing fairly large numbers of bulls which permits rather intense selection among them. Therefore the deficit in the accuracy due to lower numbers compared to regular A.I. bull selection schemes can be balanced by the greater intensity of selection possible. Therefore genetic progress due to such breeding plans should be competitive. However, in contrast to regular A.I. schemes more bulls participate in the reproduction which should decrease the inbreeding increment and increase the genetic effective population size (N ) thus permitting sustained genetic improvement without the necessity to import genetic material from other services.

Table 4 GENETIC PROGRESS IN THE NORTH TYROLEAN GRAUVIEH POPULATION 1977 TO 1985

	b daughters/bulls x year			
	Daughters of all bulls			Daughters of bulls in Nsprogeny testing programme
	1977-1985	1977-1980	1980-1985	
Milk-kg	0.3	6	12	-1.4
Fat-%	-.0025	-.0095	-.019 <sup>1/</sup>	-.01 <sup>2/</sup>
Fat-kg	-.3	3	-.6	-.8 <sup>1/</sup>
		$\Delta$ G/year		
Milk-kg	-.5	-11	-24	3
Fat-%	.005	.01	.04	.02
Fat-kg	.5	-.5	1.2	1.7

<sup>1/</sup> p < .05

<sup>2/</sup> p < .10

<sup>b</sup> regression coefficient of daughters of a bull on year.

$\Delta$  G/year genetic change per year.

### 3. SUMMARY

Genetic progress is expected to be greater in larger populations. Experimental investigations bear this out in populations of small size (up to 50 breeding animals). Empirical evidence fails to indicate any connection between numerical size and genetic progress in U.S. dairy cattle populations, also genetic effective size of populations of domestic animals appears to be similar, almost independent of actual size.

The large expense of identification of superior sires in dairy cattle breeding favours large populations. Therefore, low cost methods of identifying superior transmitters are of paramount importance if modern methods of genetic improvement are to be applied in numerically small populations.

It appears that progeny testing of natural service bulls in combination with intense selection permits effective identification of superior sires. Collection of semen from the young bulls as soon as sufficient progeny is assured permits their use as future bull sires. Therefore such a system should be a feasible alternative to the conventional A.I. schemes wherever general A.I. is absent and/or where the populations are too small to sustain large scale progeny testing and selection of A.I. bulls.

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**POSSIBILITIES OF UTILIZATION OF ENDANGERED CATTLE BREEDS IN  
PRODUCTION OF MILK, BEEF AND VEAL, IN CONSERVATION OF THE  
NATURAL ENVIRONMENT OR IN OTHER NON-ECONOMIC SPHERES**

R. Siler, L. Bartos, J. Fiedler 4/ and J. Plesnik 2/

In the opening reports many economically important as well as other aspects were mentioned indicating quite explicitly the necessity of restoring threatened breeds or individual species of farm animals. Thanks to the intensive worldwide movement for conservation of the natural environment, where FAO and UNEP (1980, 1983) play such an important role in the sphere of animal production, practically all countries have gradually become aware of the need to preserve and conserve the diversity of present species as well as to pass on the results as fully as possible to future generations. We therefore appreciate that the present symposium will concentrate its attention on major species of farm animals.

We will consider genetic resources primarily in cattle, and contemplate the possibilities of utilizing threatened and disappearing breeds not only in the context of production of milk, beef and veal, but also in the non-economic sphere.

Let us consider individual possibilities of genetic resources preservation in cattle. Taking into account existing experience, present state of knowledge and further development of some biotechnical techniques in reproduction, particularly in cryogenic storage of sex cells and early embryos, the following possibilities of genetic resources preservation are available:

- small populations of living livestock;
- preservation of frozen semen;
- preservation of frozen embryos;
- combination of the above alternatives;
- establishment of a so-called gene-pool.

Each of these possibilities has its advantages and disadvantages, both of a biological and economic character.

The first possibility is the breeding of live animals in small populations where it is most important to avoid selection pressure and retain the complex of traits and characters of a corresponding genetic resource, unchanged if possible, from generation to generation. From the genetic point of view it is therefore imperative to choose a constant number of offspring per each sire and dam and through an appropriately controlled plan of mating (rotational system) prevent undesirable effects of inbreeding and random pressure, designated also as genetic drift and/or the effect of Sewal Wright, leading either to full elimination or fixation of some alleles.

The major disadvantage of the second possibility, when the genetic resources are preserved in the form of frozen semen only, i.e. from the sires, is that grading up through repeated matings of each next generation of crossbreds must be done with the semen of genetic resource to develop in such a way the preserved genetic resource in living animals, which must be carried out for five generations at least to achieve the gene proportion of the genetic resource amounting to approximately 97 percent. This accounts for a considerably long period owing to the length of the generation interval in the corresponding animal species. The possibility of practical use of the genetic resource obtained in such a way is therefore remarkably problematic in cattle. Supposing the generation interval is 5 years, 25 years will be needed to obtain living animals of the genetic resource. During this time economic conditions, market demands and technological systems may change so much that the development of the new genetic resource will no longer be desirable.

In terms of time, the third possibility, i.e. preservation of frozen embryos, is the most advantageous. Live animals capable of further reproduction may be obtained during one generation. The present state of development and utilization of this biotechnical method indicates its wide implementation in selection work in the immediate future. However the possible negative influences of those techniques on the transfer of pathogenic microorganisms and/or on future development should also be investigated in detail.

The fourth possibility consists in the combination of the above-mentioned possibilities. For instance, with live animals kept in small populations it is convenient to preserve the desirable number of sires through frozen semen to ensure the necessary rotational matings. The combined preservation of frozen embryos with frozen semen is also advantageous, which substantially extends the blood basis and thus the establishment of genetic resources in living animals. To avoid using grading up, prolonging considerably the "animation" of preserved genetic resources, it is convenient to sustain a certain number of living dams when frozen semen is used.

The fifth case, i.e. the establishment of a so-called gene pool, remains a theoretical possibility for the time being. Its realization is possible, of course, as evidenced for example by the American experience with the establishment of a gene pool in pigs. Again, generally it concerns the breeding of living animals obtained on the basis of one breed with subsequent inclusion of other breeds. Animals mate with one another which results in a mixture of various hybrids, out of which the animals of desirable type are obtained through strict selection, i.e.

not indigenous breeds entering the gene pool. In this case, the aim is not to preserve the breeds as such but their genes.

Therefore, this fifth possibility for back restoration of disappearing breeds is not simple. Desirable animals for such a gene pool may be obtained only through particular and long-term selection on in the course of a number of generations aimed at a desirable productivity type and an increase in the numbers necessary for reproduction.

An integral and important aspect in contemplating the choice of a certain possibility of genetic resource preservation is the economy, which plays an important role above all in the cattle, horses, pigs and sheep, while in subtle species of farm animals, particularly in poultry and rabbits, many indigenous breeds are preserved only thanks to enthusiasts.

Work by Brem *et al.*, (1982) provided some initial information. The data indicated that 5breeding live animals in small populations is the most expensive method. The second method is less expensive. However due to the necessity of grading-up for approximately 25 years, the final costs are particularly high. Another adverse feature of this method (when only semen is used) is the loss of resource of extrachromosomal genetic information comprised in the female sex cell.

The most favourable seems to be the use of frozen embryos and semen. Purchase costs are high. However live animals with genetic reserves are available within one generation. Therefore this method of preservation is recommended most frequently and indicative calculations carried out in Czechoslovakia in cooperation with the State Breeding Enterprises, General Management, also confirm this fact.

Detailed model calculations of costs for individual methods of genetic resources preservation in animal production were carried out by Smith in UK (1984a, 1984b).

Based on present current prices in UK the costs of genetic resources preservation in small populations, in the form of frozen semen and finally in the form of frozen embryos were established by Smith (1984c) in cattle, sheep, pigs and poultry, with the similar conclusion as that from Germany (Brem *et al.*, 1982).

Despite the high costs of genetic resources preservation in the form of live animals in small populations, in some cases this method is almost imperative and justified. In the context of general breeders, public, historical and cultural values, therefore also of international importance, it is hardly conceivable to breed a certain breed through a gene bank. However, in such cases too if not embryos, then at least semen of individual sires, participating in the development of a certain population in the course of its genesis, should be preserved, particularly due to possible inbreeding depression.

The review which is presented of costs of individual methods of gene resources preservation indicates equally the desired numbers of animals. These numbers must be minimal. In genetic resources preservation in small populations the ratio of 5 males to 25 females is currently reported, whereas the ratio of 50 to 250 is being recommended in cases with traits of low heritability. With the objective of ensuring consistent rotational matings the more convenient ratio is 1:1. When selecting males to freeze their semen, 25 unrelated animals must be chosen. Twenty-five different matings must be ensured to freeze the embryos.

Apart from their aesthetic and cultural significance, genetic resources preservation and conservation are important in terms of selection and thus are of national economic value.

Economic effects resulting from possible later utilization of the hereditary basis of the preserved genetic resources are given by the difference between the overall increase in performance of animals with the proportion of genes of the breed preserved and the costs for preservation of the breed used. In the model calculations by Smith (1984a) the product of the value expressing the used proportion of genes of the genetic

resource and relative profit in economic efficiency, expressing the justification of conservation and preservation of genetic resources, is underlined.

Also in this case we will make use of the model calculations valid for UK. It is surprising how low a proportion of genes of the genetic resource used is sufficient to achieve a great economic effect. This is, by the way, in harmony with the well-known experience that a seemingly high investment used for a relatively small number of selection herds is reflected in tremendous financial gains in commercial herds.

Under UK conditions Smith (1984a) chose the following example. He Presumed a genetic resource preserved for 20 years. After this period it was used again and would be used for another 20 years. A yearly inflation rate of 5 percent was considered. For instance, in dairy cattle, genetic resource preservation is fully justified at only 0.1 percent use of this resource, and at 1 percent profit in economic effectiveness. In the case of frozen semen, the values were even lower.

Thus, on a national-wide scale, the conclusion can be drawn from the above economic considerations that although the envisaged possibility for future use of genetic resources is small, it is worth preserving because the potential economic profitability will greatly exceed the costs for its preservation.

What is as a matter of fact the common feature of all endangered local cattle breeds? First of all it is their extraordinarily good adaptability to local conditions, i.e. relatively better utilization of local feed resources, resistance and longevity. The old proverb is fully true which says that a breed is the product of the soil, i.e. of the natural conditions under which it has originated and has been formed. This outstanding adaptability to extraneous natural environmental conditions can be illustrated by the almost disappearing breeds of the USSR, e.g. Kirgizian breed (Kasachian), Siberian, Petchorian, North Carrelian or Buryatyan (Zebrovskij *et al.*, 1984).

Perfect adaptability is also a prerequisite for a notable heterosis effect in possible commercial crossing of local breeds with improved cultural breeds thus providing better results compared with crossbreeding for improvement or grading up. Another important character, much appreciated by the breeders, is modesty and associated with it hardiness, so that production achieved, however low in comparison with a highly improved but demanding, breed corresponds fully to production conditions of the given region and for this reason is also economically advantageous. Local breeds are also distinguished for their satisfactory diverse, not only one specialized, performance. The quality of consumable products, i.e. milk or meat, of local cattle breeds is better regarding the ratio of their components, particularly protein and fat, and in terms of meat production, better taste and smell, due to a direct effect of free pasture or utilization of animals for draught.

We will now contemplate the possibilities of using local breeds for milk, beef and veal production. Without going too far for an example, we shall pay our attention to the characters of Bohemian red cattle formerly kept in our country. This breed of cattle has gradually disappeared and become a component of the Czech Pied cattle (Bílek 1926, 1933; Valenta, 1930; Smerha *et al.*, 1955). Bílek (in Smerha *et al.*, 1955) reports that the Bohemian Red cattle "were good draughters due to their lively temperament and breathing habits, were good dairy cows with yellow, fatty and very tasty milk, and butchers appreciated their good quality meat. Their major disadvantage was relatively late maturity for which they were displaced by earlier maturing, however, more demanding, Simmenthal Bern cattle with no better results in milk yield, ability to draught and longevity at relatively low demands achieved in the poorer mountainous regions along frontiers or in South Bohemia with its primary rocks."

Some concrete data on performance were reviewed by Valenta (1930) demonstrating that, e.g. in the Giant Mountains, the liveweight of Red cattle was higher compared with Bern Bohemian cattle and that with respect to their liveweight (522.2 kg) and low protein consumption (251 kg) they showed the most economic milk production amounting at that time to 2817 kg with 4.1 percent fat, being the highest of all the breeds compared.

The situation was also similar in the country of our hosts with their Polish Red cows always giving a desirable performance due to their advantageous characters and following further improvement by Polish breeders. On this occasion we would like to recall the International Agricultural Congress in Warsaw, 1925, which accentuated local breed maintenance as one of the most attractive items of the working programme in the sphere of animal production (Bílek, 1933).

In Hungary, where Hungarian Gray cattle have been successfully conserved with 187 females and 6 bulls, a number of experiments demonstrated the suitability of these cattle as a component part in maternal lines in the production of beef by crossbreeding (Bodó, 1985).

Similarly we could report on local cattle breeds in other European countries. In this connection as an example we refer to a publication on autochthonous cattle breeds in Spain (Belda, 1981) with 25 breeds recorded.

The situation overseas does not differ, of course. For further illustration only we present some conclusions from the comprehensive study by Wilkins (1984) on Criollo cattle in both Americas, and in various countries of Latin America in particular. This study provides explicit evidence that grading-up of these cattle aimed at obtaining a more cultural breed was a mistake because the purebred Criollo, which is not to be preserved and extended, has a whole number of more favourable characters when compared to both European breeds and zebu.

Compared with zebu, for instance, Criollo cattle have not such a developed herd instinct so that animals are scattered over pastures, which is of considerable advantage under Bolivian conditions. Also the temperament of the Criollo is milder compared with zebu. Zebu is a wilder animal and therefore worse to manage and that is the reason why even hybrids are refused by farmers. However zebu hybrids achieve better meat production and, using the knowledge of genetics of quantitative traits, also show higher fecundity, reduced mortality in calves and a higher growth rate.

Crossbreeding with European dairy breeds is beneficial; the adaptability of the tropical breed with the high milk performance of the European breed is achieved explicitly with the F<sub>1</sub> generation, but not in the following generations.

The Criollo, improved by selection for higher milk performance, is very favoured in small isolated farms in the countries of Latin America where its production amounting to over 2000 kg milk for rearing a calf is fully satisfactory for farmers's needs because under such conditions no hybridization scheme can be used (Wilkins *et al.*, 1984).

However here we are in the sphere of ecology, particularly in the sphere of complicated relationships between organisms within pasture chains (Farb, 1977; Odum, 1977). In our case this concerns the so-called pasture chain beginning with green plants, continuing over herbivorous to carnivorous animals; compared with other chains it is relatively simple.

In essence, the effectiveness of pasture depends on two decisive circumstances. First, on their primary productivity and, secondly, on the share of net production which can be annually taken away so that sufficient reserves ensure the future grass stand and plant composition to survive occasional periods of bad weather such as drought etc. (Humphrey, 1949).

When the reasonable utilization of pastures is ensured - and under this precondition only - local cattle breeds, which spread out on pastures, can considerably contribute to better pasture utilization and cultivation, particularly in mountainous regions, so forming a grass stand of good quality and preventing the loss of pasture areas which occur usually on the edges of forests due to natural self-sowing. History speaks mostly of the opposite case when excessive overgrowing of pasture stands has resulted in erosion first and later in complete landscape devastation (Dorst, 1974). Another practical and important characteristic of local cattle breeds in

terms of selection is their use as a control population not only with the breeds developed from them through improvement or grading-up but also with imported breeds substituting them gradually. In all cases the technique of frozen semen or early embryos may be used, i.e. the widespread preservation methods used in cattle breeding.

Justification of conservation and preservation of disappearing and endangered local breeds is not based on their economic utilization only. There is a whole range of other aspects that should be taken into account in terms of cultural, historical, research, study and other points of view some of them having already been mentioned and referred to so truly by Maijala (1984).

From the cultural and historical aspects, local cattle breeds represent a vivid proof of the creative work of ancient selectioners and breeders establishing many populations through experience and observation and therefore being as valuable a monument as a costly restored and preserved historical construction.

Hence, from the point of view of selection process the endangered and disappearing cattle breeds, as well as all other species of economically significant animals, are extremely valuable material reflecting accurately the goals of past national economies and also the concept of selectioners at that time of animal body conformation. The existence of living animals of these breeds facilitates important comparative studies of anatomical and particularly physiological character, determination of many polymorphous traits enabling evaluation of phylogenetic relations in presently kept breeds, etc.

It is therefore highly desirable to present typical individuals of the endangered and disappearing cattle breeds at agricultural shows for object studies on possible changes in animal performance and breed during the process of improvement. This would be of special value when such breeds are kept in conserved regions, sanctuaries, etc. as already mentioned in the example from Hungary.

In conclusion it can be deduced that the possibilities of utilization of endangered and disappearing local cattle breeds as well as other animal species are indeed versatile. In any case we must not forget our moral and human obligation to preserve these breeds for future generations as a vivid proof of the creative activities of man. If the human community can spend astronomical sums on armaments, construction of spaceships and technical development, then it ought not to hesitate to devote a negligible fraction of these expenses to conserve and preserve natural resources including endangered breeds because they are decisive and necessary for the further existence of man on this planet.

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## **POLISH RED CATTLE - BREEDING, BREED PRESERVATION AND UTILIZATION**

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## 1. HISTORY OF THE BREED

The Polish Red breed (PR) belongs to the brachycephalic type of cattle that has existed in central Europe since prehistoric times and was reared by western and northern Slavs. Until the second half of the 19th century no organized breeding work aiming at improving the basic directions of local breed performance had been conducted. According to Jakóbiec (1959) the most important influence on the formation of this primitive local breed has been the specific mountain and submountain environment of southern Poland where in small farms the only feed available is hay in winter and poor pastures in summer.

In the 19th century many enlightened farmers were already aware that the local cattle varieties had such qualities as strength, resistance to diseases, good roughage utilization and adjustment to local rearing conditions (Rolnik i Hodowca, 1899). The native cattle were acknowledged as being the most suitable for small farms and where conditions did not allow intensive breeding. According to Pruski (1967) local cattle populations varied in colour - from black and brown to red and mouse-grey.

When discussing the history of the Polish Red breed Pruski (1967) reports that the local cattle were concentrated mainly in the area of sub-Carpathia, Swietokrzyskie mountains and Lomza. Because of poor industrial and transportation facilities the market for milk and milk products was very small. Thus, good milk performance was not the most important aim in breeding. According to Pruski (1967) Swietokrzyskie cattle of one colour were known in the middle of the 19th century as being mainly good oxen.

In the second half of the 19th century an important role in improvement of dairy breed performance was played by large herds formed from cattle purchased from small farmers. Among the first herds were those formed by Jan Popiel in Wójeza and Adolf Rudzki in Branszczyk in 1869.

Sub-Carpathia was an important region as far as breed improvement was concerned. In 1894 the Red Cattle Breeders' Association was established under the auspices of the Agricultural Society in Cracow. At that time Stefan Romer from Jodlownik formed a Red cattle herd which is still existing. In 1906 official milk performance recording was introduced. First herd books of the Polish Red cattle were published in 1913. At the beginning of the 20th century other important herds were formed by Kuberski in Subierczyn, Frackiewiez in Wieprzowe Jezioro, Czecz in Kozy, Slonecki in Jurowce, Bujwid in Wolica, and Mars in Limanowa.

After the Second World War the most important breeding herds of Polish Red cattle, apart from Jodlownik, were those in the Experimental Farm in Konskowola, the State Pedigree Breeding Stations in Koszecin, Elk and Tarnawatka, the Animal Science Experimental Farm in Grodziec and Rossocha, as well as individual farmers' herds: in the Wysokie Mazowieckie centre, the herds of F. Kulesza in Golasze-Puszcza, M. Wlostowski in Mystki-Rzym, J. Kulesza in Kalinowo-Czesnowo; in the Podhale centre, the herds of A. Serafin in Kobylec, L. Krzak in Golkowice, J. Zur in Chabówka W. Majchrowicz in Skawa; in the Cieszyn centre, the herd of J. Miech in Godziszów; in the Lubliniec centre, the herds of S. Piechaczek in Sucha near Strzelce Opolskie and Kolaczuch in Harbutowice. Many of the herds mentioned had already existed for about 40 years or more.

After the war many scientific centres carried out investigations on the improvement of Polish Red cattle; the following scientists should be mentioned: Professors Z. Zabielski, M. Czaja, T. Marchlewski, Szezekin-Krotow and H. Jasiorski and Drs. S. Poczynjlo and K. Zukowski.

Milk productivity of Polish Red cattle was not high (Table 1) due to the lack of selection in the post-war period when the main task was to reproduce a sufficient number of animals. Since there was no marked progress in milk performance, in 1950 upgrading with Danish Red cattle was introduced by Prof. M. Czaja in the Animal Science Experimental Farm in Grodziec Slaski (Zukowski and Luchowicz, 1964).

Table 1 DAIRY PERFORMANCE OF POLISH RED COWS

Year of recording	Average	Average year productivity		
	number of cows	Milk kg	Fat kg	Fat %
1955	11 990	2 425	93	3.85
1960	23 633	2 551	99	3.87
1970	13 065	2 901	116	4.01
1975	5 365	2 961	121	4.09
1980	4 245	2 901	118	4.05
1985	1 414	3 085	130	4.21

A total of 1969 full lactation records were collected from 481 cows sired by 51 bulls (Table 2). Milk productivity was over 17 percent better in cows with 1/4 Danish blood, 19 percent in 1/2 Danish cows and 22 percent in cows with 5/8 and 3/4 Danish blood.

In 1959 the first Red Danish herds were established, mainly in the State Pedigree Breeding Stations, from a few thousand heifers imported from Denmark. At the same time crossing was introduced in mass breeding and in breeding herds. For this purpose, Red Danish and crossbred bulls were purchased for the insemination stations in all areas in Poland where Red cattle were bred, except the Cracow region where Danish bulls were not imported until 1964. The main effect of this crossing programme seems to be a steady increase in fat content in the milk of Polish Red cows observed over the last ten years (Table 1).

According to Szarek et al. (1981) the quantitative and qualitative needs of the Polish milk and beef market changed in the 1960s. In order to adjust Polish Red cattle to changing maintenance and utilization conditions resulting from better feeding, other attempts at upgrading were made. Red Danish and Jersey cattle were used as improving components (Jasiorowski and Poczynajlo, 1970). A change for the better in the dairy performance of crossbreds was evident (Table 2). This crossing model, however, was not adopted in practice because of the poorer beef performance of the offspring. Red and White bulls were then used for crossing. They improved milk productivity by about 400 kg and even if they did not improve beef performance, which took place especially when body weight was lower than 450 kg (Nahlik, 1973), they did not make it worse (Szarek *et al.*, 1981-Table 6).

**Table 2 DAIRY PERFORMANCE OF PRIMIPARAS OUT OF PR COWS WITH DANISH RED OR JERSEY BULL MATINGS**

Genotype	Milk	Productivity kg		
		Fat	Fat Content %	Source
Polish Red	2 561	100.0	3.97	Jasiorowski H., Poczynajlo S. materials of IGHZ PAN Jastrzebiec, 1970: performance in the Bull. Eval. Station, Szepietowo
PR x Danish Red	4 287	175.3	4.09	
PR x Jersey	3 733	175.2	4.69	
Polish Red	2 334	93.6	4.01	Zukowski K.: Effect of improving crossing with DR cattle on dairy performance of Polish Red cattle (experimental data ) from Exp. Farm in ZZD Grodziec S1.), 1970, Ms. PP 99.
PR x Danish Red (DR)	2 781	111.4	4.00	
F <sub>1</sub> x F <sub>1</sub>	2 698	107.3	3.97	
3/4 dc DR	3 163	125.8	3.98	
3/4 DR x 3/4 DR	3 565	142.4	3.99	

By the end of the 1970s crossing with Angler bulls began. First results were encouraging. F<sub>1</sub> cows in a first lactation produced 1000 kg more milk and 0.15 percent more fat than the daughters of Polish Red bulls (Staszczak, 1985). The Angler crossbreds were decisively of dairy type.

By the end of the 1960s the population of Polish Red cattle was about 2 million animals, i.e. about 18 percent of the whole cattle population in Poland. A tendency in the 1970s to intensify Polish agriculture resulted in the disappearance of Red cattle from the greater part of the area where they had existed up to that time. This was also a consequence of administrative directives. The herds of Red Danish cattle also ceased to exist at that time, some because of mass leukaemia, others as a result of new opportunities for export of young beef slaughter cattle not including, however, Red bulls which in the importers' opinion were not suitable enough for fattening. In northern and central Poland, Red cattle were replaced by Black-and White cattle, and in south-eastern Poland by Red-and-White cattle.

## 2. PRESENT SITUATION

A concentration of Polish Red cattle still remains in sub-Carpathia within the boundaries of the Nowy Sacz province. This population, together with animals disseminated in the adjacent Bielsko, Tarnów and Cracow provinces, is estimated to comprise 100 000 cows. Another 100 000 Red cattle are found in enclaves in Białystok, Kielce and Rzeszów provinces. These two populations together form about 3 percent of the whole Polish population of cattle.

Breeding work was continued only in the Nowy Sacz province and in the surrounding area. Since 1975 this work has been conducted in line with an officially accepted breeding programme. Milk recording is applied to under 1 500 cows. The main centre around which this work is concentrated is the State Animal Breeding Station in Jodłownik where breeding bulls are performance tested in rearing stations. Milk progeny testing is carried out at the station. Seven young Red bulls purchased every year by Animal Insemination stations in Brzesko and Zabierzów are tested in this way About 50 percent of cows in the Nowy Sacz province are inseminated. An interest in this native breed and willingness to breed it may be testified by the fact that since 1982 when the

official regionalization of cattle breeds was cancelled, the regions mentioned previously have bought from the Nowy Sacz region considerable amounts of semen of proven Red bulls.

Environmental conditions in sub-Carpathia have improved in recent years. Feeding of cows is better and production has increased. Breeders anticipate better animal material capable of higher productivity. Tables 3, 4 and 5 show characteristics of milk and beef performance of Polish Red bulls tested in recent years. The aim of future work will be to breed animals of higher productivity and fat content in milk which determines the price. With present needs in view, upgrading with the Angler breed is carried out. In the Nowy Sacz province a moderate crossbreeding programme with 50 percent bulls which constitute a half of all the bulls used for insemination is practised. In the remaining regions of Red cattle breeding use is made of the semen of proven Angler bulls received by the Cattle Breeders' Association in Nowy Sacz from the Angler Cattle Breeders' Association in 1983 and 1985.

**Table 3** PRODUCTIVITY OF RP PRIMIPARAS IN STATIONARY MILK PROGENY TESTING OF BULLS IN POHZ JODLOWNIK IN YEARS 1980-1984 (Nahlik K., Bienkowski M. and Zukowski K., 1986, in press)

No. of primiparas	No. of sires	Calving age months	Dairy performance					
			Days of milking	Milk kg	Fat kg	Fat %	Protein kg	Protein %
342	30	28	271	2 574	110	4.28	88	3.40

**Table 4** GROWTH AND DEVELOPMENT OF PR HEIFERS IN THE PROGENY BULL EVALUATION STATION IN POHZ JODLOWNIK FROM 1980-1984

No. of:		Body weight at:		Measurements at 18 months age:			Index of:	
Heifers	Sires	12 mths kg	18 mths kg	Height at withers cm	Forechest depth cm	Forechest circumference cm	Depth	Massivity
390	30	264	348	117	59	161	50	138
				Measurements and indexes 10 days after calving			Index of:	
Primiparas	Sires	Calving age months	Body weight 10 days after calving	Height at withers cm	Forechest depth cm	Forechest circumference cm	Depth	Massivity
342	30	28	437	121	64	174	53	144

**Table 5** BEEF PERFORMANCE TEST RESULTS OF YOUNG BULLS IN THE JODLOWNIK REARING STATION (Szlag and Nahlik, 1980-84)

No. of bulls	Body weight at 12 mths of age kg	Daily gain: 121-360 days g	Height at withers cm	Forechest circumference cm	Index of massivity
244	398	1 132	117	167	143

The aim of breeding work is to achieve an average milk production of 3500 kg with 4.5 percent fat content and 3.6 percent protein content as well as to improve lactation length to about 300 days. The body weight of Red cows should be 450-500 kg and height at withers 125 cm.

It is expected that this programme for the improvement of Red cattle will lead to the formation of a population with at least a 25 percent share of the Angler genotype. At the moment it is difficult to predict to what degree the genotype of native cattle will change.

Stalinski (1985), when discussing the future of Polish Red cattle as a breed in danger of extinction, supposes that if the breed improvement process is still based on a small, as at the moment, active population and concentrated (including the production of sires for the breed) around only one herd - Jodlownik - it will be necessary to look for "genetic qualities from the outside" and then only will it be possible to talk about Polish Red cattle as a gene reserve in preservation herds. The author is convinced of the necessity to preserve the breed.

At present two programmes are being carried out: breed improvement and preservation of the gene pool. In view of the need to preserve the old Polish Red breed type the following action was undertaken:

- a reserve of semen from 39 Polish Red sires was formed (an average of 320 doses per sire);
- embryos were frozen from the most valuable cows (long living, fertile and healthy). Sixty-nine embryos from 19 cow donors were collected (Wierzbowski *et al.*, 1984). It is planned to collect 650 embryos from 50 cows which, according to Smith (1984), may provide a sufficient frozen genetic stock;
- three preservation herds comprising 280 cows were established. The cows were purchased from all the regions where the breed was kept. The male to female ratio is planned to be 1:10 to 1:15. The herds will be divided into groups comprising 10-15 females.

The size of the preservation herd will be constant, thus only a very small percentage of offspring will be necessary for herd reproduction. In order to prevent a decrease in variability, offspring will not be selected. To counteract too much inbreeding only one son per sire will be left for rearing and, if possible, one daughter to replace her mother.

### **3. CHARACTERISTIC TRAITS OF THE POLISH RED BREED**

Environment, and most of all feeding, have not led to high milk Production in Polish Red cows. Natural selection in this breed developed traits which make it possible to adapt to local conditions but which, unfortunately, usually lead to low milk production. A very slight improvement of performance traits through selection was accomplished and so the breed is not specialized and is characterized by a high genetic variability of productive traits. Average milk production of cows in small private farms is about 2500 kg with a general tendency for lactation to be restricted to 200-250 days. The cows whose milk performance was recorded in 1985 produced 3055 kg milk, with 4.21 percent fat and 130 kg fat. In various dairy laboratory analyses it was found that protein content in milk in Red cows reaches 3.5 percent and dry matter content 12.7 percent. The milk, from these cows is highly regarded by the dairy industry due to the higher output and quality of casein coagulum which is necessary for cheese production. Table 8 presents a comparison of dairy industry data from adjacent regions where Polish Red and Red-and-White cattle are bred. To produce one unit of low-fat cottage cheese, less than 6.2 percent milk from Red cows is needed. For high-fat cottage cheese this difference reaches 5.5 percent. Dairy industry technologists feel that the milk from Red cows is the most suitable for the production of noble cheese types, especially emmentaler.

Beef performance traits are rather poorly developed in the Polish Red breed. Young cattle fattened extensively and semi-intensively give fairly good results, but because of the small size of an animal, fattening has to be finished early. Bulls should be slaughtered when their body weight reaches about 400 kg since further fattening is unprofitable because of the early development of a fatty carcass and low weight gains (Szarek *et al.*, 1980). Fattened cattle utilize roughage feed well. Their carcass tissue composition and dressing percentage are good. They do not, however, belong to the highest slaughter classes. Excellent material for fattening is obtained by mating Red cows to beef-type Charolais or Simmental bulls (Tables 6 and 7).

Table 6 BEEF PERFORMANCE OF PR BULLS X CHAROLAIS; PR X RED- AND-WHITE (RW), AND PR X SIMMENTALER CROSSBREDS  
(Szarke *et al.*, 1980)

Trait	Genotype			
	PR	PR x RW	PR x Sim.	PR x Charol.
Mean daily gain from 120-500 kg	720	709	769	733
Consumption of oat feed units per 1 kg gain.	7.3	7.2	7.1	7.3
Dressing percentage	57.6	57.6	58.6	59.5
Meat share in a carcass-side %	68.3	69.6	71.6	70.5
Fat share in a carcass-side %	10.4	9.1	7.8	9.2
Musculus longissimus dorsi section area (cm <sup>2</sup> )	77.8	93.4	92.1	90.2

The investigations of Cieslar and Wawrzynczak (1978) show that when compared with Red-and-White, Polish Red cattle are distinguished by good quality meat properties, i.e. better raw meat consistency, better texture after heat treatment, more tender, juicy and better organoleptic qualities. Meat of Polish Red bulls has the highest indices of so-called total quality.

Table 7 NORMS OF RAW MATERIAL EXPENDITURE IN CHEESE PRODUCTION

Assortment	Breed Region	Producer	Raw material expenditure for production of 1000 kg cheese calculated so-called plasma units of milk		
			Year average	Winter season	Summer season
Low-fat	RW	Bobowa	8 202	8 062	8 342
Cottage	RW	Gorlice	8 112	8 094	8 130
Cheese	PR	Nowy Targ	7 690	7 060	8 320
	PR	Zakopane	7 706	7 566	7 846
High-fat	RW	Bobowa	8 228	8 202	8 374
Cottage	RW	Gorlice	8 364	8 314	8 414
Cheese	PR	Nowy Targ	7 829	7 150	8 508
	PR	Zakopane	7 957	7 690	8 224

Source: 1986 Woj. Zw. Sp. Melecz., Nowy Sacz.

**Table 8 COMPARISON OF SLAUGHTER VALUE OF FATTENED BULLS  
(IN SLAUGHTER CLASS A)**

Breed	No. of animals	Pre-slaughter weight	Dressing percentage	Share of 5 cuts in hot carcass	Share in 5 cuts		
					Meat	Fat	Bone
PR	10	483	53.1	61.6	75.4	6.4	18.2
RW	17	499	53.9	58.0	72.4	9.0	18.6
Sim	8	534	55.9	59.0	75.8	6.5	17.7
PR x Ch.	9	509	57.3	62.0	77.2	6.2	16.6
PR x Ch.	13	516	57.5	58.7	75.4	8.0	16.7

The Polish Red breed has features typical of primitive populations which are well adjusted to local environmental conditions and management. This is expressed in longevity, resistance to diseases, good fertility and good calf-rearing performance. This may be illustrated by the fact that there were no problems in choosing 14-20 year-old cows which were still fertile to be donors of embryos for genetic reserves (Wierzbowski *et al.*, 1984).

The results achieved in test bull rearing stations proved the good reproductive ability of this breed. Only 2 percent Red bulls are culled because of bad semen quality which could not be used for reproduction. In Black-and-white and Red-and-White bulls 9 percent of animals were culled for this reason (Szelaq and Nahlik, 1980-1984).

The health of Polish Red cows is much better than that of Friesian cattle. Metabolic disorders, footrot and limb and hoof ailments are practically unknown in Red cows. Udder inflammation is also rarely found. The good health standard of the breed may also be testified by the fact that in a group of 400 cows, mostly old, purchased from several provinces to complete preservation herds, no cases of illnesses, including leukaemia, were officially recorded.

#### **4. PROSPECTS TO UTILISE THE POLISH RED BREED**

It is difficult to foresee at the moment which traits characteristic of the Polish native breed may be utilized in the future. Friesian cattle including Holsteins, although having undeniable production qualities are characterized by lower fertility and susceptibility to numerous diseases and thus their period of production is shorter. As a result even when milk productivity increases, the economics of cattle breeding become unattractive due to the poor results from rearing young cattle. Polish Red cattle have these qualities which highly-productive breeds lack.

Sceptics claimed that it was no use building up genetic reserves since from the economic point of view crossing with low-productive local breeds would not be profitable. In recent years, however, the situation has changed. Due to the development of genetic engineering it becomes possible to use not only the whole genotype or genome, but also selected chromosome fragments which carry particular genetic information. Theoretically, this would make it possible to introduce a qualitatively important trait without the risk of causing a decrease in the performance parameters which could take place in the case of a simple interbreed crossing.

The possible utilization of primitive breeds does exist. In Poland some pastures are not fully utilized because of unfavourable environmental conditions and it would appear that feed reserves both in the north and on mountain pastures could be successfully used by Red cattle.

At present it is difficult to predict the future nutritional diet for ruminants. At present more and more grain feeds are being used. In the years to come it might be advisable to offer cattle feeds which are not suitable for human consumption, i.e. forage, straw and by-products of agricultural production. Animals of the Polish Red type could prove very useful in a production system based on straw feeds complemented with concentrates.

If local breeds are distinguished by some specific production qualities characteristic of a given genotype, there should be no doubt as to the necessity of their preservation. There are some specific examples of local breed utilization for the improvement of production traits, as in the case of crossing Finnish sheep with Romanowska.

It is likely that quality, including taste of products of animal origin will become so valued with time that they will be given economic importance. Then the positive traits distinguishing the milk and beef of Polish Red animals will be appreciated, which could become the basis for wider breed utilization.

Genetic reserves in the preservation herds may also be treated as a control group in the estimation of genetic progress in the active population. Animals from preservation herds may be used in immunogenetic, physiological and nutritional investigations.

Those who are against the active protection of local breeds of domestic animals emphasize the costs of this undertaking. Also, there is no certainty that the protected breeds will ever be useful and therefore they doubt if these activities are justified from the economic point of view. These doubts are difficult to be refuted with valid arguments. However one may certainly talk about reasons of an aesthetic nature, willingness to preserve elements of material culture of previous generations or, simply, saving from complete extinction. We live in times when the views on future development models of civilization on our globe are changing. This change is caused by the shortage of energy and minerals. If it is desired to have the possibility of manoeuvrability in animal breeding, we cannot waste the genetic potential of local breeds.

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### GENETIC ANALYSIS OF THE EUROPEAN BISON POPULATION

Wanda Olech 1/

In 1923, at Poland's suggestion, the International Society for the Protection of the European Bison was created. Its principal aim was to preserve the European bison by planned breeding and reproduction. Stocktaking in 1924 showed that only 54 individuals existed (29 males and 25 females) with a reliable pedigree. The European bison pedigree book was initiated for this species and it is still in operation. For each animal the book contains its sex, number, name, dates of birth and death, numbers of parents and breeding place.

The species was derived from a foundation herd of only 17 animals. Some pairs of ancestors were represented by only one descendant and that is why the gene pool of the species contains only 12 genotypes. It was impossible to prevent inbreeding in this population, and in consequence the inbred animal has a negative influence on viability, fertility and health. The aim of this paper is to show the situation in the population of European bison born before 1985 according to their inbred level.

The European bison is a wild species living in a mostly natural environment, but mating is under control. This is why very interesting material exists for studies on inbreeding and its effects.

For bison born before 1985 the following values were computed: inbreeding coefficient, length of life, and for females also age at first calving, average interval between calvings and number of offspring.

Mean value of inbreeding coefficient for 4509 animals is  $0,202 \pm 0.002$ ; for 68 individuals it is greater than 0.500. Such a high value of inbreeding coefficient can seldom be found in stocks of farm animals. That fact could lead to the conclusion that the population of bison has degenerated. This is not true: bison are very well adapted to their living conditions, they are healthy and their reproduction level is satisfactory. It was noticed that only young animals were sensitive to a high inbred level. With the growth of inbred level the percentage of juvenile deaths increases. The chi-square test showed that this influence is highly significant. Table 1 presents percentage of juvenile deaths (in to the age of two years) in groups with a growing value of inbreeding coefficient.

Correlation between inbred and some reproduction traits was estimated, and the results are presented in Table 2. Correlation coefficients are rather low, the only significant fact being that inbreeding increase: the average interval between calvings and the age at first calving and indirectly decreases the number of offspring. This influence is highly significant but still rather low. If parents have high inbreeding coefficients, the smaller number of their offspring takes part in further breeding (i.e. have offspring themselves). On the whole,, such a low influence of inbreeding on reproduction traits is surprising.

**Table 1** PROPORTION OF JUVENILE DEATHS ACCORDING TO INBREEDING COEFFICIENT VALUE

Inbreeding coefficient value (%)	Number of animals	Percentage of juvenile deaths
0-3	608	21.55
3-10	616	25.00
10-17	690	22.61
17-24	744	20.57
54-30	779	21.57
30-37	528	25.76
37-44	306	25.16
44	238	29.41

**Table 2** CORRELATION COEFFICIENTS BETWEEN INBREEDING COEFFICIENT AND SOME REPRODUCTION TRAITS

	Females	Males
Age at first calving	0.14 xx	
Average interval between calvings	0.15 xx	
Number of offspring	-0.116 xx	0.022
Proportion of offspring for breeding	-0.070 x	-0.097 x

Percentage of genes of each of the 12 ancestors was estimated for all bisons born between 1980-1984 (876 individuals). The results obtained were almost the same as given by Slatis (1960) for animals living in December 1954 (Table 3). The proportion of ancestral genes has practically remained unchanged in 30 years. Unchanged genetic contribution proves that variability of the population was preserved, which is rather difficult to obtain in inbreeding.

Table 3 PROPORTION OF ANCESTOR GENES FOR BISON BORN BETWEEN 1980 AND 1984.

Number, name and of ancestor	sex	Proportion for bison living in 1954 (Slatis)	Proportion for bison born between 1980-84
15 Begriinder	M	7.05	8.2
16 Plavia	F	7.70	9.1
35 Plevna	F	3.23	2.7
42 Planta	F	19.30	18.8
45 Plebejer	M	27.03	26.4
46 Placida	F	1.33	0.9
87 Bill	M	7.71	7.2
89 Bilma	F	10.09	9.6
95 Garde	F	3.51	3.8
96 Gaczyna	F	5.68	6.3
147 Bismrck	M	0.62	0.9
100 Kaukasus	M	6.74	6.1

The reconstitution proved to be successful because the genetic variability has not been lost. The inbreeding depression has rather small effects on adults but results in lower viability of young animals. It is probably an indication of natural selection, the intensity of which is directly proportional to the inbreeding coefficient.

The reconstitution was successful due to several reasons:

- great number of breeding places (thus subpopulations were formed);
- loss of artificial selection - only natural selection which favours healthy and vital animals;
- keeping animals in their natural environment, which avoids development of physical sensibility.

### **THE ROLE OF SHEEP AND GOAT GENE RESOURCES IN PRODUCTION, NATURAL ENVIRONMENT CONSERVATION AND IN OTHER ACTIVITIES**

L. Veress 1/

#### **1. INTERNATIONAL TRENDS IN SHEEP AND GOAT BREEDING**

There are two trends in modern sheep and goat breeding: to compete with other branches of agriculture, producers strive to increase products per animal and thus decrease production costs. Of necessity, sheep and goat breeding becomes intensive (Veress, 1984).

The rural population will leave areas unfavourable for agricultural production, arid and semi-arid steppes and mountain regions if sheep and goat breeding is not supported by the state and consequently these lands will become unused (Veress, 1984). The examples are some mountain pastures in Yugoslavia and Slovakia, where the number of sheep has greatly diminished. In UK, the Soviet Union and a number of other countries sheep and goat breeding is supported by the state in such regions to retain the population and protect the environment.

Ancient breeds have mostly survived in regions having unfavourable conditions where views on breeding and economy are more conservative. It is also in these regions where efforts are made to preserve them.

Unfortunately breeding in farms of these regions is carried out with the help of their own gene reserves, which diminishes their chances of making a profit. This process in itself therefore does not guarantee the prevention of further decreases in the population and the immigration of genes. The creation of the "Rare Breeds Survival Trust" in UK is considered an important step on an international level. This Trust gives further support to preserve breeds that have a less than 20 percent ratio from outside the breed. It is firmly believed that the ancient breeds can only be preserved if state aid is accompanied by social unity together with financial support.

This conviction led us in 1982 to establish the Society of Hungarian Racka Breeders whose members are mostly private breeders. Breeding and further improvement of Racka sheep are carried out by the members partly through a sense of patriotic duty to preserve this noble and well-composed breed. Apart from the fact that this activity gives pleasure, it is also a useful hobby.

The leaders of the Society were elected by the members and they do their jobs unpaid. Since the Society was founded, interest in Racka breeding has increased, the stock has also multiplied and breeding animals have also been sold abroad. Meetings and consultations are held on workdays but out of working hours.

## **2. WHAT ARE THE REASONS FOR PRESERVING ANCIENT BREEDS?**

It is well-known that local breeds are well-adapted to local conditions, in many cases with an unfavourable climate, and that they utilize the less attractive vegetation better than culture breeds. For example, the main feed of the North Ronaldsay sheep are the mosses washed onto the sea-shore (Alderson, 1981). In fact, crosses with culture breeds will not improve, but in certain cases decrease, the productivity of the population (Hodges, 1984).

Several local breeds seem able to resist certain diseases (piroplasmosis, scrapie, etc. - Rendel, 1981).

Growth rates of several local breeds remain stable in poor feeding seasons, but these are fully recuperated on spring pastures. Other breeds such as fat-tailed and fat-rumped sheep endure thirst and hunger excellently, and use their fat deposits to satisfy their needs.

Especially at the turn of the 19th and 20th centuries, experts aimed at a thicker skeletal conformation of culture breeds. They supposed that the animals might grow stronger this way. The clumsy, usually diploe-skeleton resulted in difficult lambing. The unrefined breeds are usually characterized by finer skeletons and easy lambings.

All over Europe breeders nowadays are forced by the slaughter animal trade to produce animals that are not far from the phenotypes of the so-called terminal breeds. The outcome is that within the English Down breed type, mature weight differences between the early maturing Southdown and Dorset Down types and later maturing Oxfordshire Down and Suffolk breed types diminish, or more exactly body weights in both breeds become higher (e.g. American Suffolk). A similar case can also be seen with mutton Merinos, since their mature weight has increased by about 40 percent in 30 years. I consider it to be even more irrational that milk Friesians are selected for mutton in Western Germany (Luke and Müsch, 1983). The body weight of the Finnish breed known for its prolificacy increased to an even greater extent than that of the German mutton Merinos. It is an aim in Romanov stock sheep farms to increase body weights and wool production. At the same time the frequent lambings which are characteristic of this breed have in many stock farms been reduced to one lambing per year. In broiler production it was made clear a long time ago that it is possible to have the least expensive and at the same time a very good quality slaughter chicken by crossing a prolific mother line having a small body weight with a less prolific but heavy and well-muscled cock line. Increases in body weights in reared sheep and goat lines decrease the number of population per given (and at the same time non-increasable) land unit and so the number of lambs possible to include in this unit also becomes fewer. It is well known that the bulkier breeds

demand for feed is greater. I would like to mention one Brittany breed as a rarity whose mature body weight does not exceed 10 kg (J.M. Elsen, 1985, personal communication).

Another, also poorly studied topic, is mutton quality. In Europe, mutton containing less total pigment is regarded to be of better quality because it is supposed to be less mature. Nevertheless, in UK the more finely muscled Herdwick breed having a smaller body, and in France the Massif du Central breed, also with a small body and mutton of a darker colour, give the tastiest mutton. At the permanent agricultural exhibition in the USSR lambs of the same age from 20 different breeds were slaughtered and given to the best known sheep breeders of the country to taste. The meat of finely muscled Romanov breed with high total pigment was most favoured (Kovnerev, 1978, personal communication).

In New Zealand, the question as to which breed tastes best was answered by the most authoritative Romney breeder, A. McGregor (1985, personal communication), who said it was the meat of the Merino because its mutton is less fatty, more finely fibred and pigmented. It is well known in Hungary that the mutton of the Racka breed is much tastier than that of Merino. The ancient sheep breeds having lighter body weights usually have tastier mutton than the mass-produced mutton breeds whose muscles contain more insoluble connective tissues.

In most culture breeds the aim is to select a white stock despite the well-known fact that it is the fleece of pigmented crossbreed types that gives the best hides (e.g. Romanov). A couple of years ago several scientific articles from Iceland claimed that the local pigmented breeds had a higher fecundity and a longer, more favourable heat season (Adelsteinsson 1970; Dyrmondsson 1978; Dyrmondsson and Adelsteinsson 1980). More recently Maijala (1981) also put forward a proposal to preserve the earlier colour variants in Finnish breeds. In a smaller sized Merino Landschaf selected for the highest possible litter size and lambings in every 7 or 8 months more and more frequently smaller or bigger pigment spots appeared on the heads and legs (M. Burgkart, 1981, personal communication). A similar case was observed in Booroola Merinos.

In the Kazahstan region of the USSR Butarin (quoted by Litovcsenko and Esaulova, 1977) has for the sake of better acclimatization crossed the Argali breed with Merinos. Mason (1981) gives an account of crosses with moufflons in Cyprus. The experiments made with crossing dedomesticated goats and angora goats in Tara Hill by the Invermay Agricultural Research Institute are also of great interest (J. Allison, 1985, personal communication). However I must agree with the earlier standpoint of Cunningham (1980) and Bodó (1982) that the carefully studied local breeds seem more suitable to create new synthetic breeds.

So long as a breed consists of a small population inbreeding cannot be avoided (Bodó, 1982). The low variability seen in immunogenetical examinations of pure-bred animals also points to this fact (Fésüs, 1981). The black variant of the Hungarian Racka sheep was conserved for more than 30 years by one of our members who rarely bought rams from other stocks. Lambs from the inbreeding of the Romanov breed, which has a relatively small population, gave more favourable results in body weight increase and fecundity rate than the ones from top-cross matings. Only the lambs from very loose inbreedings ( $R = 0.25$ ) had a significantly higher mortality rate (Arszeniev, 1982). This points to the fact that the probability of lethal and sublethal genes appearing is greater in breeds having a small population than in the highly populous ones.

### **3. MEASURES TO BE TAKEN IN THE FUTURE**

Many excellent proposals to preserve breeds have been advanced by others (Bodó *et al.*, 1980; Barker, 1980; Alderson, 1981; Maijala *et al.*, 1984) and two of these only will be repeated: in breeds likely to be utilized in gene reserves, at least 500 ewes and 7 or 8 ram lines have to be conserved in every colour variant. So as to preserve a wider possible range of gene frequency in breeds it is advisable to deep-freeze semen from excellent rams and zygotes from outstanding ewes. St. Salamon (1985, personal communication) had a 60 percent fecundity rate through direct endoscopic insemination into the uterus with ram semen stored for 15 years.

As far as possible the intervals between generations have to be widened, i.e. animals with great life productions and a solid body frame have to be kept for breeding for possibly longer periods.

The fashion of crossing for its sake alone has to be abandoned. Local breeds must be entered in international flock books (Dohy 1984). Apart from state support national collaboration is also essential. National funds are needed to preserve, individually register and mate breeds. In addition the hobby of breeding ancient breeds has to be popularized in areas where herds can be put on common pastures in summer and can spend winter around houses surrounded by large sites.

The tastier mutton of local breeds has also to be popularized to increase its demand which would lead to higher purchase prices of animals for breeding and for slaughter.

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### **FUTURE PROSPECTS ON THE USE OF POLISH NATIVE SHEEP BREEDS**

S. Zalewska, S. Jankowski 1/ and M.J. Radomska 2/

Several native breeds of sheep could be distinguished in Poland before World War II. The most important among them were the following:

- |           |   |   |
|-----------|---|---|
| Zackel    | - | white and dark varieties - in the Carpathian mountains in the south of Poland |
| Fagas     | - | along the Baltic Sea shore  |
| Karnówka  | - | central northern part of Poland   |
| Krukówka  | - | south eastern part of Poland  |
| Swiniarka | - | central part of Poland  |
| Wrzosówka |   |   |

Most of these local breeds were described in the outstanding book of M.L. Ryder, "Sheep and Man" (1983).

These native breeds were either improved later by means of crossing with cultural European breeds or they completely disappeared. However the sole native breed which now exists was recently conserved as a gene resource, viz. the Wrzosowka or Polish Heath sheep. This is a very old native breed of small, grey fleeced sheep, once forming a numerous population which is very well adapted to the extensive system of feeding and management. It expanded over into the north-eastern territories of Poland within her former borders.

In the late 1920s, in the centre of this region, the Polish Government established an experimental station in Swiskocz (actually in Belorussian SSR) with the main task of studying the local native breeds of farm animals. The present authors are fortunate in being able to compare the actual data on performance of the Wrzosówka sheep with the report on this breed by Czaja (1937), who was director of the experimental station in Swislocz at the time.

The situation changed during World War II, but we still have within our borders a large strip of land formerly occupied by the Wrzosówka breed.

In the 1950s and 1960s the Wrzosówka population rapidly decreased in favour of more productive breeds of sheep. In 1970 it was nearly extinct, at which point the conservation programme started. At present (1986) we have about 1000 breeding ewes registered in the Wrzosówka flock book and several hundreds in commercial flocks of this breed. The breeding scheme adopted is based on a model elaborated in New Zealand: 1 nuclear flock and 10 affiliated flocks, introducing rams from the nucleus and sending some replacement ewes there.

The Wrzosówka fleece is a coarse one, consisting of numerous and rather long down fibres supported from inside by comparatively short, stiff, medullated hairs. The fleece as a whole is downy. the skins are thin, light and show a good tensile strength. A short tail is characteristic for Wrzosówka sheep. This trait together with the

type of fleece and body conformation are important indicators of the mouflon origin of the breed, which is usually classified as belonging to the North European, short-tailed group of sheep. As such it is a close relative of the Romanov breed, but there are apparent differences: it is smaller, its body is more compact and its nutrient requirements are by far lower. A very important trait of the Wrzosówka breed is its good reproductive performance level (see Table 1). Its breeding season extends nearly all the year round First matings of ewe lambs can be successfully done at the age of 8 months. Average litter size in adult ewes ranges up to 1.75-1.82. Good results were obtained with Wrzosówka ewes in a frequent lambing system (see Table 2).

Wrzosówka sheep can be kept in pure-bred flocks, especially in areas where extensive, poor grazing on light sandy soils is available. Its wool can be best utilized for hand-made folklore type carpets. Its skin is an excellent material for making coats, which are light and well insulated from the cold.

**Table 1** PERFORMANCE LEVEL OF POLISH HEATH OR WRZOSOWKA SHEEP  
In once per year lambing system  
(according to Zelewska *et al.* 1985)

Age group of ewes	Total number of ewes put to ram	Lambing period	Fecundity %	Litter size at birth	Number of lambs weaned	
					per 100 lambs born	per 100 ewes put to ram
Ewes over 1 year old (mixed age)	1 541	Jan-Mar	84.2	1.71	91.2	131.0
		July-Aug				
		Nov-Dec				
		1975-80				
Ewes over 1 year old (mixed age)		Jan-Mar 1981	92.5	1.50	89.0	123.8
		Feb-Mar 1982	90.6	1.38	92.0	115.3
Average			86.0	1.64	90.9	128.5
Ewe lambs bred when 8 mths old	57	Jan-Feb 1983	93.0	1.36	90.3	114.0
	43	Feb-Mar 1984	97.7	1.48	100.0	139.5
Average for ewe lambs			95.0	1.41	94.8	127.0

**Table 2 PERFORMANCE LEVEL OF POLISH HEATH OR WROZOSOWKA SHEEP**  
**In frequent lambing system**  
 (according to Zalewska *et al.*, 1985) Mixed age of ewes, all over 1 year old.

Lambing period	Interval between previous to present lambing	Total number of ewes put to ram	Fecundity %	Litter size at birth	Lambs weaned per 100 lambs born	Number of lambs weaned	
						per 100 ewes put to ram per one lambing	per 100 ewes put to ram per year
Nov-Dec 1982	9 months	173	87.3	1.46	93.7	119.7	159.6
Oct-Nov 1983	11 months	175	92.6	1.64	96.2	146.3	159.6
May-June 1984	7 months	161	93.8	1.82	95.4	154.0	264.0
Feb-Mar 1985	9 months	196	94.9	1.69	92.4	148.0	197.3
Average	9 months	92.2	1.65	93.1	142.0	189.3	

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## OLKUSKA SHEEP - A HIGHLY PROLIFIC POLISH SHEEP

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In the region of Olkusz a local type of sheep is known for high litter size (triplets and quadruplets). It has never been acknowledged as a breed but is known as the Olkuska sheep. At present the old type of Olkuska sheep is endangered as a result of crossing with rams of different breeds, e.g. Romney Marsh. Compared to 10 000 Olkuska sheep in 1960 the number of today is estimated at no more than 200. It can be found on small private farms, usually numbering from one to five. Ewe lambs are mated for the first time at the age of 10 months. Ram lambs as well as part of the ewe lambs from multiple litters are slaughtered for their skins in the autumn.

For several years studies have been conducted by the Department of Animal Genetics and Breeding, Agricultural University, Krakow, on the old type of Olkuska sheep in the "Domana" flock of about 50 ewes, owned by W. Grabowski, graduate of the Agricultural University. Observations show that the Olkuska ewes attain a body weight of about 60 kg, display high litter size (Table 1), good milking performance and mothering ability. It is exemplified by the ewe "Greta", which up to the age of 7 years gave birth to 28 lambs, including 26 weaned, and by the ewes "Kaledonia" (Table 2). Studies are also carried out by the Institute of Animal Genetics and Animal Breeding, Polish Academy of Science, on inheritance of high litter size (Olkuska rams are crossed with Merino ewes). The F<sub>1</sub> ewes aged one year have shown high fecundity, unusual in Merino (Table 3). We consider that the Olkuska sheep is suitable for developing synthetic fertility lines.

The need to preserve the genetic material of Olkuska sheep should be officially recognized otherwise it will be completely lost since it is a sheep typical of small private farms which with time is becoming less and less numerous.

**Table 1** PEDIGREE OF SIRE KORLEONE FROM DOMANA FLOCK

♂KORLEONE														
♂Tobiasz						♀Brahma		3x3						
♂Babinicz				♀Tenka		3		♂Alik			♀Babka 4			
♂Alik		♀Babka 4		♂Alik		♀Szatana 4		♂Graca		♀Asia 5		♂NN	♀NN	
♂Graca	♀Asia 5	♂NN	♀NN	♂Graca	♀Asia 5	♂NN	♀NN	♂NN	♀Greta 6	♂NN	♀NN			

Maximum number of lambs in a litter born by each ewe is evident.

**Table 2** REPRODUCTIVE PERFORMANCE OF EWE KALEDONIA BORN IN 1982

Year	Successive lambing	No. ♂	of ♀	lambs Total	Litter weight (kg)	Body weight and sex of the smallest lamb (kg)
1983	I	1	-	1	-	-

1984	II	1	2	3	11.90	3.65
1985	III	1	1	3	16.95	4.75
1986	IV	1	2	4	16.55	3.45

In 1984 body weight of ewe Kaledonia was 63 kg.

**Table 3** FECUNDITY OF EWES (F<sub>1</sub>) OBTAINED BY CROSSING OLKUSKA RAMS WITH MERINO EWES

Ram	Daughters No.	Mean litter size $\bar{X}$	Litters with triplets No.
Tobiasz	9	1.60	1
Godymin	5	1.40	1
Babinicz	7	1.30	-
Graca	9	1.77	-

Notice: age at first lambing - 1 year.

### UTILIZATION OF EQUINES MAINTAINED AS A GENETIC RESERVE IN AGRICULTURE, TRANSPORTATION, MEAT PRODUCTION, SPORTS AND OTHER ACTIVITIES

E. Rossier 1/, B. Langlois 2/ and A. Audiot 3/

France as well as European countries have kept and still keep an outstanding wealth of equine genetics formed by centuries of service to man especially for traction or transportation. The progressive suppression of these uses since the beginning of the 20th century has caused a decline in some of them, and an increase in others, and in all cases, it has caused deep mutations of the equine population, involving threats upon this wealth. What are the prospects for exploiting equine breeds as genetic reserves?

#### 1. PRESENT MUTATIONS OF EQUINE PRODUCTION

A close look at world stocks over the last 30 years shows a drop of about 17 percent in horse numbers (FAO, 1985). This downward movement is gradual compared to France over the same period: 85 percent (Rossier *et al.*, 1984) In compensation, during the same period, an increase of about 14 percent of the number of small equidae (donkeys and mules, Table 1) can be observed, especially in developing countries. The main reason for these movements which have slowed down in recent years, is the intensive mechanization of agriculture and transportation.

**Table 1 EVOLUTION OF THE NUMBER OF HORSES AND SMALL EQUIDAE IN THE WORLD FROM 1950 TO 1984**  
(‘000 head)

Year	Horses	Small equidae (donkeys and mules)
1950	79.7	48.4
1960	67.2	54.9
1965	67.0	55.8
1970	66.8	57.2
1975	65.8	55.7
1980	61.0	54.0
1984	63.9	55.2
Evolution 1950-84 (%)	-19.8	+ 14.0

Source: FAO, 1985.

In developed countries, the present large decrease in equine production must be analysed more accurately. In fact, two opposite trends are noticeable: a slow but steady increase of racing, sport and pleasure horses but not enough to compensate the rapid disappearance of draught horses, threatened with extinction. Therefore, husbandry is more oriented toward pleasure activities than to food production (horse or small equine meat), and more rarely toward keeping some for draught purposes. This is verified in most of the western and northern European countries (Bjarnason 1973; Graaf; Hulsbergen, 1984; Jansson, 1984; Leuenberger, 1984; Rasmussen, 1974; Stelzer, 1973).

Of course, the situation varies with the country: United Kingdom or Germany have almost no draught horses left; in France, these breeds still form almost half of the population (Boue and Rossier, 1979; Bour and Rossier, 1982; Rossier, 1985). The number of small equidae is particularly high in southern Europe: Greece, Italy and Spain (Zafrakas, 1985; Gougoud, 1984); they are almost inexistent in northern countries. Can this be explained by the movements of both horses and donkeys throughout history? Horses would have touched northern Europe through Asia, while the donkey, probably from Nubia, had two routes, one to southern Europe, the other to northern Africa, spreading across the Middle East and the Mediterranean (Poplin, 1985).

We can therefore see a development of highly specialized racing breeds, strong consumers of feed and needing much equipment and various infrastructures, such as the Thoroughbred for flat racing or the trotting breeds for trotting races. In the same way some special lines of saddle horses for jumping, three-day events, dressage or driving have progressively been established. On the other hand, the old specialized draught breeds are changing, at least in France, Belgium and Netherlands, to produce meat. Finally, strong development of pony breeds has been observed.

Deep changes, both structural and geographic have occurred in the populations of these countries, in the composition of stocks and in their uses. With time these changes tend to make these species marginal, compared with the main objective of animal production (Rossier, 1985). This is, without any doubt, one of the difficulties in saving these breeds.

In developing countries, mechanization, even if well introduced, still leaves a large place to animal traction (Rossier, 1984b). This probably explains the increase of the world stock of donkeys and mules (Audiot, 1982).

Rustic animals, with small maintenance needs, seem particularly well suited in this case. Thus, we note the use of local breeds, which can utilize profitably with low costs, local natural resources.

Equine production in the world and in particular in Europe, is therefore tending to develop:

- in rich areas, toward an elaborate adaptation to pleasure activities, with a steady diversification;
- and in poorer areas, towards rustic animals, able to utilize roughage and scarce feed, which would otherwise be unused.

## **2. PROBLEMS TO PRESERVE EQUINE GENETIC MATERIAL**

The changes undergone by our societies which are mentioned above and which are sometimes extremely rapid, endanger many potentials (such as the genetic types of domestic animals) often heavily and sometimes irrevocably. In general it is not known if there will be a need for them in the future.

In fact the current difficulties in marketing some products, in particular in Europe and EEC with 12 members, and the new constraints they dictate in connection with world markets, cause the emergence of new production systems which may be more economical than during past decades. These systems are not yet very well known, and we should treat our animal genetic material with great care.

The evolution of animal product demand arising from new knowledge in dietetics, the increase in the standard of living, new fashions, more quality requirements, the need to reduce production costs and from environmental changes, strongly encourage the fight against the loss of genes (Maijala, 1970). We must try to conciliate the imperative needs of the present and the possible needs of the future, i.e. in operating and selecting the animal populations in the current economic context, we must preserve their genetic resources and their capacity for future evolution (Vissac, 1972).

In the equine breeds, we are becoming increasingly aware of these problems in relation to the very different uses of these breeds. Some preservation measures are created, such as museums, animals and documentation collections, natural reservations, national and regional parks. Numerous documentation coming from old manuals, local papers, postcards, interviews, calendars, fairs or travel reports, etc., enable the collection of traditional knowledge, but do not always ensure the preservation of the breeds themselves (Society of Ethnozootechny, 1982).

These preservation measures, in some breeds with populations from one to ten head, can even include the freezing of semen of remaining stallions (Bodó and Pataki, 1984), such as of the Dutch breeds, Groningen or Gelderland (Buis, 1984). In France, an "Office of Genetic Resources" has been created in the Department of Research, to coordinate action in this field.

As an illustration, the existence should be mentioned of Poitou donkeys in the zoo of the "Museum d'Histoire naturelle" as well as the creation of a state "donkeyhouse" by the Regional Natural Park of the Marais Poitevin, to restore quality stock by continuous crossbreeding.

The difficulty of these actions is however more often in their mode of financing, in addition to the human factor. Our economies essentially aim at profitable investments and the long-range is never more than 5 years. It seems that the general increase of people's availability for activities other than directly productive (development of the tertiary sector involving state incentives, civilization generally qualified as a "leisure civilization" allowing the development of new activities) can bring solutions and help conservation. In the horse more than in other species, the preservation of the old and even current genetic types is closely dependent on maintaining their specific utilization and breeding techniques.

The horse is the domestic species showing the biggest polymorphism in development (adult weight ranging from 1 to more than 10), in capacity (draught horses, pack horses, gallopers, trotters, jumpers and walkers) (Langlois, 1973) and above all in adaptation to the most varying and difficult natural environments. This variability which man has used in different ways in various epochs, has been preserved almost undamaged until today by the multiplicity of uses for leisure of the horse. It enabled some breeds to escape the death threat which struck them all in the 1950s.

However, preservation problems arise from local breeds threatened by absorption by some higher performing genetic types, but essentially for specialized breeds whose traditional market has disappeared.

The disappearance of local breeds which were numerous during the 19th century (such as the pony of Corsica, France mentioned by Tertrais, 1982) is a classic feature. It is not specific to the horse and does not always correspond with a loss of potentiality. It is not possible to keep everything, and some choices are necessary.

Conservation or promotion of local varieties is most often only justified by their adaptation to particular and difficult breeding conditions. For instance:

- The French horse of Merens: found in the wild and isolated mountains of Ariège (Pyrenees), protected by people strongly attached to tradition. It has its homogeneity, which is a zootechnical curiosity, because mating occurs freely in the range (Prunet, 1956; Thevenin, 1982).
- The Pottock: perpetuated by the maintenance of a very old method of environmental management, used in the wild hills of the Pays Basque and considered by the regional farmers as a standard part of their economic system, a product to be harvested (Lizet, 1976, 1983). The same situation occurs across the border, in Aragon (Spain) and for the Asturian and Galician ponies.
- The breeds of native horses and ponies in Greece; as for instance the ponies from Skyros, Pindos, Peneia, or from Kefalonia island (Menegatos, 1985a and b).
- Some particularly rustic pony breeds from the United Kingdom: Exmoor, Dartmoor, New Forest, Highland, etc. (Boue and Rossier, 1979) or from other countries: Iceland, Norway (Fjord) and Germany (Dulmen).

In these conditions, even if submitted to crossbreeding with improved breeds, they are most often preserved by themselves. A good example is the Corsican horse through breeding traditions adapted to the hard and frugal environment (essentially based on two principles "freedom" and "no human intervention on the territory"), they survived by progressive and continued elimination of the so-called "improving" genes which were not compatible with breeding methods (Tertrais, 1982; Audiot and Flamant, 1982). The Corsican horses, submitted to a harvest system, must find their feed in winter in a vegetation where only the cellulose-rich parts remain.

The crossbred products, which are more demanding, must be bred more carefully otherwise they develop badly and are quickly eliminated. The conservation of local varieties depends much more on biotope preservation and breeding methods than on the conservation of the animals themselves (Audiot and Flamant, 1982). The breed of Camargue in southern France is also a good example of this situation: the homogeneity of the type is preserved by natural selection, despite the various choices made in every "manade" (herd) by the breeders (Langlois, 1977).

The initiation of horse husbandry in hilly areas, in often very simple maintenance conditions, should promote some genetic types well suited to this environment. The recent development of draught horse breeds of Breton-type or Comtois-type in the mountains of southern France is an outstanding example of the convergence between an animal production objective (contributing to the protection of a threatened patrimony by finding another end purpose and low cost breeding methods) and the utilization of difficult areas, which are becoming increasingly deserted and damaged. The horse appeared as a very good instrument to utilize and manage land

areas (Coleou and Rossier, 1986). Otherwise, breeding methods must be improved; this is only possible if economic conditions exist. As for the pony breeds, the appearance of an interesting market, through youth riding, has led breeders to put more care in their husbandry. This enables them to use improved breeding stock and to increase the quality of their production. However, this trend does not lead to the disappearance of the rustic types, constituting the biggest part of these populations but permits more value to be obtained from more economical animals, with less obvious but more varied performances, well suited to the taste of the public as useful and durable products.

On the contrary although traditional markets have not completely disappeared for draught horses, they have decreased so strongly that the breeds concerned are threatened with disappearance (Bougler *et al.*, 1983). The classical symptoms of the dangers threatening the breed's with small populations are appearing: dissemination of the population, inbreeding, genetic drift, disappearance of coordination structures and advanced age of the remaining breeders. This is proved by recent studies made on some French breeds of draught horses: (Breton: Treguer, 1980; Comtois: Guillon-Dubeuf, 1981; Cob: Gorioux, 1982; Boulonnais: Rossier *et al.*, 1983) or foreign breeds (Danish breed of draught horses from Jutland: Johansen, 1984):

The average number of mares per farm does not exceed two in each case.

According to the authors, the average coefficients of inbreeding, in general still low except for the Boulonnais (Table 2), have increased during recent years. This situation is especially disturbing as the highest coefficients are shown by the youngest animals. The situation is the same for the "Baudet du Poitou": Audiot (1977) computed an average inbreeding coefficient of 1.5 percent. The case of the Danish Jutland breed is still more serious with an average coefficient of 14.2 percent (Johansen, 1984).

**Table 2 AVERAGE COEFFICIENTS OF INBREEDING OF VARIOUS BREEDS OF FRENCH DRAUGHT HORSES**

Breed	% of inbreeding	Author
Breton	0.7	Treguer, 1980
Cob	0.4	Gorioux, 1982
Comtois	1.2	Guillon-Dubeuf, 1981
Boulonnais	4.6	Rossier <i>et al.</i> , 1983
Bandet du Poitou	1.5	Audiot, 1977

The breeders are on average older than the breeders of any other animal species. In UK 85 percent of the breeders are more than 40 years old, the average being 50.2 years old; 77 percent of the Comtois horse breeders are more than 40 years old. Among the Boulonnais breeders, almost 80 percent are more than 45 years old. The succession of the oldest is not always ensured.

This could be stopped only by a strong increase in draught horse production for meat (see below), and/or by the appearance of a "leisure" husbandry, carried out by amateurs attracted by the originality and rarity of these animals. These are other ways of utilization. Some preservation associations, more or less regional, can be created, state or private funds can be collected, new activities can be promoted or old activities can be reorganized (driving, ploughing, breeding shows, draught horse races as in numerous foreign countries: USA, Canada, Japan, Germany, UK, etc.). Such races are now organized in France, on the Japanese racing model.

But often, the type of breeder is changed. In these new uses and in the production of milk, hormones or serum, the true problems come from the coexistence between traditional and amateur breeders. The conservation of the breeds does not have the same meaning for both.

### **3. DRAUGHT HORSES: AN EXAMPLE OF THE CHANGE-OVER FROM AN ANIMAL FOR SERVICE TO ANIMAL FOR PRODUCTION**

#### 3.1 The Consumption of Horse Meat - An Opportunity to Retain Tradition

The consumption of horse meat offers an additional market for the heavy breeds. Moreover it offers the opportunity to utilize rustic breeds as a part of territorial planning, and particularly in the planning of marginal areas (Langlois, 1980; Audiot and Flamant, 1982). The case of France is representative: it is a traditional horse meat consumer, and has therefore kept a large population of heavy horses. Thus, France will be taken as an example, although in the EEC, Belgium, Luxembourg, Denmark, Italy and Spain are also consumers, as well as some other European (Switzerland and Sweden) and eastern countries.

The high consumption of horse meat evolved in France at the end of the 19th century, among the lower classes, such as workers and employees. This meat was considered healthy, tender tonifying, low in fat, red and cheap. It was widely consumed in families with children. Most of these remarks are still true, except perhaps regarding price.

Today, the situation has slightly altered. Retail prices have considerably risen and tend to be equal or above the prices of beef meat. French production cannot supply red meat, except for slaughtered blood horses: production is orientated toward the production of young animals with white meat (6-8 months old) or especially pink to dark pink (foals of 10 to 24 months old) (Rossier, 1984a).

Horse meat still keeps a very good image, and its consumption progressed until around 1980, in part due to the better type and location of sales points; after that year, higher retail prices have discouraged buyers.

Horse meat consumption, under various forms (not only steaks or hamburgers, but also as a delicatessen), essentially depends on the efficiency of the delivery network. It is possible that some other countries might be encouraged by this trend, in particular if they want to better utilize their slaughtered blood horses.

Can this consumption really help to create a production system? This is a difficult question, but the description of the economic situation of this production in France can highlight some facts.

#### 3.2 Economic Situation of Horse Meat Production in France

France consumes around 70 000 tonnes (carcasses) per annum of horse meat, but they produce only 20 percent and import 80 percent.

Production, which was sufficient to meet French consumption in 1955 has continually decreased since this period with disappearance of animal traction. Currently, the relative part of slaughtered blood horses is increasing: 48 percent of national production. Draught horses, whose breeding stocks are now stabilized and are even increasing again, supply the remainder, either through slaughtering, or by specific foal meat production.

The deficit in production was first filled by imports of living animals from eastern countries. As the deficit worsened frozen meat from the USA appeared on the market. In 1984, out of 100 kg of consumed horse meat, 20 kg came from French horses, 19 kg from horses imported alive and slaughtered in France, and 61 kg from frozen meat.

Therefore, since 1972, and especially since 1979, action has been taken to reorient draught horse husbandry toward meat production: incentives to breed young mares, market clarification and organization, production

organization by producer groups, increase of prices at production, development of research and application of results in the field, especially in reproduction (control of cycles, better mare management, echography, pasture exposure, artificial insemination, etc.) But there was no desire of conservation in these measures: they only arose from the economic situation.

The most worrying problem remains the small number of our breeding stock, with the low fertility rate of this species which is the main restrictive factor for the organization of effective production.

Consumption of 70 000 tonnes represents 21 000 slaughtered horses with an average carcass weight of more than 330 kg. This corresponds to the production of around 420 000 mares or to the slaughter of 2 million horses approximately, used on average, for 7 to 8 years. This is much over the present capacity of France's equine stock and the need to import is clear. These compulsory imports do not encourage the progress of national production and had until a few years ago even caused a decline. However, this type of production has some valuable resources and it must develop them: nine breeds, which are a genetic patrimony unique in the world; some additional income possibilities if associated with another type of production utilization i.e. cattle; of misused or no longer used ranges and of unfavourable areas; important productivity gains; a possible export market for breeding stock; a potential power supply; and also a consumption market based on organoleptic and dietetic qualities of this meat.

It is evident that national production which supplies a white or light pink meat, must be clearly differentiated from the imported product (red meat from slaughtered animals). With a particular "label", promotion of the product, based on a policy of quality, becomes possible.

Two types of production can be distinguished:

- the traditional areas, so-called "berceaux de race" (cradle of the breed); all of them are located in northern France, in a relatively intensive farming environment;
- the so-called "production or multiplication areas", relatively recent, located in southern France and especially in the Massif Central, Pyrenees, the Alps and Jura mountains.

The first case includes the residue of draught husbandry; its evolution toward meat production requirements is necessarily slow. The costs are high and productivity is still low: draught stallions traditionally breed the mares in stations or in "breeding trucks"; land prices are high and horse production is in competition with other more profitable ventures. There is therefore little or no production payback, which implies reducing stock. This is only stopped by subsidies and by traditional selection means, such as breeding shows, considered as rural animation. In 1984, draught mare stock bred in these conditions was only about 18 000 head; the total registered breeding mares are around 40 000 head. Draught breeding, which still has a small market, especially for export, is supported by the Government and by a kind of leisure activity breeding shows; these have a place in the more general policy of rural animation. This type of production can be encouraged, if economic conditions are suitable, only by the development of intensive or semi-intensive fattening units for heavy foals.

On the other hand, in the mountainous areas of central or southern France, there has been a tendency in recent years to settle horses on little productive and increasingly deserted agricultural areas. In these conditions, the use of ranges together with cattle, leads to greatly reduced production costs. The herds are bigger and pasture lands can be better utilized. Animal size is, in general, smaller than in the "berceaux de race", and in some valleys of the Pyrenees, it can even be of pony size. the stallions used are of a semi-heavy type: they are almost exclusively Bretons, Comtois, or Ardennais. The attempts to introduce larger-sized breeds such as Percheron or Boulonnais, do not seem to be successful. Breeding conditions, often very primitive, are without any doubt at the origin of this failure.

### 3.3 Future Prospects and Possibilities of Action

As can be seen, the existence of an important market for horse meat, that could justify the production of around 300 000 horses a year (current total horse population in France), will delay, but cannot stop the progressive disappearance of draught breeds.

However, the combination of draught horse breeding with mountain agriculture, has, without doubt, been a wise choice; this is proved by the sometimes explosive increase in this type of husbandry in some areas. But this development cannot balance the loss registered in the "berceaux de race" .

If this deficit is to be stabilized, either we have to decrease consumption, which could risk destabilizing the whole sector, or we have to increase all breeds of breeding stock.

Whatever the proportion between blood mares and draught mares, a way must be found to produce these 60 000 horses per year, if only to maintain the current production level. In 1984, there were approximately 50 000 blood mares and 40 000 draught mares, or a total of 90 000 breeding mares. They will produce only 43 000 to 48 000 foals. In these conditions, our meat deficit can only increase. Therefore, our objective is to stabilize at an annual production of 45 000 foals, or around 15 000 tons of meat, and a self-sufficiency rate of 20 percent. Every breeding mare, whatever the breed, will have to be kept.

The racing sector does not show a visible increase in breeding mare numbers. The momentary increase of trotter mares balances the decrease of Thoroughbred mares, and their production, for the main part, is flowing into the pleasure sector. This field has, for some years, increased considerably. Will this expansion balance the regularly registered losses of the draught mare breeding stock in the "berceaux de race"? Will the rise of draught horse production in the production areas continue? The achievement of the previous objective will depend on this factor.

### 3. 4 Possible Action

The conservation of draught horse stocks starts with a market organization which protects the producers from uncontrolled fluctuations in production price. Otherwise, the draught breeds will disappear from France, as well as from other European countries with only residual populations, in general less than 5 percent of the total.

If this economic plan continues and strengthens meat production could be considered from draught breeds in both existing breeding situations: "berceaux de race" and production areas.

a. In the "berceaux de race" two types of action are taken: to conserve and to promote.

As a conservation activity the continuance of the breeding shows can be mentioned and traditional breeders are strongly attached to them. This social and historical aspect is very important and should not be forgotten. Servicing in "breeding trucks" has been developed and financed to breed mares which are becoming increasingly scattered in country areas. Less and less mares are bred per stallion, but the latter are kept in service to avoid reducing the remaining mares, by their disappearance. Stallions are changed frequently enough, giving this type of production an additional market for its stallions. Traditional husbandry structures are maintained through this commercial stallion channel.

In about 1961, some attempts were made to stimulate horse traction; they resulted in new equipment (AVTRAC) which was more competitive than the old type and was sometimes fitted with auxiliary motors. At this time, however, these attempts failed. Today, with energy savings, the concept of the horse as a supplier of energy is not completely Utopian: the use of horse traction is expanding again in some farms and for some functions.

However, the genetic situation of French draught horse husbandry in these areas is still alarming, even though a small increase of breeding mare stocks is noted. Programmes for genetic management should be set up as soon as possible for some breeds at least to limit the effects of inbreeding and genetic drift. Stud books need to be

reorganized and their structures and rules renovated to equip them with the necessary means for a successful genetic policy. The most important step has been the setting up of a unique identification procedure for all animals and a unique production information channel (Bougler *et al.*, 1983). This unique identification procedure is not operational in France.

As a promotional activity, the incentive of setting up intensive or semi-intensive fattening units and the development of better techniques in meat production can be mentioned. Some experiments are undertaken to improve stock productivity: artificial insemination, protocol of compensatory breeding for the mares found not pregnant (by echography) at the end of July, and experiments for growth and sexual control of draught stallions (in testing stations). Some advertising is made in foreign countries to export these breeding horses.

b. In the production areas, it has been recommended to settle the horse again in some underused grazing areas. As a complement to cattle, this action is justified in pasture utilization and in breeder income, independent of its own return.

In these conditions, the horse does not rival cattle. On the contrary, it enables the recovery with low costs, of some deserted pastures. Maintenance costs during winter seem the only constraint to its development. In this system, when the horse does not cost, it pays back; but then, it must be able to resist rigid environmental conditions. If the animals are not well suited to regional production conditions, there is a great risk that bad foals for meat and bad horses for riding will be produced. The development of local breeds which have disappeared since the 19th century can constitute an important organizational factor in this type of husbandry from the technical as well as the commercial aspects. In addition, the definition of various regional policies would be useful, because of the uncertainty of future production. Several ways are possible depending on the areas and the evolution of the economic situation follows:

1. Heavy foal prices at production will be increased and stabilized: this action would then tend to create important "closed herds", to improve technical control of pasture use and to try to extend these pastures to permanent "open herds", for instance in breeding stations. As far as feeding and breeding techniques are concerned the most suitable levels and periods of optimal supplementation in a system are usually sought which require the least investment. In the genetic field, the typing of our draught breed characteristics leads to the improved use of the variability between genetic types in crossbreeding. The definition of "sire breed" (growth potential, meat ability) and "dam breed" traits (size, milk ability, rusticity) becomes more important (Langlois, 1984).
2. Prices at production cannot be stabilized: draught horse husbandry will be retained only if it is impossible to replace it by type of production which is sometimes the case. Then, the promotion of rustic types, clearly defined by region, can be considered. Some mixed solutions, "meat-saddle" are even possible but in this case regional mare breeding stocks must be defined, organized and homogenized and both potentialities (cob type) must be preserved. Some other radical solution, such as the use of mares, can also be studied based on the model of Jersey cows crossed with Charolais bulls. There would appear to be some important and unexplored potentialities in horses, although these have been well known for a long time.
3. If heavy foal production completely disappears, the only way to produce a minimum of meat would be through the strong promotion of pleasure riding in all its forms by a policy of crossbreeding with any kind of French horse. To reduce our deficit, it is better to import horses to breed them, rather than just to consume them. A coordinated import policy of rustic breeding mares should be considered.

#### 4. CONCLUSIONS

Perhaps in this paper, we have given more emphasis to the draught production for meat. However it is a good illustration of utilizing a small horse population.

The extraordinary diversity of existing breeds has been noted as well as the large variety of possible uses, for agriculture, meat production or leisure activities. Without doubt, this wide variety, in addition to an excellent adaptation to hard environments, has enabled the continuance of all these horse breeds up to the present time.

Today, choices need to be made and perhaps we are better armed to make them. However, the human factor might be the most difficult problem to solve.

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**FUTURE USE OF THE POLISH NATIVE BREED, KONIK POLSKI, AS A  
DRAUGHT HORSE IN AGRICULTURE AND AS A RIDING HORSE  
FOR SPORT AND RECREATION**

Tadeusz Jezierski 1/

The Polish Primitive Horse (Konik) derives from the Tarman wild horses which inhabited Eastern Europe in the Middle Ages. In the 18th century the wild horses in Poland were already becoming rare and valuable animals and received special protection in zoological gardens belonging to wealthy people. At that time the Tarpans were considered unsuitable for any kind of work because of their inherited wildness. Due to their wildness and courage the Tarpans were sometimes used in show-fights with predators. Some of the wild Tarpans were brought into a private zoological garden near Bilgoraj belonging to the Count Zamojski. At the beginning of the 19th century the horses, which had so far lived free in that garden, were captured and distributed among the peasants of the neighbouring villages and were tamed and crossbred with the local mouse-grey peasant ponies, though a considerable number of them retained the pure blood of their wild ancestors. The Bilgoraj region was poor and backward, isolated from other parts of the country, thus the type of primitive horse originating from the old wild horse survived until the 20th century. They were 110-130 cm tall, mouse-coloured with a dark dorsal streak, highly resistant to severe environmental conditions and able to find their feed in forests, wasteland and marshes.

For a long time no interest had been given to these small and primitive horses - descendants of the wild Tarpans. In 1914 Grabowski and Schuch described primitive horses from the Bilgoraj environs. Since then many horse breeders under the guidance of Prof. Vetulani began to take interest in primitive horses and to rescue them from extinction. In the inter-war period Prof. Vetulani bought from the peasants in the Bilgoraj environs most of the typical primitive horses and placed them in a forest reserve at Bialowieza in order to breed them back to their wild state. In addition, some studs of Polish Primitive horses, which Vetulani named "Konik", were established.

At present there are five state farms which breed the on the Konik (Table 1). The population of the Konik in state farms has increased during the last few years, but the situation in private breeds is less optimistic. Although there are about 100 breeding mares in private hands, the breeding material is dispersed and practically out of control.

The measurements of the Konik are given in Table 2. According to Kownacki (1963) the height of the Konik has not changed much since. 1920. On the other hand, the forechest girth, cannon girth as well as the body weight have considerably increased mostly due to better feeding. The Konik are characterized by an excellent ability to adapt themselves to local environmental conditions, utilize cheap feeds very well and resist difficult weather conditions. Young Konik horses are able to compensate for slow growth caused by insufficient feeding in some periods. In the subsequent more favourable period their growth is accelerated. Having small feed

requirements, the Konik do not tolerate intensive concentrate feeding. They display behavioural traits such as distinctly marked social hierarchy, vitality and cleverness which are characteristic of primitive breeds of animals. Excellent physiological characters of the Konik strong constitution, good health, fertility, long life cycle and hardiness make them especially suitable for keeping outdoors.

Table 1 POLISH PRIMITIVE HORSE (KONIK) AT STATE STUDS AND FARMS (1985)

Stud or Farm	Number of Stallions	Number of Mares
Polish Academy of Sciences		
Experimental Station (reserve)	3	14
Popielno (Suwalki province) (stable)	6	12
State Stud		
Racot (Leszno province)	4	34
State Stud		
Sierakow (Poznan province)	4	26
State Farm		
Dobrzyniewo (Pila province)	3	15
Roztoczanski National Park		
Zwierzyniec (Zamosc province)	3	5
Bialowieski National Park		
Bialowieza (Bialystok province)	1	4
Total breeding material	24	110

Table 2 BIOMETRIC MEASUREMENTS OF THE KONIK (according to Kownacki, 1984)

Measurement (cm)	Stallions		Mares	
	x	(min-max)	x	(min-max)
Height at withers	136.3	(134-140)	134.2	(127-144)
Height at sacrum	140.3	(135-144)	137.1	(131-146)
Trunk length	139.5	(132-155)	147.1	(141-153)
Chest girth	182.5	(174-190)	170.5	(160-180)
Chest depth	65.7	(63-67)	64.9	(57-76)
Chest width	44.0	(41-47)	38.5	(35-44)
Foreleg length	70.7	(68-73)	69.3	(62-75)
Cannon girth	19.1	(18-20)	17.5	(16-19)
Width of hips	50.0	(46-54)	49.3	(44-52)
Length of head	56.2	(52-61)	53.5	(50-59)
Body weight (kg)	420.0		450.0	

The ability of the Konik as a working horse should however be supported by systematic performance tests and selection. Unfortunately, so far, performance of the Konik horses, especially those from state farms, has tended to decrease in recent years. At state farms the horses are first of all selected for body conformation and not for working ability. It is an undesirable tendency because the Konik can lose its remarkable hardiness and endurance as an economic working horse.

Table 3 RESULTS OF VARIOUS PERFORMANCE TESTS OF THE KONIK

		Long-distance draught trials					
Author and year	Total distance (km)	Mean distance per 1 day (km)	Maximal distance per 1 day (km)	Mean speed (km/h)	Weight of carriage (kg)		
Vetulani, 1928	576	43.6		6.83	610		
Zwolinski, 1968	1 000	48.0	62.0	5.20	840		
		Draught per format tests					
		Maximal draught power in % of body weight		Mean time for 1 km (in min and sec)		Mean length of steps (cm)	
		Stallions	Mares	Walk	Trot	Walk	Trot
Vetulani, 1951		83.6	86.6	10'04"	4'03"		
Zwolinski, 1953		79.2	86.2	11'31"	4'27"		
Kownacki, 1962 <a href="#">a)</a>			64.8	11'32"	3'49"	137	232
Kownacki, 1962 <a href="#">b)</a>			65.2	9'54"	3'51"	150	258
Kapron and Soltys, 1983			47.3	12'05"	4'28"	132	222

a) Popielno Stud

b) Stubno Stud

During the last two years an attempt has been made to establish systematic training and draught performance tests for young stallions breeding mares should undergo in future a proper performance test before they are included into the stud. In 1982 and 1983 experimental saddle horse training of Konik stallions was conducted. The Konik have never been selected or intensively used for riding. Their body conformation i.e. poorly marked withers, short and straight shoulders as well as a' short gait, strong social instinct and sometimes stubbornness are not desirable in riding. Saddle-horse training has revealed however, that the riding ability of the Konik can be improved. Some riding performances of the Konik are given in Table 4.

Table 4 SOME RIDING PERFORMANCES OF THE KONIK

One-hour distance in walk	6 496 m
One-hour distance in alternate gaits:	
5 x (8 min walk + 3 min trot + min canter)	12 200 m
5 x (9 min walk + 3 min trot)	8 000 m
Maximal speed in canter	666 m/min
Mean speed on a distance of 20 km	8.2 km/h
Mean time for 10 km	1 hr 20 min
Mean time for 30 km	4 hr 20 min
Free jump	130-140 cm
Jump with ballast 13-15% of body weight	115 cm
Ballast allowed for cross-country riding (in % of body weight of horse)	23%

At present the state farms have no difficulty in selling young Konik horses. According to an enquiry published in agricultural periodicals, 191 private breeders, 18 agricultural schools and 14 riding clubs are interested in buying the Konik. The demand for the Konik was estimated at approximately 506 animals. Since not all potential buyers have responded to the enquiry, this figure seems to be underestimated. The state farms can offer for sale about 30 mares and 30 geldings a year, i.e. far below the demand. Most of the buyers intend to use the Konik for two or three purposes (Table 5).

**Table 5 PLANNED USE OF THE KONIK BY BUYERS**  
(according to Sasimowski et al. 1984)

	Purpose	Horse breeders		Horse users	
		Number	Percent	Number	Percent
Private buyers	Work in the field	108	81.2	19	90.5
	Transport	94	70.7	19	90.5
	Horticulture	19	14.3	3	14.3
	Riding	49	36.8	4	19.0
	Other use	20	15.0	2	9.5
Experimental farms of agricultural schools	Work in the field	5	55.6	2	20.0
	Transport	2	22.2	2	20.0
	Horticulture	3	33.2	5	50.0
	Riding	2	22.2	-	-
	Other use	1	11.1	-	-

So far the Konik has not been intensively used for crossing with other breeds to transmit their outstanding qualities. Some crosses were made with pure-bred Arabian and Anglo-Arabian horses. Crosses with Anglo-Arabian are good saddle horses for recreation. Crosses of the Konik with heavy draught breeds, suitable for harder work, are needed by the farmers.

The Konik stallions were also exported to countries of Western Europe. Among others, some Konik stallions were bought by Herzog von Croy for his herd of primitively-kept wild horses in Dulmen (Federal Republic of Germany).

In conclusion it can be stated that the Konik is a native breed of small-sized working horses suitable for small farms. It can be also used for carriage, sport, recreation and distance riding.

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### PROSPECTS OF UTILIZING HUCUL HORSES IN AGRICULTURE, SPORT AND RECREATION

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The Hucul horse holds a special place in Poland. In April 1979 a resolution was passed by the Horse Husbandry Team of the Research and Technical Council, supervised by the Minister of Agriculture, on preserving the Hucul horse together with its valuable genetic traits which have been handed down over many generations and are typical of this breed.

The Hucul horse of today is characterized, among others, by its relatively large head, low-set neck of middle length, long, wide and deep thorax as well as short and strong legs. It has a remarkable uniformity in build, is highly active, of extreme docility and longevity, has a perfect feed utilization, is easy to house and resists diseases.

The Hucul horses are by no means big animals. Their dimensions are within the following range:

Table 1 MEASUREMENTS OF HUCUL HORSES

	$\bar{x}$	Min.	Max.	$\bar{x}$	Min.	Max.
Height at withers	137.5	133	142	137.0	130	145
Chest circumference	173.0	162	188	180.6	167	192
Cannon circumference	19.0	18	19.5	17.9	17	19

The Hucul horse originated in the Carpathian mountains. The rigid mountain conditions often forced the horses to cover long distances and the harsh environment with scarce feed has toughened them over many generations. Their descent is not fully elucidated in spite of great interest shown by many investigators.

According to Prawochenski, "as early as 1603 K. Dorohostajski, the author of "Horse-riding" knew the Hucul horse and considered it perfectly adapted to its existence as a mountain horse".

The first Polish scientist who emphasized the need to give particular attention to the Hucul breed, as being economically valuable, was Prof. Karol Malsburg (1895).

Since this breed has a long history, only some names of the most Prominent Polish hippologists can be mentioned, such as S. Bojanowski, E. Hackl, M. Herrmann, M. Hollander, Z. Sosnowski, T. Starzewski and K. Ostaszewski .

In the inter-war period much consideration was given to Hucul horse deeding. In 1925 the Association of Hucul Horse Breeders was established with E. Bohosiewicz, a noted breeder of the Malopolska district, as chairman.

At that time the Hucul breeding stock was purchased in Poland by Bulgaria, Czechoslovakia, Greece, Luxemburg, Germany and Hungary.

Following World War II Hucul horses were scarce due to heavy losses suffered during the war. And it is only thanks to the unselfish work of many people that the breeding of Hucul horses is now steadily developing. Mention should be made here of: Zdzislaw Hrobni, former chief of the Department at the Ministry of Agriculture; Eugeniusz Skucinski, former Inspector of the Polish Horse Breeders Association; and Kazimierz Gajewski, animal scientist in the Union of Animal Breeding and Trade.

At present the breeding of Hucul horses is located at:

1. Siary state stud farm near Gorlice, with 50 mares (dams) and young stock. Director: mgr Jan Barzyk.
2. Zootechnical Experimental Station of the Institute of Animal Science at Rymanów, with 10 mares (planned to be 20 mares). Director: dr Stanislaw Kolat.
3. Klikowa stallion depot near Tarnów, with 15 stallions. Director: mgr Adam Niedzialkowski.
4. Private breeders, members of the Polish Horse Breeders Association. The total number of the Hucul horse population amounts to 25 sires and 75 mares.

Pedigree horses are derived from 7 male and 11 female lines. Mean inbred index for mares is 0.014 (in the range 0.000-0.250) and for stallions 0.0127 (in the range 0.000-0.127). Mean inbred index for state mares and stallions is 0.1111.

In 1962 Miss Elisabeth Broad purchased 9 Hucul horses in Poland, which were then transported to the United Kingdom. They became acclimatized very easily and were then successfully crossed with English Thoroughbreds and purebred Arab horses. In the 1970s 3 stallions and 3 mares were sold to Finland.

Despite their low height, the ways of utilizing Hucul horses are manifold: as pack horses, saddle horses and draught horses. For long they have been used as pack horses displaying *an* ability to move in very rough field conditions. They are noted as being able to overcome carefully and quietly precipices or rapid streams as well as perfectly jumping over natural obstacles with innate agility.

Holländer found them useful as draught horses. Sasimowski *et al.* have shown in their studies an easy adaptability of the Hucul horse to supplement mechanical traction in field work. They established the normal pulling force for the mare to be 50.14 kg and for the stallion 56.84 kg. Studies on working ability and suitability of the Hucul horse to field work in the region of the Carpathian mountains in Poland were conducted by Krzysztof Bilil. His estimates of normal pulling force for horses were higher and amounted to 57.54 kg for mares and 61.6 kg for stallions. For many years horses were selected among others for their suitability as draught horses. An inquiry among horse breeders and individual users has revealed that the horses are greatly appreciated, being used for light work as a supplementary force to that of a tractor or being kept in large industrial farms of an advanced standard.

As early as 1874 Czapski reported that the Hucul horse was excellent for riding. Gregorowicz (1898) pointed out its ability to overcome obstacles with a rider on horseback. At present they are being kept as riding horses in the Siary stud, and frequently used by holiday makers or scouts during summer holidays.

Wherever the Hucul horse is used, it displays three very positive characters: intelligence, obedience and productivity. Mention should also be made of an important economic aspect - small feed requirements and very low maintenance costs compared to other breeds.

Under the project R-II-8, coordinated by the Ministry of Science and Higher Education, the Agricultural University at Krakow has elaborated a long-term plan (by the year 2000) to preserve the Hucul breed. All Polish experts in horse breeding were involved in preparing the plan which was partly presented at the 4th International Symposium in Leipzig and as a whole was discussed at the following International Symposium in Lublin.

The plan provides, among others, the development of breeding work aimed at the preservation of the Hucul horse in the state sector involving 70 mares (dams) and 15 stallions. This sector will be supplemented by the individual breeder sector involving 30 mares and 15 stallions. Basic aims are pure breeding with much consideration to male and female lines. A preliminary mating plan has been worked out for the next 49 years aimed at preventing an undesirable increase in inbreeding and too close relationships. It was suggested to use a selection method of independent culling levels, and to keep the present biometric standard.

Regulations concerning performance tests, peculiar characteristics of the breed and utilization of Hucul horses in field work and recreation are under elaboration.

The Hucul horse should preserve the valuable traits which have been accumulated as a result of many years' breeding work and coded genetically. We do believe it will perfectly supplement mechanical traction as well as serving the purpose of recreation.

New prospects are open of cooperation with Czechoslovakia, Romania and the Soviet Union in the field of Hucul horse breeding.

In a long-term breeding plan aimed at preserving this breed much consideration is given to the staff working with the animals. Great successes can be expected only when all breeding work is conducted according to the principle of "The right man in the right place".

### **POLISH XDNIKS IN THE ROZTOCZE NATIONAL PARK**

E. Sasimowski 1/ and J. Slomiany 2/

The breeding of Polish Koniks in the Roztocze National Park (RNP) in Zwierzynice (Figure 1) was started in 1982 at the initiative of Professor Miroslaw Kownacki. Four mares and one stallion which had been kept in stables and bought from the National Stud in Racot composed the initial material. Their names showing relationship and inbreeding are given in Table 1.



Figure 1. Location of Zwierzyec and Janów Lubelski.

**Table 1 THE INITIAL STUD OF KONIKS - COEFFICIENTS OF RELATIONSHIP ( $R_{xy}$ ) AND INBRED ( $F_x$ )**

Horse - sex		$R_{xy}$				$F_x$
		Mohacz	Husaria	Moda	Tuba	
1. Mohacz - sire	–	5.93	19.87	7.58	11.49	6.250
2. Husaria - dam	5.93	–	12.37	11.30	12.68	7.81
3. Moda - dam	19.87	12.37	–	28.86	30.73	2.15
4. Tuba - dam	7.58	11.30	28.86	–	29.16	5.76
5. Hanula - dam	11.22	12.68	30.73	29.16	–	5.66
Jointly $\bar{x}$	11.22	10.57	22.96	19.22	21.02	5.52

At present the stud consists of one sire, five dams (one three-year-old dam of own breeding with foal) and 14 foals and young of different ages; four-year classes of foals have been obtained so far. The stud is under the care of mgr ing. Jan Slomiany of the RNP and co-author of the present article. Research is supervised by the Zootechnical Science Committee of the Polish Academy of Sciences and directed by Professor E. Sasimowski (co-author).

The habitation of the Koniks embraces an area of about 100 ha forest and pasture which is enclosed by a wooden-poled fence. A stream and ponds on the grounds provide a watering-place all the year round.

This area is almost exactly on the spot where at the turn of the 19th century the last heir of the Zamoysky family had his reserve of wild hunting animals - among others Tarpan. When the reserve was disbanded the Tarpan were distributed to neighbouring farms and up to the present horses with some characteristics of Tarpan - e.g. mouse colour - are seen in this region. It seems reasonable that the breeding of Koniks in the RNP should aim at creating a population which is well accustomed to the natural environment of the nature reserve which is also useful in improving the stock of this breed kept under stable conditions mainly in the neighbourhood.

In this instance the improvement of the Koniks in the reserve could be compared to that of Thoroughbreds and Purebred Arabians in breeding and producing half-bred horses. Thoroughbreds and Arabians are selected by races which test their vigour and physical efficiency; the Koniks in the RNP are similarly tested - a good adaptation to severe conditions without stabling and concentrates is the basic test of desirable properties. It can be acknowledged as a sufficient selection factor for dams - with attending maternal care - but it appears insufficient for selecting stallions among others because movement is less intensive.

Observation continued day and night (Table 2). Both the gallop and trot portions were relatively small. The distance covered in these gaits and walk jointly averaged 5.6 +2.5 km. Moreover, in this movement there is a lack of such elements as jumps which play a significant role in the case of walk saddle horses and as surmounting resistance which is of main importance in harness.

In this connection in the previous year three two-and-half-year-old stallions were excluded from the stud and trained under saddle and in harness. This year when training was completed a performance test was carried out. It enabled us to determine many significant indices (Table 3).

**Table 2 FRACTIONS (IN MIN) OF PARTICULAR GAITS IN THE OVERALL MOVEMENT OF KNONIKS AND THE DISTANCE COVERED DURING DAY AND NIGHT (IN KM)**

		Walk				Trot				Gallop				Way passed			
Horses	n	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S
Sire	7	72.9	42.1	125.9	26.4	5.0	0.3	14.4	4.5	1.4	0.1	7.7	2.8	5.9	3.3	10.9	2.7
Dams	28	67.7	42.3	93.7	16.6	3.4	0.3	9.2	2.9	1.2	0.2	6.8	2.3	5.4	2.7	11.8	2.5
Two-year-olds (born in 1983)	8	78.6	36.8	124.9	26.5	3.8	1.2	6.7	2.4	0.3	0.2	0.7	0.2	5.6	2.5	8.0	1.5
One-year-olds (born in 1983)	20	65.2	41.3	96.5	16.5	3.0	0.3	10.4	5.1	2.0	0.2	7.3	2.6	5.4	2.5	9.7	2.3
One-year-olds (born in 1984)	8	74.0	40.8	106.7	22.3	3.9	1.2	6.3	2.1	0.2	0.2	0.5	0.1	5.3	3.0	6.8	1.2
Sucklings (born in 1984)	16	98.6	57.7	133.7	25.2	3.5	0.3	18.0	4.2	2.6	0.5	18.0	4.2	7.8	4.4	19.0	3.4
Sucklings (born in 1985)	2	150.8	138.5	163.1	17.4	7.6	6.6	8.6	1.4	5.1	1.0	9.1	5.7	12.8	10.1	15.5	3.8

Table 3 RESULTS OF PERFORMANCE TESTS OF STALLIONS (MIN-MAX)

Efficiency of movement during one hour under saddle:		
- 5 x (8' walk + 3' trot + 1' gallop) - 8320 m - 9072 m		
Efficiency of movement during one hour in harness with a resistance of 8 percent body weight:		
- 5 x (9' walk + 3' trot) = 6558 m - 6666 m		
Maximum pulling power:		
248 - 252 kg (2433 - 2472 N) - 73% - 89%		
Speed at a distance of 1 km,	in walk:	11.21'-12.53'
	in trot:	4.30'-4.55'
	in gallop:	2.00'-2.50'
Size of obstacles passed at liberty:		95-115 cm
Size of obstacles passed under rider		80- 90 cm
Length of jumps:		250-300 cm
Length of step in walk	- in hand:	143-166 cm
	- under rider:	141-155 cm
	- in harness:	121-151 cm
Length of step in trot	- in hand:	210-240 cm
	- under rider:	200-210 cm
	- in harness:	180-224 cm
Length of foulée in gallop	- in hand:	224-272 cm
	- under rider:	310-330 cm

All these indices make it possible to compare the stallions observed among themselves and with the results of experimental training and performance tests carried out on three-year groups of Koniks by Dr. S. Siudzinski at the Agricultural Academy in Poznan and Assistant-Professor R. Tomczynski at the Agricultural-Technical Academy in Olsztyn. The tested stallions can also be compared to the whole population of Polish Koniks.

This year one of the three-year-old tested stallions will become a new sire of the stud.

These tests are also useful as the stallions which cannot be included in the stud or those eliminated from the main herd are immediately used for saddle or harness. In winter during their stay in the reservation, they are even used for transporting hay which is indispensable as additional feed for the stud. They can be used for transport in the area of the RNP and can also be tried as saddle horses for the tourists resting in Zwierzyniec and in teaching local children to ride.

Observations so far demonstrate that rearing the Koniks in liberty in the pasture-forest reservation assures optimal health. Even during the recent very frosty winters when the temperature often dropped under 30° C no symptoms of cold appeared either in adults or in foals. There were also no disorders of the alimentary canal, except for worms which require" systematic treatment (deworming) twice a year - in spring and autumn.

Simultaneously, the hooves must also be trimmed as they do not wear sufficiently on the relatively soft ground and due to not very intensive movement.

Reproduction and rearing are not disturbed and are interesting to observe. Research results of behaviour, stud hierarchy, growth and development of foals controlled by weighing, biometric measurements and haematological tests are also interesting. The latter and the examination of coat and hoof horn structure also include adults.

The results of environmental research - phytosociological, hydrobiological and animal health are important in breeding. Some of them have already been reported and are now being published. The rest are now being prepared and completed by a greater number of new observations.

It is worth mentioning that the authors are actually cooperating with breeders in another herd of Polish Koniks in Janów Lubelski placed about 50 km from Zwierzyiec and 80 km from Lublin, in the Partisans' Park of National Memory. The initial material consists of local mares, i.e. the Bilgorajski horses which have the Polish Konik blood. The results arising from this research are also of interest.

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**APPENDIX 1**  
**ADDRESS OF WELCOME**

Dr. H.A. Jasiorowski  
Director, Animal Production and Health Division, FAO

Mr. Minister, Mr. Chairman, Ladies and Gentlemen,

I am pleased to welcome you here on behalf of the Director-General of FAO and the Executive Director of UNEP to the second meeting of the joint FAO/UNEP Expert Panel on Animal Genetic Resources Conservation and Management and I am especially happy that the meeting is taking place in my own country, Poland. It is

very gratifying that we have such a distinguished group of scientists from all over the world gathered here to address the important work of this meeting.

This Expert Panel was established in 1983 to 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 two Organizations have now established a commendable record of joint activities in this field, starting shortly after the establishment of UNEP in the early 1970s and continuing the pioneering work in animal genetics initiated by FAO soon after it was created 40 years ago.

Cooperation between FAO and UNEP has grown considerably during the last twelve years. It now embraces not only specific national projects, but also sub-regional interests and the development of regional and global infrastructures for the support of animal genetic work. The joint activities have included surveys of indigenous breeds, improved use of animal genetic resources for the production of meat, milk fibre and draught animal power, training activities for developing country scientists, publications, expert consultations, plans for the establishment of data banks and gene banks and plans for the preservation of endangered breeds, especially in developing countries.

The importance our host country, Poland, attaches to the subject of this Panel is clearly shown by the presence here of the Minister of Agriculture, Dr. S. Ziemia, the Deputy Minister of Environment Preservation, Dr. Michna, and the Permanent Secretary of the Ministry of Higher Education, Science and Technology, Dr. Kurowski. I wish to welcome them here and to thank them on behalf of all those participating in this meeting. I am sure we can consider their presence here as a sign of the support and interest this country is giving to FAO's activities.

I also wish to welcome the President of the Polish Society of Animal Production, Professor E.A. Potemkowska, and the Rector of the Warsaw Agricultural University, Professor M.J. Radomska.

Both FAO and UNEP attach much importance and expectations to the advice received from this Expert Panel. As you know, the focus of concern for the Panel covers all aspects of animal genetic resources which is a wide field. It includes both the improved utilization of animals and also the preservation of those animal breeds which have unique traits developed during the long process of domestication. The latter of these two objectives, namely preservation, received prime attention at the first meeting of the Expert Panel in 1983. We expect that during this meeting you will also devote attention to the problem of the improvement of utilization of genetic resources which is especially important to the developing countries where during the last decades we have observed in some cases a decline in animal protein production per caput, stagnation of livestock productivity and an increasing dependency on imported animal products. Improvement of productivity and preservation of indigenous breeds is one of our main goals in developing countries.

If mankind were still using the local indigenous breeds of animals in each place where they have been used for thousands of years, there would be no need even to consider preservation. However, we are in the middle of a huge revolution of animal genetic resources utilization which started at the beginning of this century and which has gained momentum during the last 30 years. The first impact of this revolution is concerned with breed substitution on a grand scale. It has swept through Europe, where there were old established traditional breeds in each locality until this century. Many of these have gone and have been replaced by the more productive and economically viable breeds.

The domination of milk production by Black and White cattle in Europe which has recently been improved by crossing with Holstein-Friesians from North America is testimony to this change.

Europe has responded to the need to preserve the older local breeds relatively late but in a positive way by trying to keep them where possible, as small populations of live animals which are often open for the public to

visit in natural settings. Where this is not possible, or indeed as an additional means of preservation, the European countries have also deposited semen and embryos in cryogenic gene banks for posterity. Even in highly developed countries the funds for animal genetic preservation are not easily available.

Some people view these activities as luxuries. They feel it is impossible to predict when the economic benefit of preservation will occur, and indeed there may never be such a time. On the other hand, some people regard these preservation activities as having a moral basis and obligation upon mankind, to prevent the total loss of genetic variation which is unique and cannot be replaced. We in FAO and UNEP wholeheartedly support the latter attitude.

When we turn to the developing countries we find similar principles at work, but with some special angles. First, the replacement, of the local breeds by those of higher economic value is under way. But, it is not so much a matter of breed substitution as gene substitution, through crossbreeding, since it is rare in the tropics to be able to introduce temperate breeds as purebred animals without a high level of feeding, special management and high investments and risks.

Mass crossbreeding with local animals to combine their adaptation and disease resistance with the higher production of exotic breeds is the most frequent situation in developing countries. This places a special demand upon the indigenous breeds. They are needed initially for the production of crossbreds and perhaps even over the long term if it is not possible to create a stable self-perpetuating crossbred. Yet at the same time, the indigenous breeds are becoming even more obviously uneconomic in their performance levels and farmers are reluctant to keep them. Therefore, there is evidently a need to combine the approach of improved utilization which must have priority in developing countries, with the to conserve the local animal genetic resources for the present and future use.

I am glad that it was possible to arrange this meeting of the Expert Panel on genetic resources in association with the European Association of Animal Production Symposium which is being arranged by the Polish Society of Animal Production on a similar subject.

The EAAP/PSAP Symposium is addressing particularly the issues of the use of small populations in the European context. There will be excellent opportunities therefore for members of our Expert Panel and the Polish and visiting European scientists at the Symposium to gain from each other's experience and also, I hope, to produce more than either would have produced alone.

Some of you were present at the first meeting of the Expert Panel in 1983. You will recall that much of the agenda was devoted to the topics of data banks and gene banks for animal genetic resources. I am pleased to be able to tell you that the recommendations you made at that meeting have been followed with some success by FAO and UNEP. On the subject of data banks we were able to carry out trials for two years in several countries in Africa, Asia and Latin America. As a result, we were able to design a methodology which has been adequately tested and proven in the field. We are publishing the methodology which includes the first comprehensive descriptors of the major species of domestic animals and poultry.

We trust that when the publications are to hand, we shall be successful in seeking funds for the establishment of regional data banks for animal genetic resources. But data banks should be considered as an introductory phase to the practical programmes of genetic resources preservation. Here more funds will be needed for developing countries and they may be difficult to obtain. Your advice and clear recommendations on this subject are expected.

In looking ahead to the improved use of animal genetic resources in the next years, we are aware of the great need and responsibility to rapidly improve the utilization of animals and to increase their productivity in

developing countries. We feel the need to apply the rapidly advancing science of genetic engineering to animal production also in developing countries.

It seems likely that the rapid advances towards the creation of transgenic animals may eventually have a special contribution to make to the problems of joining the productive potentials of the temperate breeds to the adaptive advantages of the indigenous breeds of the Third World. Harnessed to the existing techniques of A.I. and the growing flexibilities of Multiple Ovulation Embryo Transfer there are entirely new opportunities for us to break away from the conventional methods of field testing large numbers of animals to calculate breeding values. We know that the creation of the desired infrastructures of field testing schemes in the tropics has been a task of formidable difficulty. Rarely has a developing country been able to set up a livestock improvement scheme comparable to those of the developed world. It is exciting to look forward to the possibility of bypassing these obstacles and to implementing genetic improvement by the use of biotechnology. In this way the developing world will not fail to benefit from the advance of science which otherwise threatens to widen the technological gap rather than to diminish it between the north and the south. You may wish to advise us on this important policy question.

We are pleased that today here at the Expert Panel meeting, while you are attending in your individual capacity as scientists, you are also representing the different regions of the world in which FAO and UNEP are working. We are glad, too, that you represent many of the regional and sub-regional institutions concerned with animal breeding and genetics. We also invited a small group of Polish geneticists to attend this meeting. I am sure they will benefit by listening to your discussions.

Finally, may I convey good wishes to you for success in the meeting not only from myself, but from all your colleagues in the Animal Production and Health Division. We thank you for coming. We look forward with great interest to your recommendations on this important subject of animal genetic resources.

Dr. Hamdallah Zedan  
United Nations Environment Programme  
Nairobi, Kenya

It gives me a great pleasure and is my privilege to be with you on this occasion.

The United Nations Environment Programme (UNEP) is most grateful to the Secretariat of FAO for planning and organizing this consultation and to the Government of Poland for hosting it. I wish also to express our gratitude to Dr. Hohn Hodges (FAO) and Dr.- J. Kwiatkowski (Polish Institute for Cattle Breeding and Milk Production) for their tireless efforts and to the dedicated scientists coming from different countries, regions and organizations to participate in this meeting. It is indeed heartening to see such a distinguished group of experts in animal genetic resources assembled to discuss, exchange information and advise on experiences, achievements and methodologies for efficient management and conservation of the world's animal genetic resources for future needs. To all these we are most grateful.

Since the very beginning of human life on earth, man and animal have been tied together in intimate association and while domestication of plants provided humans with the main source of food and fibre, that of animals was the main source of protein, hide and fur. Over 56 million tons of edible protein and over 1 billion mega calories of energy annually come from livestock. The highly valuable protein for human consumption is over 50 percent of that produced by plant crops and in terms of fertilizer value animal waste is said to contain valuable plant nutrients which has been estimated annually to be worth over 1 billion.

With the current situation of about two thirds of the world's population already suffering from inadequate intake of protein and with the estimate that within the next 30 years the population will double, the potential deficit of

livestock products by the year 2000 staggers our imagination. It is therefore essential that man must have at his disposal both the plant and animal genetic resources that would be deployed to meet his needs.

The impact of developments in animal breeding on animal populations combined with vast technological advances in this field is likely to swing the balance in favour of the economically superior breeds to meet the requirements of the growing world populations. A natural consequence of this process is a gradual decline in genetic variability within domestic animal populations particularly in developing areas with dense populations and dwindling resources.

Just like crop plants, the presently available broad diversity of breeds (varieties, strains, races, populations, etc.) of domesticated animals is the product of thousands of years of environmental adaptations, even more consciously guided by man. Quite often the progenitors and wild relatives of presently domesticated species are extinct and hence further genetic diversification will have to rely on existing breeds. Commercial pressures for the use of exotics in developing countries has also often been excessive and the indiscriminate crossing of local breeds from outside the local environment has probably already caused serious loss of valuable local adaptations and characteristics. The tendency among decision-makers - because of the pressing needs - to put an emphasis on developmental aspects and immediate livestock improvement through imported genet material may have reduced future options for improvement of livestock production through the use of indigenous well adapted genetic material. The technical ease with which artificial insemination could be applied and the recent developments in preservation and transportation of germplasm made the loss much more rapid and drastic in recent years. As a result indigenous breeds are disappearing and small farmers and villagers cannot afford the high input breeds that are being introduced.

The loss of genetic variability is a matter of concern to both FAO and UNEP, to many other organizations and to the scientific community when viewed against present and future trends in livestock production. There are examples that can be given of breeds which were thought to have little value under a prevailing economic condition at a certain time but proved important when the requirements for breeding and production systems have changed. We must not be concerned only with domesticated animals, we should be also concerned with wild feral populations as human intervention in domestication of animals is not yet complete. Some of the species existing in the wild today may be domesticated in the future.

The UNEP concern is fully expressed in the 1980 overview on genetic resources and in the various Governing Council decisions since 1973. We are not interested in conservation for conservation nor is FAO or other active organizations. Our goal is that the broadest genetic diversity within each of those species which have significant, or potentially significant, socio-economic value among domesticated or semi-domesticated farm and pastoral animals (including their wild relatives) should be preserved and to help make such genetic material and information thereon freely accessible for utilization in environmentally sound bioproductive systems so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of the future generations.

The emerging awareness of the need for urgent positive action to conserve and develop the world's animal genetic resources as man's chief insurance against their destruction has resulted in a number of limited uncoordinated efforts. UNEP and FAO have a history of cooperation since 1974. They supported a number of joint activities in this important field. The early joint activities 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 consultation on animal genetic resources in Latin America and on dairy cattle breeding in the humid tropics, an inventory of special conservation herds and a high level FAO/UNEP technical consultation in 1980 to identify the world's problems facing the world's animal genetic resources and to draw a plan of action for international cooperation which was lacking. The

creation of the FAO/UNEP Panel of Experts on Animal Genetic Resources Conservation and Management and its first meeting in 1983 was a realistic step towards the establishment of an international programme in this important field and both FAO and UNEP were instrumental in the implementation of the proposals recommended by the expert consultation and the Panel where many of you have participated and contributed. Pilot trials for the establishment of data banks in Africa, Asia and Latin America, pilot inter-country conservation schemes for selected breeds which are often scattered in several countries, training of animal scientists from developing countries, publication of the Newsletter "Animal Genetic Resources Information", creation of inventories about the livestock resources of the USSR and China and plans to establish regional gene banks for cryogenic conservation of animal genetic resources in developing countries and to restore the Przewalski horse to its natural habitat are all in progress since the previous meeting of this distinguished Panel.

One major event in this area has taken place since the previous meeting. Recognizing the fact that conservation is an integral part of sustained management and utilization of genetic resources, the African Ministers' Conference on the Environment, called by UNEP and held last December decided to establish an African Regional Network for the Conservation and Management of Genetic Resources (as one of eight regional networks that will be established). Another decision which also bears relevance to animal genetic resources is the implementation of 150 village pilot projects and 30 pilot semi-arid stock-raising zones aiming at self-sufficiency in food and energy.

We shall ask you to address an appraisal on the work which was achieved or is now in progress and to advise on how to proceed. We shall be looking to you for assistance in the establishment of the African network on genetic resources. The task will undoubtedly remain the responsibility of national authorities and the scientific and learned societies. But a certain minimum guidance and coordination will be needed and the Panel meetings give a good example of the provision of scientific, technical and logistical guidance. With the collective experiences and wisdom of such a distinguished group of experts, I have no doubt that we shall all come out with concrete recommendations. We thank you for coming and we look forward with great interest to continued cooperation.

Thank you.

## **APPENDIX 2**

### **FAO/UNEP JOINT EXPERT PANEL ON ANIMAL GENETIC RESOURCES**

### **CONSERVATION AND MANAGEMENT**

#### Terms of Reference

#### I. 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 caused 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 to 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 resulted in the 1970s 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 animal 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 was considered desirable to establish an FAO/UNEP Panel of Experts on Animal Genetic Resources Conservation and Management. This is 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.

## 2. OBJECTIVES AND FIELDS OF ACTIVITY

The objectives of the Panel are to:

- Review periodically ongoing work on animal genetic resources conservation and management in 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 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 ex situ conservation methodology of 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.

### 3. MEMBERSHIP

The Panel is a standing and authoritative body of experts, the total number not exceeding 40. The number of participants at specific meetings depends on the topics dealt with, as well as on the budgetary allocations available.

Half of the members are nominated by the Director-General of FAO and half by the Executive Director of UNEP. The nominations are 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 rests 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 genetic resources, it is envisaged that other international agencies concerned, such as UNDP and the World Bank, will be encouraged to support the Panel.

### 4. 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 of 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 is an extension, taking into account experiences gained during the initial period.

#### 5. PERIODICITY OF SESSIONS

It is planned 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.

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**APPENDIX 4**  
**SECOND MEETING OF THE JOINT FAO/UNEP EXPERT PANEL ON**  
**ANIMAL GENETIC RESOURCES**

Warsaw, 13-18 June 1986

## AGENDA

Friday 13 June

- 08.30 1. Introduction
- 09.00 2. Welcome Address on behalf of FAO/UNEP (Dr. H.A. Jasiorowski)
3. Welcome Address try Representative of Host Government of Solano.
4. Adoption of the Agenda
5. Election of Chairman and Vice-chairman  
(Dr. H. Newton-Turner and Dr. Jorge de Alba were unanimously elected)
6. Review of Business of the Meeting (Dr. John Hodges)
- 10.00 Break
- SECTION A - PRINCIPLES FOR INDIGENOUS ANIMALS IMPROVEMENT IN TROPICS Cattle  
(Rapporteur: Dr. Jorge de Alba)
- 10.30 7. Professor E.P. Cunningham (Kenana in Sudan)
- 10.50 8. Dr. F.E. Madalena (Crossbreeding in Latin America)
- 11.10 9. Dr. Jorge de Alba (Criollo in Latin America)
- 11.30 10. Dr. John Hodges (Sahiwal in Kenya and Pakistan)
- 11.50 11. Discussion
- 12.00 Lunch
- Buffalo (Rapporteur: Dr. F.E. Madalena)
- 14.00 12. Dr. S. Sivarajasingam (General Asian experiences)
- 14.30 13. Dr. John Hodges (FAO/UNDP/Philippine Government Project)
- 15.00 Break
- Sheep and Goats (Rapporteur: Professor C. Novoa)
- 15.30 14. Professor A. Lahlou-Kassi (North African/Mediterranean experiences)
- 15.50 15. Dr. Pushkar Nath Bhat (Asian experiences)
- 16.10 16. Dr. L.L. Ngere (African experiences)

16.30 17. Discussion

Saturday 14 June

SECTION A (CONTINUED) - PRINCIPLES FOR INDIGENOUS ANIMALS  
IMPROVEMENT IN TROPICS

(Rapporteur: Professor L.L. Ngere)

Camelidae (Rapporteur: Professor A. Lahlou-Kassi)

09.00 18. Professor C. Novoa (Latin America)

10.00 Break

Pigs (Rapporteur: Dr. Pushkar Nath Bhat)

10.30 19. Professor J.W.B. King (General)

11.15 20. Discussion on Section A (led and summarized by Professor E.P.  
Cunningham)

12.00 Lunch

SECTION B - EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN THE TROPICS

(Rapporteur: Professor J.W.B. King)

14.00 21. Professor A. Lahlou-Kassi (Africa)

14.15 22. Dr. S. Sivarajasingam (Asia)

14.30 23. Professor C. Novoa (Latin America)

14.45 24. Professor E. P. Cunningham (Developed country view)

15.00 25. Discussion

15.15 Break

SECTION C - PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN  
TROPICS

(Rapporteur: Dr. Pushkar Nath Bhat)

15.45 26. A. Teixeira Primo (Brazil National Plan)

16.05 27. Professor C. Novoa (Camelidae)

- 16.25 28. Dr. H. Newton-Turner (Sheep and goats)
- 16.45 29. Professor Imre Bodó (Principles in use of live animals)
- 17.05 30. Dr. Stefan Wierzbowski (Principles in use of cryogenic storage)

Sunday 15 June

Field Visits

Monday 16 June

\* SECTION D - PRINCIPLES AND PRACTICES OF USE OF RARE BREEDS OF CATTLE, HORSES, SHEEP AND GOATS IN EUROPE

NOTE: Section D was held jointly with the EAAP/PSAP Symposium

- 09.00 31. Opening Session
- 10.00 32. Roles of animal genetic resources in production, natural environment, conservation, human enjoyment and recreation (Rapporteur: Professor J.W.B. King)
- 11.00 Break
- 11.20 33. Cattle (Rapporteur: Dr. Jorge de Alba)
- 13.00 Lunch
- 15.00 34. Horses (Rapporteur: Professor Imre Bodó)
- 16.20 Break
- 16.40 35. Sheep and Goats (Rapporteur: Professor C. Novoa)

Tuesday 17 June

(Rapporteurs: Dr. A. Teixeira Primo and Dr Y. Madkour)

- 09.00 36. Short papers on Section D
- 15.00 Horse riding show

Wednesday 18 June

SECTION E - REGIONAL GROUPS DISCUSS PRIORITY TARGETS AND DESIGN PROJECTS FOR ACTION NATIONALLY AND REGIONALLY

- 09.00 37. African Region -  
(Rapporteur: Cunningham) Professor E.P. Cunningham  
Professor A. Lahlou-Kassi  
Dr. Y. Madkour  
Dr. K.O. Adeniji  
Dr. L.L. Ngere
38. Asian Region -  
(Rapporteur: King) Dr. Pushkar Nath Bhat  
Professor Imre Bodó  
Dr. S. Sivarajasingam  
Professor J.W.B. King
39. Latin American Region -  
(Rapporteur: Newton-Turner) Dr. Helen Newton-Turner  
Dr. Jorge de Alba  
Dr. F.E. Madalena  
Professor C. Novoa  
Dr. A. Teixeira Primo  
Dr. Stefan Wierzbowski

SECTION F - RECOMMENDATIONS PRESENTED, DISCUSSED AND ADOPTED

- 14.00 Presentation of recommendations by  
rapporteurs

Section A - PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN TROPICS

40. Cattle (Dr. Jorge de Alba)
41. Buffalo (Dr. F.E. Madalena)
42. Sheep and goats (Professor C. Novoa)
43. Camels (Dr. L.L. Ngere)
44. Camelidae (Professor A. Lahlou-Kassi)
45. Pigs (Dr. Pushkar Nath Bhat)
46. Section B - EDUCATION FRAMEWORK (Professor J.W.B. King)
- Section C - PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN TROPICS
47. General (Dr. Pushkar Nath Bhat)
48. Cattle (Dr. Jorge de Alba)

49. Horses (Professor Imre Bodó)

50. Sheep and Goats (Professor C. Novoa)

Section D - REGIONAL PRIORITIES AND PROJECTS

51. African (Professor E.P. Cunningham)

52. Asia (Professor J.W.B. King)

53. Latin American (Dr. H. Newton-Turner)

18.30 Conclude

**APPENDIX 5**  
**JOINT FAO/UNEP EXPERT PANEL ON ANIMAL GENETIC**  
**RESOURCES**

Warsaw, Poland, 13-18 June 1986

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## **APPENDIX 6 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 Strategy, 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 description of:

- i. the genetic attributes of an animal species or breed which has a unique genetic identity; and
- ii. the environments to which 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.

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7. Environmental impact of tsetse chemical control, 1980 (E\* F\*)
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21. Guideline for dairy accounting, 198 (E\*)
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Availability: June 1987

Ar	—	Arabic	* Available
C	—	Chinese	** Out of print
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**PAPERS PRESENTED AT EAAP/PSAP SYMPOSIUM ON  
SMALL POPULATIONS OF DOMESTIC ANIMALS IN EUROPE**

**GENERAL  
CATTLE  
BISON  
SHEEP/GOATS  
EQUINES**

## **POSSIBLE ROLE OF ANIMAL GENE RESOURCE IN PRODUCTION, NATURAL ENVIRONMENT CONSERVATION, HUMAN PLEASURE AND RECREATION**

K. Maijala 1/

### **1. INTRODUCTION**

Genetic variation in animals has developed during millions of years. In the course of time the usefulness of different genes and gene combinations has been under severe tests, especially concerning adaptability to different conditions and resistance to diseases and parasites.

During the last ten thousand years man has partly influenced this evolution, and many breeds adapted to local needs and environments have been developed. The possibilities of making changes in the genetic make-up of farm animals and of concentrating on the utilization of the breeds considered to be the best, have increased in recent decades, thanks to the availability of modern reproduction, computer and communication techniques.

The increased rate of changes and parallelization of breeding goals have awakened concerns about losses of genetic variation both within and between breeds. Many breeds have disappeared or are threatened. A recent survey showed that 81, 51, 67 and 12 European breeds of cattle horses, sheep and goats, respectively, were considered endangered (Maijala *et al.*, 1984).

Activities for preventing gene and breed losses have been started in different parts of the world (FAO, 1981), in order to maintain the possibility of adjusting animals to future, unpredictable needs. In many countries the emphasis is on conserving breeds, and hence it is topical to discuss whether this could be done economically, when the current competing ability of the breed is unsatisfactory and the population is small.

### **2. REASONS FOR CONSERVING SMALL POPULATIONS**

Before discussing the possibilities and ways of maintaining small populations or so-called rare breeds it is important to make clear why they should be conserved. In Europe, the reasons for conserving genetic variation have been discussed among others by Maijala (1970), Mason (1974), Simon (1984) and Maijala *et al.* (1984). On the basis of these and other papers, the following list of arguments for conservation can be made:

#### A. Economic-biological reasons

1. The production conditions for farm animals are changing. This concerns especially feeding, since one has to find new economic feedstuffs, and to utilize various kinds of wastes from agriculture and industry. It may also become topical to return to extensive pastures in case the intensively cultivated areas will be needed for direct production of human food or energy crops. Changes in management of animals may also continue to change (e.g. mechanization, milking frequencies and methods, densities, etc.). Similarly, the housing conditions (regulation of temperature, moisture, light etc.) may change. Changes are possible also in the hygienic conditions of animals (new kinds of disease agents, new vaccines and medicines) and in climatic conditions (temperature, humidity, altitude).
2. The demands for products and services desired from animals may change for many reasons, e.g. with opinions and knowledge concerning wholesome food, with increased standard of living and leisure time or with new fashions in eating and clothing. Changes in international trade and trade blocs influence costs of materials and prices of products. The increased human population may increase the need of quantities, and it is important to combat hunger. The need of compensating exhausted natural reserves of fuels, minerals, etc., with renewable plant and animal materials may become more and more topical. The competition between animal species in production costs and services, as well as that between animals

and plants as food producers may affect the usefulness of various kinds of animals. The need of finding new ways of utilizing agricultural plant products in case of surplus problems may also increase.

3. Experiences of crossbreeding in utilizing heterosis and complementarity speak in favour of maintaining the possibility of systematic crossbreeding also in the future.
4. In order to satisfy the rapidly changing needs it is important to make rapid, one-sided progress in some populations without losing the possibility of starting again in another direction if needed.
5. There is an increasing need of being able to adjust the breeding work to the new biotechniques such as embryo transfer, splitting and sexing, or gene technology.
6. There may appear needs to overcome selection limits and antagonisms.

#### B. Scientific reasons

1. For the measurement of genetic progress and correlated responses control populations or frozen stocks are very useful.
2. Research in genetics, physiology, biochemistry, immunology, morphology, etc., benefits from maintenance of a large variety of animal materials.
3. Many different populations are valuable for research in evolution, ontogeny, behaviour, etc.
4. They are also useful as teaching material in animal sciences.

#### C. Cultural-historical reasons

1. Conserved breeds can be considered to be valuable memorials of nature and culture (living cultural heritage).
2. They can be used as research and teaching material in history and ethnography.
3. There are ethical-moral grounds to take care of the existence of different creations of nature.

In many points (e.g. A.1, 2, 4) it is a question of maintaining the possibility of changing breeding objectives according to unpredictable changes in needs. Even negative changes in the production conditions of ruminants are possible, if grains are needed directly for human consumption or for fuel. In Italy it has already been necessary to return to the original local breeds in utilization of dry mountain pastures (Rognoni, 1980).

The arguments A.3, B.1-4 and C.1-3 require conservation of entire breeds. Availability of distinct and different kinds of breeds or lines makes the utilization of conserved variation more rapid and effective in the case of need, both in pure- and crossbreeding. Gene combinations are conserved besides genes, and both the cultural-historical and emotional interest are satisfied, which is not the case in storing material in frozen form or as gene pools. On the other hand, both the initial and maintenance costs are high, and there are risks for diseases, accidents, genetic drift, inbreeding and contamination from other breeds. Because of the smallness of population, genetic improvement by selection is slow, and hence the gap in current breeds or selection lines increases (Maijala *et al.*, 1984).

These disadvantages can be considerably lessened with the aid of simultaneous conservation of frozen semen and embryos, which also makes it possible to manage with rather small numbers of live animals (e.g. 20-300 females). These are needed for evaluation purposes as well as for cultural-historical reasons even if frozen semen and embryos were satisfactory for the conservation of the genetic variation itself. It is also very probable that the frozen material would be forgotten in store by our descendants, if no live animals could be seen and studied.

Additional arguments for maintaining many breeds as pure were given by Land (1981), who suggested a planned development of strains with divergent biological traits, since some old local breeds have proved themselves useful in many countries, because of their special traits for the modern market (e.g. lean carcasses,

double-muscling, high fertility). Their maintenance would increase genetic flexibility and the rate of progress and ensure the availability of desired genetic variation at the time of need.

Bowman (1981) considered that "the conservation of a wide range of genetic variation coupled with the development of a capability to reproduce and multiply quickly and cheaply desirable types of animals, are far more important to the future of animal production than the development of over sophisticated forms of within-population selection".

### 3. COSTS AND PROFITS

An idea of the relative costs for maintaining purebred populations for the purpose of genetic conservation can be obtained from Table 1, based on the studies by Brem *et al.* (1984) and by Smith (1984).

In both calculations, maintenance of live animals as pure breeds was many times as expensive as frozen semen, even though the number of animals was assumed to be very low, allowing no selection in the population during storage and not even in the first years after starting its reuse. In the study by Brem *et al.* (1984) the conservation as frozen embryos was also considerably cheaper than as live animals, while there were very little differences in the study by Smith (1984). In the latter study, conservation of sheep breeds was not essentially cheaper than that of cattle breeds.

Availability of many-sided semen stores makes it possible to conserve a breed without big risks for genetic drift and inbreeding depression. Frozen embryos offer the additional advantage that the breed can be regenerated and used for crossbreeding within a generation, even if the number of live animals of the breed is zero or minimized to show only its type and colours to our descendants. In addition, frozen embryos conserve better than frozen semen gene combinations and frequencies. It is likely that the costs of preparing embryos for frozen stores will decrease, especially if it becomes possible to make embryos by taking ova from the ovaries of slaughtered females and by using in vitro culture and fertilization.

**Table 1** ESTIMATED ANNUAL COSTS FOR CONSERVING CATTLE AND SHEEP BREEDS IN THREE DIFFERENT WAYS, WHEN STORAGE TIME IS 20 YEARS AND INVESTMENT COSTS AND INTERESTS ARE NOT CONSIDERED

Species	Author	Live animals		Frozen semen 1/		Frozen embryos 2/	
		Establ.	Remarks	Establ.	Remarks	Establ.	Remarks
		+storage		+storage		+storage	
		cost/yr.		cost/yr.		cost/yr.	
Cattle	B 3/	4 860 £5/	5m,25f	174 £5/	25mx20d	694 £5/	25f x 4e
Cattle	S 4/	5 000 £	10m,26f	600 £	25mx50d	4 250 £	25f x 25e
Sheep	S 4/	3 000 £	22m,60f	635 £	25mx30d	3 000 £	25f x 25e

<sup>1/</sup> Requires at least 10 additional years to regenerate the breed.

<sup>2/</sup> Requires about one generation (3 yrs in cattle) to regenerate the breed

<sup>3/</sup> Brem *et al.*, (1984)

<sup>4/</sup> Smith (1984)

<sup>5/</sup> 1 £ = 3.6 DM

m = males, f = females, d = doses, e = embryos

The returns from breed maintenance are still more difficult to estimate than the costs, because of the difficulties in predicting the future. However, Smith (1984) tried to calculate the probabilities of future uses of stocks to justify conservation from the national viewpoint. He based his calculations on the following factors: (1) total value of market, (2) cost of conservation, (3) proportion of the stock used in future commercial production, (4) proportional gain in economic efficiency over current stocks, (5) number of years until commercial use, and (6) length of the utilization period. Table 2 shows the estimated probabilities for the market volume in the U.K.

The general conclusion of Smith (1984) from the probability-values was that even small gains in efficiency and low proportions of the genes from a conserved stock would bring profit for the nation. Thus, it would be worthwhile to maintain a stock, even if there is a very small chance that the stock would be useful in the future. The costs of conservation appear to be small relative to possible future gains in national production. The required probabilities were the lowest for frozen semen, while those for live purebred animals and for frozen embryos were 5 to 10 times higher. In small countries with a limited market the probabilities required are, of course, higher. It has to be stressed also that the profits can be harvested only on the national level, not by individual enterprises.

In his extended studies Smith (1985) calculated the reduction in uncertainty about the permanence of breeding objectives by selecting alternative stocks for different sets of objectives. The size of each line was 5 males and 150 females, of which 50 were selected per year. The national return/cost ratio (in U.K.) in one year of one year's genetic improvement was 1900 in dairy cattle, 940 in beef cattle, 500 for meat production traits in sheep, and 200 for sex-limited traits in sheep. Even if these values might not be entirely realized in practice, there appears to be sense in developing alternative selection stocks for reducing the uncertainty with regard to the future needs and breeding objectives. The longer the time horizon, the higher number of stocks one could develop profitably. The high R/C values can be applied on the national level, while smaller investors have to apply lower values (e.g. 10), where the maximum benefit is sensitive to the number of stocks selected.

**Table 2 PROBABILITIES NEEDED FOR THE USE OF CONSERVED CATTLE AND SHEEP STOCKS IN U.K. TO JUSTIFY THEIR CONSERVATION, ACCORDING TO SMITH (1984). USE MADE AFTER 20 YEARS FOR 20 FURTHER YEARS. REQUIRED ECONOMIC EFFICIENCY OVER THEN CURRENT STOCKS 5%**

Species	Products	Method of conserv.	Probability (%) needed with different degrees of substitution		
			100%	50%	10%
Cattle	Milk 1/	Live	0.021	0.042	0.211
Cattle	Milk	Semen	0.003	0.006	0.027
Cattle	Milk	Embryos	0.018	0.035	0.177
Cattle	Beef 2/	Live	0.027	0.053	0.267
Cattle	Beef	Semen	0.004	0.007	0.035
Cattle	Beef	Embryos	0.023	0.045	0.226
Sheep	Meat&Wool 3/	Live	0.060	0.120	0.600
Sheep	Meat&Wool	Semen	0.013	0.025	0.127
Sheep	Meat&Wool	Embryos	0.060	0.120	0.600

100% = complete substitution

50% = 2-breed cross or synthetic

10% = specialized use

<sup>1/</sup> Total annual value of production in U.K. 1900 mill. £.

<sup>2/</sup> Total annual value of production in U.K. 1500 mill. £.

<sup>3/</sup> Total annual value of production in U.K. 400 mill. £.

Smith concluded from his calculations that there is scope and many benefits from creating and manipulating genetic diversity to maximize the future economic efficiency of our livestock.

#### **4. WHICH BREEDS DESERVE TO BE MAINTAINED?**

In spite of the many motives for maintaining several breeds and of the obvious national economic profitability of their maintenance in the long term it may not be possible or realistic to maintain all breeds. A choice is often made necessary by the fact that the number of people understanding the motives is limited, and hence also the resources available are limited. The criteria for choosing breeds for maintenance have been discussed by many authors (e.g. Mason, 1974, Simon and Schulte-Coern, 1979, Simon, 1934, Maijala *et al.*, 1984, Bodó *et al.*, 1984). They are closely connected with the motives and partly with the methods of conservation.

An important question is whether there is time to evaluate a breed before deciding to conserve it. Provisional maintenance may often be well-founded. Evaluation is even impossible for unknown traits, which may-become important in future. Compromises are needed between ideals and possibilities, between motives and methods and among different objectives. Both practical experience and theoretical knowledge from different sectors are important in the decision making, which thus may sometimes become complicated. The main viewpoints to be considered can be listed as follows:

1. Value of the breed as a biological material
  - a. performance (overall or in some special trait)
  - b. adaptation (climate, feed, management system, local tastes)
  - c. resistance (infection, parasites)
  - d. special characteristics (major genes, biochemical traits)
  - e. heterosis or complementarity expectations in crosses
2. Genetic status and distinctiveness of the breed
  - a. history and age as a separate breed
  - b. breed purity and relationships within breed
  - c. relationships to other breeds and evolutionary origin
  - d. population size and its trends (vulnerability)
3. Ecological aspects (e.g. landscape management)
4. Cultural-historical and aesthetical importance
5. Social importance (e.g. in leisure time)
6. Possibilities of evaluation and maintenance, and availability of adequate information.

It is important to consider whether the breed should be preserved without selection or maintained with simultaneous selection. For some breeds which occur in several countries, international cooperation is desirable in both decision making and action.

## **5. UTILIZATION OF RARE BREEDS IN PRODUCTION**

The economic-biological reasons mentioned above for maintaining minority populations referred to possible future needs. However, changes in needs and production conditions do not vary only with time but also with geographical and agricultural location within a certain era. Considering the whole world, some places are now living the stage of development which in some other places occurred hundreds of years ago. An interesting feature of history is that it often repeats itself even at the same location. Taking into account the wide spectrum of environmental and economic circumstances and the versatility of many farm animal species, it should be possible to find good economic niches for many minority breeds. Examples of special uses for cattle, goats, horses and sheep are listed in Table 3.

There are several alternative uses for each species, and it is likely that different breeds suit differently for them. It is also probable that some minority breeds can be utilized many-sidedly, while the popular majority breeds often are specialized to just one or two tasks. An idea of the many-sided uses and of special qualifications of farm animal breeds can be obtained from a recent working party report (Maijala *et al.* , 1985). An effective utilization of the many-sidedness may be the key to the profitability. The production conditions may vary even in the same village or community, and in the era of A.I. it is possible to use males of different breeds within the village, even within a farm. For some products, marketing may cause problems, if all neighbouring farmers do not produce the same product, but for some' products it is advantageous to be the only producer in the community. A creative imagination has often given good results in finding new ways for production and marketing, and its importance is obviously increasing in the era of surpluses concerning conventional products.

**Table 3 POSSIBLE SPECIAL USES IN ECONOMIC PRODUCTION FOR BREEDS OF SOME FARM ANIMAL SPECIES**

	Possible in breeds of			
	Cattle	Goats	Horses	Sheep
Tractive power in difficult conditions	X		X	
Production of "biological" food	X	X		X
Production in prison farms	X	X	X	X
Production at school farms	X	X	X	X
Pasture and lawn management	X		X	X
Forest management, underbrush-clearing				X
Production of sera for research & health	X		X	
Production of unallergenic milk				
Production of other medicines		X		X
Dam line in crossbreeding for meat	X	X	X	X
Utilization of harsh environments	X			X
Utilization of marginal areas	X	X		X
Experimental animals in research	X	X		X
Production of luxury furs	X	X	X	X
Production of wool for handicraft				X
Animals in part-time farming		X	X	X

Utilization of marginal areas or otherwise harsh environments deserves special attention, since ruminants do not have competitors in that field, the importance of which may increase. It is important that some breeds are continuously kept and selected in those conditions, in order to have suitable animals available at the time of need. Especially beef cattle, whose feed efficiency is poor, should be kept under extensive conditions, in order to minimize the costs of calf production. The adaptation and hardiness of local breeds can be exploited now by using them in commercial crossing for meat production with specialized meat breeds. Mason (1989) considered that a commercial crossbreeding system serves breed conservation because of the need of continuous supply of local adapted breed as foundation stock, giving financial inducement for maintaining such breeds.

The utilization of prison farms for breed conservation turned out to be possible in Finland, when it was realized that animals on these farms serve largely the psychological care and employment of prisoners so that top yields are not necessary and not even possible.

## **6. USE OF RARE BREEDS IN CONSERVATION OF NATURAL ENVIRONMENT**

Animals are part of nature, and hence native breeds of farm animals are often kept in natural parks. In France, at least two breeds of cattle, two breeds of 'sheep and one goat breed are kept in that way (Mason, 1982). The Rove goats graze the fire-breaks and keep them clear of scrub. In Hungary, flocks of indigenous breeds of cattle (Hungarian Grey) and of sheep (Racka and Cigaya) are kept in two big national parks (Hortobágy, Kiskunság), which were established in 1972 and 1974 (Salamon, 1982, Szabo, 1982). Bodó *et al.* (1984) considered that "the

costs in maintenance of cattle can be minimized by keeping them in national parks, where they can also help to maintain the biological balance by grazing the tall grasses".

Small numbers of indigenous farm animals are also kept in ecological museums in different countries.

## 7. UTILIZATION OF RARE BREEDS FOR HUMAN PLEASURE AND RECREATION

An important way of decreasing the costs for conservation of breeds is to use them for leisure time activities, the demand for which is increasing with shortening working time and increasing standard of living. Examples of such activities are given in Table 4.

Table 4 POSSIBLE USES OF FARM ANIMAL BREEDS FOR PLEASURE AND RECREATION

Kind of use	Possible in breeds of				
		Cattle	Goats	Horses	Sheep
Animals in national parks	X			X	
Farm animal parks and museums	X	X	X	X	
Trotting-matches			X		
Riding for hobby and racing			X		
Agricultural and native place museums	X	X	X	X	
Social company of humans, pet-keeping		X	X	X	
Aid in bringing up children, 4 H-farms	X	X	X	X	
Maintenance of local culture & tradition	X	X	X	X	
Exhibition in zoos	X	X	X	X	
Tourist attraction	X	X	X	X	
Folk art			X		
Ceremonial purposes	X		X	X	

The use for pleasure has been especially important for horses, where trotting and riding competitions bring in considerable amounts of money, not only to the successful enterprises but also to the states, which thus can support maintenance of working horses, too. At least in Finland it has been compulsory to arrange a certain proportion of starts in trotting matches for Finnhorses, and so the decrease in the number of Finnhorses has stopped many years ago, and the number of foals has been increasing in the 1980s. A working party set up by the Ministry of Agriculture and Forestry suggested in 1982 that the prize level of Finnhorses should be developed in proportion to that of warm-blooded trotters, in order to safeguard the continuation of the positive development in numbers. Whether this secures the maintenance of the right horse type for working is another question.

Finnhorse has also been found to be a suitable riding horse for beginners. Here the working type suits the purpose rather well. In order to increase this type of use of Finnhorses, the working party suggested that opportunities to participate in horse-racing should be arranged for Finnhorses in their own classes.

In some countries, there are farm animal parks, which have importance in creating interest in the old breeds among people and help in getting money for conservation activities through tourism. The best examples can be

found in the United Kingdom, where Cotswold Farm Park has representatives of 22 old breeds and attracts over 100 000 visitors per year (Henson & Henson, 1982). A Finnish animal park also has a farm animal section, and Norway has plans to establish such a farm for conservation purposes. The numbers of animals per breed in those farms are small, and hence one should have animals also elsewhere, in order to conserve enough variation and to avoid inbreeding.

The latter concerns also zoos, in which representatives of old farm animal breeds are sometimes kept. It is generally thought among animal geneticists that the role of zoos is to maintain wild ancestors of domestic breeds. The wild types would be valuable sources of genes and should thus be conserved. In 1975 there were altogether 244 Przewalski horses in 58 zoos in the world (Mason, 1980).

Mason (1980) considered pet keeping important in the sense that the close relationship between human and animal gives a motive for breeding rare or disappearing breeds. On this basis large groups of people become interested in visiting animal parks and in supporting conservation activities. Private societies for conservation purposes have been established among others in France in 1971, in the United Kingdom in 1973, in the Netherlands and in North America in 1977, in Denmark in 1981, in Austria, FRG and Switzerland in 1982. These have already increased the interest in conservation in their countries and in many cases prevented endangered breeds from disappearing.

## **8. MISCELLANEOUS PROBLEMS IN MAINTAINING SMALL POPULATIONS**

Besides the direct economic problems, for which finding other uses for the breeds is important, there are genetic, hygienic, organizational and safety problems making the conservation of breeds more difficult.

The genetic ones are mainly of two kinds:

1. One should try to minimize the risk of inbreeding and genetic drift with the aid of sufficient effective population size, appropriate mating systems and as equal sex ratios as possible.
2. One cannot make rapid genetic progress in a small population. In spite of this, some undesired natural selection may take place. Some one-sided selection could be applied in populations of 150 females, and utilization of embryo transfer techniques would give additional possibilities, but this would cause costs.

The hygienic problems are also of two kinds:

1. The animals should be protected from destroying diseases.
2. The stored material should not be a risk to other materials at the time of reuse.

An appropriate organization is needed for collecting and disseminating information, preparing mating plans, exchanging animals, etc.

In order to avoid risks of accidents (e.g. fires) the stored material should be placed in several locations.

These different kinds of problems are inclined to increase the costs of conservation. In addition, investments have to be made much before the returns, which for their part are uncertain and may be harvested by another group of people than by those who made the investment. Therefore, it is important to find and utilize various alternatives for getting immediate incomes for the material and that the society (state) takes at least partial responsibility for the costs as a national insurance fee.

## **9. SUMMARY**

The possibilities of conserving breeds of cattle, horses, sheep and goats for future needs were discussed, especially from the economic viewpoint. At first, several economic-biological, scientific and cultural-historical

motives for conservation were presented. Many of them spoke in favour of conserving entire breeds, but it was realized that simultaneous conservation of frozen semen and embryos makes the conservation cheaper or better.

Referring to the calculations by Smith (1984, 1985) it was stated that even small gains in efficiency and low proportions of the genes from a conserved stock would bring profit for the nation and that it pays to create genetic diversity to maximize the future economic efficiency of livestock.

The main viewpoints to be considered in choosing breeds for conservation were presented.

Several alternative ways for utilizing rare breeds in economic production were listed. Special attention was directed to the utilization of marginal feed resources and of local breeds as dam lines in commercial crossing-for meat production. Keeping indigenous breeds as a part of the natural environment in natural parks was also noted, as well as utilizing them for leisure time activities. These have been especially important in horses, which are used for riding and trotting. Attention was paid also to tourism, farm animal parks, zoos and hobby organizations. In spite of these possibilities, the state has to assume a partial responsibility for the costs of conservation, since the main returns from it can only be harvested in the future and not by those who invested the money.

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## **THE USE OF NATIVE HARE BREEDS IN MANAGEMENT OF AREAS OF IMPORTANCE FOR NATURE CONSERVATION IN SWEDEN**

C. Matzon 1/

### **1. THE ACREAGE OF AGRICULTURAL LAND HAS DECREASED IN A RADICAL WAY**

As a result of the improvement in and intensification of agricultural production in Sweden, the acreage of natural grazing land decreased from nearly 1 million ha to 200 000 ha from the time between the two world wars up to today.

The importance of well managed natural grazing land has been discussed in Sweden especially during the last years. In these areas, there are several endangered species of wild fauna and flora.

Agricultural policy in Sweden today is to reduce the overproduction of agricultural products and this will affect the total number of farmers and acreage of both arable land and grazing land. The number of grazing animals will probably diminish in a radical way.

### **2. NATURE CONSERVATION AUTHORITIES HAVE INSTRUMENTS FOR LAND USE REGULATIONS**

It is of great importance for Swedish nature conservation to ensure that areas of agricultural land - from the scientific and cultural point of view - will be managed in the right way to conserve fauna and flora. But it is also of vital importance for the understanding of the cultural background to use indigenous, local breeds in the management of the reserves for research and education.

Therefore, the Environment Protection Board already supports and in the future intends to support further the maintenance of native breeds.

Out of a total acreage of well over 1.5 million ha of national parks and nature reserves about 10 000 ha is agricultural land. A great portion of this land is owned by the government but also local communities and individuals are landowners. Restrictions through e.g. management plans makes it possible for the authorities to regulate land use.

The most significant instrument to keep adapted native breeds in reserves is through subsidies to tenants. A tenant can, if he keeps indigenous grazing animals in a traditional way, get support in the form of a lower rent

and in some cases, acreage allowances or head payment. Governmental funding can also be done for bushclearing, fencing, transport and support for farm buildings.

### **3. AN EXAMPLE OF SUPPORT FOR KEEPING NATIVE BREEDS IN SWEDEN**

Just recently, the Environment Protection Board, in cooperation with local authorities, started a scheme for the management of chalets (mountain pastures) in Dalarna county in Sweden. These chalets are not nature reserves. Chalets are a traditional, very specific type of agricultural system in the mid parts of Sweden. Cattle, sheep and goats are for about 2-3 months taken to grazing areas up in the woodlands far away from the villages in the valleys.

For each dairy cow of local breed (SKB) the farmer gets a yearly subsidy of SKr 500 (about \$75.00). If the cow is of lowland type or a crossbreed the subsidy is SKr 300. Subsidies are also available for heifers, goats and sheep.

The main reason for the Board to release funds for these activities is to get the farmers interested in this traditional form of production and by that keep the cultural landscape open. By allowing higher subsidies for native breeds the authorities emphasize the importance to preserve native breeds in the areas from where they originate, not least from the educational point of view.

### **BREEDING SCHEME AND GENETIC PROGRESS IN A SMALL CATTLE POPULATION (Tyrolean Grey)**

F. Pirchner and J. Aumann 1/

#### **1. INTRODUCTION**

Population size has received much attention both in population genetics and in applied animal improvement. Official recognition of a group of breeders as a herd book society depends in some countries, e.g. in the Federal Republic of Germany, on the number of animals deemed sufficient to carry on an effective breeding plan. Size of a population can be viewed from the genetic and economic aspects. The genetic aspect concerns prospects of genetic improvement without consideration of costs incurred by the breeding work. On the other hand, population size may reflect on the economy of the breed improvement.

Common sense would lead one to expect more genetic progress in large populations - selection intensity can be greater and outstanding and rare individuals are more likely to be found there than in small populations. However, the reproductive rate is by and large independent of population size which implies that selection differences are roughly equal in populations of different size. High selection intensity in small populations will lead to a high rate of inbreeding in much shorter time than in large populations. It can be shown theoretically (Robertson, 1960) that long-term selection response will be greater in larger populations simply because they harbour more genetic variability.

In populations with normally distributed traits, selection intensity increases somewhat with size. This increment is relatively modest and may have little impact on breed improvement except in well 'planned and precisely executed breeding schemes. Robertson (1960) has developed a theory which predicts that the total selection gain should be  $2 N_e$  times the genetic improvement of one generation selection. The half-time of the total genetic advance should be reached after roughly  $1.4 M$  generations ( $N_e$  = effective population size). However, in practical breed improvement, longterm time scales barely matter apart from the fact that the predictions were only partly substantiated by experiments. In breed improvement where changing market requirements etc. are

important, short term and medium term considerations would appear to be of overriding importance, i.e. selection gain over, say, a dozen or two dozen generations at the most.

The importance of population size on medium and long term genetic progress has been investigated in a number of experiments. Roberts (1966) reports from mouse experiments that the half-life of genetic progress is of the order of  $N/2$  generations. This indicates that genes with large effects are responsible for a large part of the genetic advance. The Australian group (Frankham *et al.*, 1968) reports rather large scale *Drosophila* experiments. They did find the expected connection between size of the population and selection intensity.

However, there was little change in the magnitude of realized heritability even though it increased slightly with increasing population size. On the long term, i.e. over 40-50 generations, large populations showed more progress but in the short and medium term the advantage of larger populations was rather modest. However, it must be emphasized that mass selection only was employed in the experiments.

An investigation by Hanrahan *et al.* (1973), employing mice, revealed clear advantages of larger populations. Effective population size was greater and the rate of inbreeding clearly lower in populations with 16 mating pairs than in those with 4 mating pairs. Genetic progress was greater in the larger population which is a consequence of a greater realized heritability. Selection intensity showed little difference which was to be expected due to within family selection.

Summarizing experimental investigations, larger populations permit greater selection gain, even on short term and medium term scale, partly due to greater selection intensity but mainly, however, due to greater realized heritability. The cause of the greater realized heritability in larger populations may be genetic drift which in smaller populations soon leads to increased homozygosity and thus to loss of genetic variability. A number of investigations indicate this in addition to theoretical expectations.

The other aspect of population size and genetic improvement concerns economics. Improvement work in large populations can be much more economical if one succeeds in spreading the genes of superior animals widely. Nowadays this may be accomplished by A.I. The advantages of large populations is great in particular if selection is very expensive as it is when progeny testing is used. A number of investigations indicate these advantages (Comberg, 1980).

The experimental investigations were performed with populations of comparatively small numbers. So the next question concerns the size of domestic animal populations and whether these are comparable with those mentioned above. The effective population size in respect -to inbreeding and drift of the latter is surprisingly small and comprises but a fraction of the real numbers.

We have investigated three Bavarian horse populations (Fehlings *et al.*, 1983). The Haflinger has an effective size of about 80, the Bavarian draught horse about 120 and the German trotter a little more. The figures are comparable to  $N_e$ 's from other horse and cattle populations. The inbreeding increment of U.S. Holsteins indicated, before introduction of A.I., an  $N_e$  of about 120 (Lush *et al.*, 1936) and that of the Bavarian Fleckvieh is not very different. Some populations have lower effective numbers and one may pose the question whether breed improvement work can be effective in such populations. However it can be stated that respect to effective population size, smaller breeds have numbers which are not much bigger than those of the largest experimental population investigated by Frankham *et al.* (1968) and others.

Another question concerns the connection between population size of domestic breeds and their genetic progress. Hintz *et al.* (1978) have published the estimates of yearly genetic progress of the five major U.S. dairy breeds over a period of about 15 years from the early 1960s to the middle 1970s. A perusal of the figures of [Table 1](#) indicates no connection between size and genetic progress of these five breeds - Brown Swiss have a

greater genetic trend than Holstein-Friesians even though their real numbers are but a fraction of the Holsteins and their effective size is also somewhat, though only little, smaller. The conclusion from this comparison must be that genetic progress depends on several things, possibly also on population size but that the latter's effect is overshadowed by other factors and that it is not discernible in the published figures. This may be due to the flattening of the curve relating genetic progress to population size when this curve approaches the asymptote. This flattening appears to occur at relatively low numbers ( $N_e < 100$ ) and other factors become much more important. At any rate, as can be judged from the figures published by Hintz *et al.* (1978) under practical circumstances population size appears to be a minor factor with regard to genetic progress.

**Table 1 GENETIC CHANGE IN YEARLY MILK YIELD OF U.S. DAIRY BREEDS**  
(Hintz *et al.*, 1978)

Breed	kg milk			Approximate number of yearly herd book registrations
	A.I. cows	Non-A.I. cows	A.I. bulls	
Ayrshire	36	36	24	11 400
Guernsey	25	35	15	24 500
Holstein	26	31	18	330 000
Jersey	25	13	18	38 100
Brown Swiss	38	36	35	13 100

In closed populations increase of the rate of inbreeding is unavoidable. However, the increase can be effectively postponed as has been found by Vangen (1983) in Norwegian horses or by Strom (1982) and Fehlings *et al.* (1983) who found inbreeding to be less than expected from inter se relationship. However, increase in inbreeding cannot be postponed indefinitely and at a later point inbreeding in such a population will even overshoot the level which would have arisen by continued panmixis (Robertson, 1964). Of course, any immigration will drastically reduce the level of inbreeding.

One must assume that populations of domestic animals are not closed to the same extent as laboratory populations are - in Central Europe herd books were never closed and only recently herd book societies on the continent have started to follow the Anglo-Saxon tradition in this respect.

Another question concerns the maximum intensity of selection compatible with a tolerable rate of inbreeding. The latter may be taken as the rate of inbreeding which is found in successful populations. In Holstein-Friesians this is roughly 0.4 percent F per generation. If one surmises that the inbreeding is largely caused by sires one arrives at a minimum number of about 30 sires per generation. The generation interval in cattle is about 5 years, therefore 6 bulls should be taken in every year, on average. This presupposes random mating after breeding animals have been chosen. If one would take one son from each sire and one daughter from each dam - not a realistic assumption if selection is to succeed - then the effective population size is roughly  $16 N_m / 3$  ( $N_m = n$  sires/generation). Again if 0.4 percent inbreeding increment is tolerated, 23 to 24 bulls should be used per generation, about 5 per year. These numbers are easily met by most breed societies.

## **2. BREEDING PROGRAMMES AND RESULTS IN TYROLEAN GREY**

The Tyrolean grey cattle number about 30 000 - 35 000 cows of which 4 000 - 5 000 are recorded each in North and South Tyrol. Insemination is Practised on about 40-50 percent but since herd size is small, the use of community bulls is the rule.

The practical genetic improvement via A.I. breeding programmes would appear to be severely hampered in such small populations. In many papers, the size of populations which permits sustained progress is in the order of several 10 000 and to become profitable the numbers should still be larger (Comberg, 1980).

The bottleneck in breed improvement lies in the selection of A.I. bulls which must be progeny tested and which would require testing of some 4 to 5 x as many bulls as are eventually desired. Furthermore, a certain number of selected bulls is required to avoid inbreeding to increase too rapidly.

In conventional A.I. breeding programmes (Comberg, 1980; Schmidt and Van Vleck, 1973) young bulls are testmated to produce 50 - 100 daughters which are tested for dairy performance which provides the criterion for selection of the bulls. About 1/5 to 1/3 of tested bulls are retained for general use while the future bull sires are chosen from the top 1/20 to 1/10 of all tested bulls. A programme such as this supplemented by efficient selection on the female side permits an increase in genetic merit for dairy performance of up to 2 percent of the average per year. However, the realized genetic advance is considerably less, more of the order of 1.0 to 1.5 percent.

The advantage of A.I. over natural service lies in the much greater numbers possible but also in the fact that daughters are distributed over many herds and preferential treatment or the prevalence of single herd effects in the progeny are unlikely.

Therefore, the fairly widespread use of community bulls and the fact that their progeny are distributed over many herds - not unlike the progeny of A.I. bulls - can result in some 15-20 daughters and thus permits a fairly accurate estimation of their breeding values. Naturally, the accuracy will be lower than that of A.I. bulls on account of the smaller number, but apart from this, the accuracy is comparable to that of A.I. progeny.

The bulls can and should be slaughtered after sufficient progeny - some 15-25 recorded heifers - can be expected. Before slaughter sufficient semen must be collected to permit their use as elite sires for producing young bulls. The procedure is fairly economical since it does not involve a waiting period of bulls or the storage of large quantities of semen. Rather the semen is collected after their use for natural service and the additional cost of the programme consists only of collection and storage of fairly limited quantities of semen. Therefore, many bulls can be tested and a fairly intense selection of bull sires is possible.

In Table 2 the theoretical genetic superiority of bulls selected in a conventional A.I. improvement scheme is juxtaposed to that of bulls from a young bull system as outlined. The differences are negligible but the loss of heterozygosity is less in the latter scheme and the costs would be much less than in the aforementioned "classical" A.I. scheme.

This "natural service" progeny testing scheme has been applied in the North Tyrolean Grey population beginning in 1977. In Table 3 bull numbers and selection intensity as well as progeny group size and age of bulls are outlined.

From 31 bulls whose semen was deposited in the 4 years 7 were selected. During this period the scheme had some difficulties as can be seen from Table 3. The numbers of progeny were uneven and the age of bulls at the time of semen collection became progressively older (the trend was reversed meanwhile).

The genetic progress in the North Tyrolean Grey population was estimated for the period 1977 to 1985. All the bulls were included which had progeny in at least 2 years. They numbered 98 with altogether 240 sire year averages (i.e. 2,4 per bull). The genetic progress was estimated via the regression of progeny average on year. The results given in Table 4 indicate considerable genetic improvement in the segment of the population which participated in the programme. In the case of milk fat-kg the genetic change amounts to more than 1.2 percent of the population average.

**Table 2 GENETIC SUPERIORITY OF BULLS SELECTED IN A.I. AND IN NATURAL SERVICE IMPROVEMENT SCHEME**

	Progeny Tested			r 1/	n 2/
	Testbulls	Bull sires	Cow sires		
AI	10	2	4	0.85	45
Δ G, kg milk/year		360	205		
Natural Service	30	3	8	0.71	15
Δ G, kg milk/year		370	260		

<sup>1/</sup> Correlation between breeding value and progeny average.

<sup>2/</sup> Size of progeny groups.

**Table 3 PROGENY TESTING OF NATURAL SERVICE BULLS IN NORTH TYROLEAN GREY CATTLE**

Year of semen collection	Tested/selected	n	Age of bulls in 1983
1977	5/2	33 (20-51)	9 ys
1978	15/5	22 (1-52)	8.5
1979	5/-	13 (3-17)	8
1980	6/-	9 (3-18)	7

The figures given in Table 4 indicate the natural service - progeny testing scheme was effective. It has been pointed out elsewhere that use of young bulls in A.I. and the use of progeny tested bulls mainly for production of the young bulls should give a high rate of genetic advance (Bar Anan, 1973). However, this was investigated for an A.I. population while the thrust of this paper is the procurement of progeny tests from natural service community bulls and selection of future bull sires from among these; The economy of this approach affords the possibility of progeny testing fairly large numbers of bulls which permits rather intense selection among them. Therefore the deficit in the accuracy due to lower numbers compared to regular A.I. bull selection schemes can be balanced by the greater intensity of selection possible. Therefore genetic progress due to such breeding plans should be competitive. However, in contrast to regular A.I. schemes more bulls participate in the reproduction which should decrease the inbreeding increment and increase the genetic effective population size (N ) thus permitting sustained genetic improvement without the necessity to import genetic material from other services.

Table 4 GENETIC PROGRESS IN THE NORTH TYROLEAN GRAUVIEH POPULATION 1977 TO 1985

	b daughters/bulls x year			
	Daughters of all bulls			Daughters of bulls in Nsprogeny testing programme
	1977-1985	1977-1980	1980-1985	
Milk-kg	0.3	6	12	-1.4
Fat-%	-.0025	-.0095	-.019 <u>1/</u>	-.01 <u>2/</u>
Fat-kg	-.3	3	-.6	-.8 <u>1/</u>
		$\Delta$ G/year		
Milk-kg	-.5	-11	-24	3
Fat-%	.005	.01	.04	.02
Fat-kg	.5	-.5	1.2	1.7

1/ p < .05

2/ p < .10

<sup>b</sup> regression coefficient of daughters of a bull on year.

$\Delta$  G/year genetic change per year.

### 3. SUMMARY

Genetic progress is expected to be greater in larger populations. Experimental investigations bear this out in populations of small size (up to 50 breeding animals). Empirical evidence fails to indicate any connection between numerical size and genetic progress in U.S. dairy cattle populations, also genetic effective size of populations of domestic animals appears to be similar, almost independent of actual size.

The large expense of identification of superior sires in dairy cattle breeding favours large populations. Therefore, low cost methods of identifying superior transmitters are of paramount importance if modern methods of genetic improvement are to be applied in numerically small populations.

It appears that progeny testing of natural service bulls in combination with intense selection permits effective identification of superior sires. Collection of semen from the young bulls as soon as sufficient progeny is assured permits their use as future bull sires. Therefore such a system should be a feasible alternative to the conventional A.I. schemes wherever general A.I. is absent and/or where the populations are too small to sustain large scale progeny testing and selection of A.I. bulls.

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**POSSIBILITIES OF UTILIZATION OF ENDANGERED CATTLE BREEDS IN PRODUCTION OF MILK, BEEF AND VEAL, IN CONSERVATION OF THE NATURAL ENVIRONMENT OR IN OTHER NON-ECONOMIC SPHERES**

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In the opening reports many economically important as well as other aspects were mentioned indicating quite explicitly the necessity of restoring threatened breeds or individual species of farm animals. Thanks to the intensive worldwide movement for conservation of the natural environment, where FAO and UNEP (1980, 1983) play such an important role in the sphere of animal production, practically all countries have gradually become aware of the need to preserve and conserve the diversity of present species as well as to pass on the results as fully as possible to future generations. We therefore appreciate that the present symposium will concentrate its attention on major species of farm animals.

We will consider genetic resources primarily in cattle, and contemplate the possibilities of utilizing threatened and disappearing breeds not only in the context of production of milk, beef and veal, but also in the non-economic sphere.

Let us consider individual possibilities of genetic resources preservation in cattle. Taking into account existing experience, present state of knowledge and further development of some biotechnical techniques in reproduction, particularly in cryogenic storage of sex cells and early embryos, the following possibilities of genetic resources preservation are available:

- small populations of living livestock;
- preservation of frozen semen;
- preservation of frozen embryos;
- combination of the above alternatives;
- establishment of a so-called gene-pool.

Each of these possibilities has its advantages and disadvantages, both of a biological and economic character.

The first possibility is the breeding of live animals in small populations where it is most important to avoid selection pressure and retain the complex of traits and characters of a corresponding genetic resource, unchanged if possible, from generation to generation. From the genetic point of view it is therefore imperative to choose a constant number of offspring per each sire and dam and through an appropriately controlled plan of mating (rotational system) prevent undesirable effects of inbreeding and random pressure, designated also as genetic drift and/or the effect of Sewal Wright, leading either to full elimination or fixation of some alleles.

The major disadvantage of the second possibility, when the genetic resources are preserved in the form of frozen semen only, i.e. from the sires, is that grading up through repeated matings of each next generation of crossbreds must be done with the semen of genetic resource to develop in such a way the preserved genetic resource in living animals, which must be carried out for five generations at least to achieve the gene proportion of the genetic resource amounting to approximately 97 percent. This accounts for a considerably long period owing to the length of the generation interval in the corresponding animal species. The possibility of practical use of the genetic resource obtained in such a way is therefore remarkably problematic in cattle. Supposing the generation interval is 5 years, 25 years will be needed to obtain living animals of the genetic resource. During this time economic conditions, market demands and technological systems may change so much that the development of the new genetic resource will no longer be desirable.

In terms of time, the third possibility, i.e. preservation of frozen embryos, is the most advantageous. Live animals capable of further reproduction may be obtained during one generation. The present state of development and utilization of this biotechnical method indicates its wide implementation in selection work in the immediate future. However the possible negative influences of those techniques on the transfer of pathogenic microorganisms and/or on future development should also be investigated in detail.

The fourth possibility consists in the combination of the above-mentioned possibilities. For instance, with live animals kept in small populations it is convenient to preserve the desirable number of sires through frozen semen to ensure the necessary rotational matings. The combined preservation of frozen embryos with frozen semen is also advantageous, which substantially extends the blood basis and thus the establishment of genetic resources in living animals. To avoid using grading up, prolonging considerably the "animation" of preserved genetic resources, it is convenient to sustain a certain number of living dams when frozen semen is used.

The fifth case, i.e. the establishment of a so-called gene pool, remains a theoretical possibility for the time being. Its realization is possible, of course, as evidenced for example by the American experience with the establishment of a gene pool in pigs. Again, generally it concerns the breeding of living animals obtained on the basis of one breed with subsequent inclusion of other breeds. Animals mate with one another which results in a mixture of various hybrids, out of which the animals of desirable type are obtained through strict selection, i.e.

not indigenous breeds entering the gene pool. In this case, the aim is not to preserve the breeds as such but their genes.

Therefore, this fifth possibility for back restoration of disappearing breeds is not simple. Desirable animals for such a gene pool may be obtained only through particular and long-term selection on in the course of a number of generations aimed at a desirable productivity type and an increase in the numbers necessary for reproduction.

An integral and important aspect in contemplating the choice of a certain possibility of genetic resource preservation is the economy, which plays an important role above all in the cattle, horses, pigs and sheep, while in subtle species of farm animals, particularly in poultry and rabbits, many indigenous breeds are preserved only thanks to enthusiasts.

Work by Brem *et al.*, (1982) provided some initial information. The data indicated that 5breeding live animals in small populations is the most expensive method. The second method is less expensive. However due to the necessity of grading-up for approximately 25 years, the final costs are particularly high. Another adverse feature of this method (when only semen is used) is the loss of resource of extrachromosomal genetic information comprised in the female sex cell.

The most favourable seems to be the use of frozen embryos and semen. Purchase costs are high. However live animals with genetic reserves are available within one generation. Therefore this method of preservation is recommended most frequently and indicative calculations carried out in Czechoslovakia in cooperation with the State Breeding Enterprises, General Management, also confirm this fact.

Detailed model calculations of costs for individual methods of genetic resources preservation in animal production were carried out by Smith in UK (1984a, 1984b).

Based on present current prices in UK the costs of genetic resources preservation in small populations, in the form of frozen semen and finally in the form of frozen embryos were established by Smith (1984c) in cattle, sheep, pigs and poultry, with the similar conclusion as that from Germany (Brem *et al.*, 1982).

Despite the high costs of genetic resources preservation in the form of live animals in small populations, in some cases this method is almost imperative and justified. In the context of general breeders, public, historical and cultural values, therefore also of international importance, it is hardly conceivable to breed a certain breed through a gene bank. However, in such cases too if not embryos, then at least semen of individual sires, participating in the development of a certain population in the course of its genesis, should be preserved, particularly due to possible inbreeding depression.

The review which is presented of costs of individual methods of gene resources preservation indicates equally the desired numbers of animals. These numbers must be minimal. In genetic resources preservation in small populations the ratio of 5 males to 25 females is currently reported, whereas the ratio of 50 to 250 is being recommended in cases with traits of low heritability. With the objective of ensuring consistent rotational matings the more convenient ratio is 1:1. When selecting males to freeze their semen, 25 unrelated animals must be chosen. Twenty-five different matings must be ensured to freeze the embryos.

Apart from their aesthetic and cultural significance, genetic resources preservation and conservation are important in terms of selection and thus are of national economic value.

Economic effects resulting from possible later utilization of the hereditary basis of the preserved genetic resources are given by the difference between the overall increase in performance of animals with the proportion of genes of the breed preserved and the costs for preservation of the breed used. In the model calculations by Smith (1984a) the product of the value expressing the used proportion of genes of the genetic

resource and relative profit in economic efficiency, expressing the justification of conservation and preservation of genetic resources, is underlined.

Also in this case we will make use of the model calculations valid for UK. It is surprising how low a proportion of genes of the genetic resource used is sufficient to achieve a great economic effect. This is, by the way, in harmony with the well-known experience that a seemingly high investment used for a relatively small number of selection herds is reflected in tremendous financial gains in commercial herds.

Under UK conditions Smith (1984a) chose the following example. He Presumed a genetic resource preserved for 20 years. After this period it was used again and would be used for another 20 years. A yearly inflation rate of 5 percent was considered. For instance, in dairy cattle, genetic resource preservation is fully justified at only 0.1 percent use of this resource, and at 1 percent profit in economic effectiveness. In the case of frozen semen, the values were even lower.

Thus, on a national-wide scale, the conclusion can be drawn from the above economic considerations that although the envisaged possibility for future use of genetic resources is small, it is worth preserving because the potential economic profitability will greatly exceed the costs for its preservation.

What is as a matter of fact the common feature of all endangered local cattle breeds? First of all it is their extraordinarily good adaptability to local conditions, i.e. relatively better utilization of local feed resources, resistance and longevity. The old proverb is fully true which says that a breed is the product of the soil, i.e. of the natural conditions under which it has originated and has been formed. This outstanding adaptability to extraneous natural environmental conditions can be illustrated by the almost disappearing breeds of the USSR, e.g. Kirgizian breed (Kasachian), Siberian, Petchorian, North Carrelian or Buryatyan (Zebrovskij *et al.*, 1984).

Perfect adaptability is also a prerequisite for a notable heterosis effect in possible commercial crossing of local breeds with improved cultural breeds thus providing better results compared with crossbreeding for improvement or grading up. Another important character, much appreciated by the breeders, is modesty and associated with it hardiness, so that production achieved, however low in comparison with a highly improved but demanding, breed corresponds fully to production conditions of the given region and for this reason is also economically advantageous. Local breeds are also distinguished for their satisfactory diverse, not only one specialized, performance. The quality of consumable products, i.e. milk or meat, of local cattle breeds is better regarding the ratio of their components, particularly protein and fat, and in terms of meat production, better taste and smell, due to a direct effect of free pasture or utilization of animals for draught.

We will now contemplate the possibilities of using local breeds for milk, beef and veal production. Without going too far for an example, we shall pay our attention to the characters of Bohemian red cattle formerly kept in our country. This breed of cattle has gradually disappeared and become a component of the Czech Pied cattle (Bílek 1926, 1933; Valenta, 1930; Smerha *et al.*, 1955). Bílek (in Smerha *et al.*, 1955) reports that the Bohemian Red cattle "were good draughters due to their lively temperament and breathing habits, were good dairy cows with yellow, fatty and very tasty milk, and butchers appreciated their good quality meat. Their major disadvantage was relatively late maturity for which they were displaced by earlier maturing, however, more demanding, Simmenthal Bern cattle with no better results in milk yield, ability to draught and longevity at relatively low demands achieved in the poorer mountainous regions along frontiers or in South Bohemia with its primary rocks."

Some concrete data on performance were reviewed by Valenta (1930) demonstrating that, e.g. in the Giant Mountains, the liveweight of Red cattle was higher compared with Bern Bohemian cattle and that with respect to their liveweight (522.2 kg) and low protein consumption (251 kg) they showed the most economic milk production amounting at that time to 2817 kg with 4.1 percent fat, being the highest of all the breeds compared.

The situation was also similar in the country of our hosts with their Polish Red cows always giving a desirable performance due to their advantageous characters and following further improvement by Polish breeders. On this occasion we would like to recall the International Agricultural Congress in Warsaw, 1925, which accentuated local breed maintenance as one of the most attractive items of the working programme in the sphere of animal production (Bílek, 1933).

In Hungary, where Hungarian Gray cattle have been successfully conserved with 187 females and 6 bulls, a number of experiments demonstrated the suitability of these cattle as a component part in maternal lines in the production of beef by crossbreeding (Bodó, 1985).

Similarly we could report on local cattle breeds in other European countries. In this connection as an example we refer to a publication on autochthonous cattle breeds in Spain (Belda, 1981) with 25 breeds recorded.

The situation overseas does not differ, of course. For further illustration only we present some conclusions from the comprehensive study by Wilkins (1984) on Criollo cattle in both Americas, and in various countries of Latin America in particular. This study provides explicit evidence that grading-up of these cattle aimed at obtaining a more cultural breed was a mistake because the purebred Criollo, which is not to be preserved and extended, has a whole number of more favourable characters when compared to both European breeds and zebu.

Compared with zebu, for instance, Criollo cattle have not such a developed herd instinct so that animals are scattered over pastures, which is of considerable advantage under Bolivian conditions. Also the temperament of the Criollo is milder compared with zebu. Zebu is a wilder animal and therefore worse to manage and that is the reason why even hybrids are refused by farmers. However zebu hybrids achieve better meat production and, using the knowledge of genetics of quantitative traits, also show higher fecundity, reduced mortality in calves and a higher growth rate.

Crossbreeding with European dairy breeds is beneficial; the adaptability of the tropical breed with the high milk performance of the European breed is achieved explicitly with the  $F_1$  generation, but not in the following generations.

The Criollo, improved by selection for higher milk performance, is very favoured in small isolated farms in the countries of Latin America where its production amounting to over 2000 kg milk for rearing a calf is fully satisfactory for farmers's needs because under such conditions no hybridization scheme can be used (Wilkins *et al.*, 1984).

However here we are in the sphere of ecology, particularly in the sphere of complicated relationships between organisms within pasture chains (Farb, 1977; Odum, 1977). In our case this concerns the so-called pasture chain beginning with green plants, continuing over herbivorous to carnivorous animals; compared with other chains it is relatively simple.

In essence, the effectiveness of pasture depends on two decisive circumstances. First, on their primary productivity and, secondly, on the share of net production which can be annually taken away so that sufficient reserves ensure the future grass stand and plant composition to survive occasional periods of bad weather such as drought etc. (Humphrey, 1949).

When the reasonable utilization of pastures is ensured - and under this precondition only - local cattle breeds, which spread out on pastures, can considerably contribute to better pasture utilization and cultivation, particularly in mountainous regions, so forming a grass stand of good quality and preventing the loss of pasture areas which occur usually on the edges of forests due to natural self-sowing. History speaks mostly of the opposite case when excessive overgrowing of pasture stands has resulted in erosion first and later in complete landscape devastation (Dorst, 1974). Another practical and important characteristic of local cattle breeds in

terms of selection is their use as a control population not only with the breeds developed from them through improvement or grading-up but also with imported breeds substituting them gradually. In all cases the technique of frozen semen or early embryos may be used, i.e. the widespread preservation methods used in cattle breeding.

Justification of conservation and preservation of disappearing and endangered local breeds is not based on their economic utilization only. There is a whole range of other aspects that should be taken into account in terms of cultural, historical, research, study and other points of view some of them having already been mentioned and referred to so truly by Maijala (1984).

From the cultural and historical aspects, local cattle breeds represent a vivid proof of the creative work of ancient selectioners and breeders establishing many populations through experience and observation and therefore being as valuable a monument as a costly restored and preserved historical construction.

Hence, from the point of view of selection process the endangered and disappearing cattle breeds, as well as all other species of economically significant animals, are extremely valuable material reflecting accurately the goals of past national economies and also the concept of selectioners at that time of animal body conformation. The existence of living animals of these breeds facilitates important comparative studies of anatomical and particularly physiological character, determination of many polymorphous traits enabling evaluation of phylogenetic relations in presently kept breeds, etc.

It is therefore highly desirable to present typical individuals of the endangered and disappearing cattle breeds at agricultural shows for object studies on possible changes in animal performance and breed during the process of improvement. This would be of special value when such breeds are kept in conserved regions, sanctuaries, etc. as already mentioned in the example from Hungary.

In conclusion it can be deduced that the possibilities of utilization of endangered and disappearing local cattle breeds as well as other animal species are indeed versatile. In any case we must not forget our moral and human obligation to preserve these breeds for future generations as a vivid proof of the creative activities of man. If the human community can spend astronomical sums on armaments, construction of spaceships and technical development, then it ought not to hesitate to devote a negligible fraction of these expenses to conserve and preserve natural resources including endangered breeds because they are decisive and necessary for the further existence of man on this planet.

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## **POLISH RED CATTLE - BREEDING, BREED PRESERVATION AND UTILIZATION**

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## 1. HISTORY OF THE BREED

The Polish Red breed (PR) belongs to the brachycephalic type of cattle that has existed in central Europe since prehistoric times and was reared by western and northern Slavs. Until the second half of the 19th century no organized breeding work aiming at improving the basic directions of local breed performance had been conducted. According to Jakóbiec (1959) the most important influence on the formation of this primitive local breed has been the specific mountain and submountain environment of southern Poland where in small farms the only feed available is hay in winter and poor pastures in summer.

In the 19th century many enlightened farmers were already aware that the local cattle varieties had such qualities as strength, resistance to diseases, good roughage utilization and adjustment to local rearing conditions (Rolnik i Hodowca, 1899). The native cattle were acknowledged as being the most suitable for small farms and where conditions did not allow intensive breeding. According to Pruski (1967) local cattle populations varied in colour - from black and brown to red and mouse-grey.

When discussing the history of the Polish Red breed Pruski (1967) reports that the local cattle were concentrated mainly in the area of sub-Carpathia, Swietokrzyskie mountains and Lomza. Because of poor industrial and transportation facilities the market for milk and milk products was very small. Thus, good milk performance was not the most important aim in breeding. According to Pruski (1967) Swietokrzyskie cattle of one colour were known in the middle of the 19th century as being mainly good oxen.

In the second half of the 19th century an important role in improvement of dairy breed performance was played by large herds formed from cattle purchased from small farmers. Among the first herds were those formed by Jan Popiel in Wójeza and Adolf Rudzki in Branszczyk in 1869.

Sub-Carpathia was an important region as far as breed improvement was concerned. In 1894 the Red Cattle Breeders' Association was established under the auspices of the Agricultural Society in Cracow. At that time Stefan Romer from Jodlownik formed a Red cattle herd which is still existing. In 1906 official milk performance recording was introduced. First herd books of the Polish Red cattle were published in 1913. At the beginning of the 20th century other important herds were formed by Kuberski in Subierczyn, Frackiewiez in Wieprzowe Jezioro, Czecz in Kozy, Slonecki in Jurowce, Bujwid in Wolica, and Mars in Limanowa.

After the Second World War the most important breeding herds of Polish Red cattle, apart from Jodlownik, were those in the Experimental Farm in Konskowola, the State Pedigree Breeding Stations in Koszecin, Elk and Tarnawatka, the Animal Science Experimental Farm in Grodziec and Rossocha, as well as individual farmers' herds: in the Wysokie Mazowieckie centre, the herds of F. Kulesza in Golasze-Puszcza, M. Wlostowski in Mystki-Rzym, J. Kulesza in Kalinowo-Czesnowo; in the Podhale centre, the herds of A. Serafin in Kobylec, L. Krzak in Golkowice, J. Zur in Chabówka W. Majchrowicz in Skawa; in the Cieszyn centre, the herd of J. Miech in Godziszów; in the Lubliniec centre, the herds of S. Piechaczek in Sucha near Strzelce Opolskie and Kolaczuch in Harbutowice. Many of the herds mentioned had already existed for about 40 years or more.

After the war many scientific centres carried out investigations on the improvement of Polish Red cattle; the following scientists should be mentioned: Professors Z. Zabielski, M. Czaja, T. Marchlewski, Szezekin-Krotow and H. Jasiorski and Drs. S. Poczynjlo and K. Zukowski.

Milk productivity of Polish Red cattle was not high (Table 1) due to the lack of selection in the post-war period when the main task was to reproduce a sufficient number of animals. Since there was no marked progress in milk performance, in 1950 upgrading with Danish Red cattle was introduced by Prof. M. Czaja in the Animal Science Experimental Farm in Grodziec Slaski (Zukowski and Luchowicz, 1964).

Table 1 DAIRY PERFORMANCE OF POLISH RED COWS

Year of recording	Average	Average year productivity		
	number of cows	Milk kg	Fat kg	Fat %
1955	11 990	2 425	93	3.85
1960	23 633	2 551	99	3.87
1970	13 065	2 901	116	4.01
1975	5 365	2 961	121	4.09
1980	4 245	2 901	118	4.05
1985	1 414	3 085	130	4.21

A total of 1969 full lactation records were collected from 481 cows sired by 51 bulls (Table 2). Milk productivity was over 17 percent better in cows with 1/4 Danish blood, 19 percent in 1/2 Danish cows and 22 percent in cows with 5/8 and 3/4 Danish blood.

In 1959 the first Red Danish herds were established, mainly in the State Pedigree Breeding Stations, from a few thousand heifers imported from Denmark. At the same time crossing was introduced in mass breeding and in breeding herds. For this purpose, Red Danish and crossbred bulls were purchased for the insemination stations in all areas in Poland where Red cattle were bred, except the Cracow region where Danish bulls were not imported until 1964. The main effect of this crossing programme seems to be a steady increase in fat content in the milk of Polish Red cows observed over the last ten years (Table 1).

According to Szarek et al. (1981) the quantitative and qualitative needs of the Polish milk and beef market changed in the 1960s. In order to adjust Polish Red cattle to changing maintenance and utilization conditions resulting from better feeding, other attempts at upgrading were made. Red Danish and Jersey cattle were used as improving components (Jasiorowski and Poczynajlo, 1970). A change for the better in the dairy performance of crossbreds was evident (Table 2). This crossing model, however, was not adopted in practice because of the poorer beef performance of the offspring. Red and White bulls were then used for crossing. They improved milk productivity by about 400 kg and even if they did not improve beef performance, which took place especially when body weight was lower than 450 kg (Nahlik, 1973), they did not make it worse (Szarek *et al.*, 1981-Table 6).

**Table 2 DAIRY PERFORMANCE OF PRIMIPARAS OUT OF PR COWS WITH DANISH RED OR JERSEY BULL MATINGS**

Genotype	Milk	Productivity kg		
		Fat	Fat Content %	Source
Polish Red	2 561	100.0	3.97	Jasiorowski H., Poczynajlo S. materials of IGHZ PAN Jastrzebiec, 1970: performance in the Bull. Eval. Station, Szepietowo
PR x Danish Red	4 287	175.3	4.09	
PR x Jersey	3 733	175.2	4.69	
Polish Red	2 334	93.6	4.01	Zukowski K.: Effect of improving crossing with DR cattle on dairy performance of Polish Red cattle (experimental data ) from Exp. Farm in ZZD Grodziec S1.), 1970, Ms. PP 99.
PR x Danish Red (DR)	2 781	111.4	4.00	
F <sub>1</sub> x F <sub>1</sub>	2 698	107.3	3.97	
3/4 dc DR	3 163	125.8	3.98	
3/4 DR x 3/4 DR	3 565	142.4	3.99	

By the end of the 1970s crossing with Angler bulls began. First results were encouraging. F<sub>1</sub> cows in a first lactation produced 1000 kg more milk and 0.15 percent more fat than the daughters of Polish Red bulls (Staszczak, 1985). The Angler crossbreds were decisively of dairy type.

By the end of the 1960s the population of Polish Red cattle was about 2 million animals, i.e. about 18 percent of the whole cattle population in Poland. A tendency in the 1970s to intensify Polish agriculture resulted in the disappearance of Red cattle from the greater part of the area where they had existed up to that time. This was also a consequence of administrative directives. The herds of Red Danish cattle also ceased to exist at that time, some because of mass leukaemia, others as a result of new opportunities for export of young beef slaughter cattle not including, however, Red bulls which in the importers' opinion were not suitable enough for fattening. In northern and central Poland, Red cattle were replaced by Black-and White cattle, and in south-eastern Poland by Red-and-White cattle.

## 2. PRESENT SITUATION

A concentration of Polish Red cattle still remains in sub-Carpathia within the boundaries of the Nowy Sacz province. This population, together with animals disseminated in the adjacent Bielsko, Tarnów and Cracow provinces, is estimated to comprise 100 000 cows. Another 100 000 Red cattle are found in enclaves in Białystok, Kielce and Rzeszów provinces. These two populations together form about 3 percent of the whole Polish population of cattle.

Breeding work was continued only in the Nowy Sacz province and in the surrounding area. Since 1975 this work has been conducted in line with an officially accepted breeding programme. Milk recording is applied to under 1 500 cows. The main centre around which this work is concentrated is the State Animal Breeding Station in Jodłownik where breeding bulls are performance tested in rearing stations. Milk progeny testing is carried out at the station. Seven young Red bulls purchased every year by Animal Insemination stations in Brzesko and Zabierzów are tested in this way About 50 percent of cows in the Nowy Sacz province are inseminated. An interest in this native breed and willingness to breed it may be testified by the fact that since 1982 when the

official regionalization of cattle breeds was cancelled, the regions mentioned previously have bought from the Nowy Sacz region considerable amounts of semen of proven Red bulls.

Environmental conditions in sub-Carpathia have improved in recent years. Feeding of cows is better and production has increased. Breeders anticipate better animal material capable of higher productivity. Tables 3, 4 and 5 show characteristics of milk and beef performance of Polish Red bulls tested in recent years. The aim of future work will be to breed animals of higher productivity and fat content in milk which determines the price. With present needs in view, upgrading with the Angler breed is carried out. In the Nowy Sacz province a moderate crossbreeding programme with 50 percent bulls which constitute a half of all the bulls used for insemination is practised. In the remaining regions of Red cattle breeding use is made of the semen of proven Angler bulls received by the Cattle Breeders' Association in Nowy Sacz from the Angler Cattle Breeders' Association in 1983 and 1985.

**Table 3** PRODUCTIVITY OF RP PRIMIPARAS IN STATIONARY MILK PROGENY TESTING OF BULLS IN POHZ JODLOWNIK IN YEARS 1980-1984 (Nahlik K., Bienkowski M. and Zukowski K., 1986, in press)

No. of primiparas	No. of sires	Calving age months	Dairy performance					
			Days of milking	Milk kg	Fat kg	Fat %	Protein kg	Protein %
342	30	28	271	2 574	110	4.28	88	3.40

**Table 4** GROWTH AND DEVELOPMENT OF PR HEIFERS IN THE PROGENY BULL EVALUATION STATION IN POHZ JODLOWNIK FROM 1980-1984

No. of:		Body weight at:		Measurements at 18 months age:			Index of:	
Heifers	Sires	12 mths kg	18 mths kg	Height at withers cm	Forechest depth cm	Forechest circumference cm	Depth	Massivity
390	30	264	348	117	59	161	50	138
				Measurements and indexes 10 days after calving			Index of:	
Primiparas	Sires	Calving age months	Body weight 10 days after calving	Height at withers cm	Forechest depth cm	Forechest circumference cm	Depth	Massivity
342	30	28	437	121	64	174	53	144

**Table 5** BEEF PERFORMANCE TEST RESULTS OF YOUNG BULLS IN THE JODLOWNIK REARING STATION (Szlag and Nahlik, 1980-84)

No. of bulls	Body weight at 12 mths of age kg	Daily gain: 121-360 days g	Height at withers cm	Forechest circumference cm	Index of massivity
244	398	1 132	117	167	143

The aim of breeding work is to achieve an average milk production of 3500 kg with 4.5 percent fat content and 3.6 percent protein content as well as to improve lactation length to about 300 days. The body weight of Red cows should be 450-500 kg and height at withers 125 cm.

It is expected that this programme for the improvement of Red cattle will lead to the formation of a population with at least a 25 percent share of the Angler genotype. At the moment it is difficult to predict to what degree the genotype of native cattle will change.

Stalinski (1985), when discussing the future of Polish Red cattle as a breed in danger of extinction, supposes that if the breed improvement process is still based on a small, as at the moment, active population and concentrated (including the production of sires for the breed) around only one herd - Jodlownik - it will be necessary to look for "genetic qualities from the outside" and then only will it be possible to talk about Polish Red cattle as a gene reserve in preservation herds. The author is convinced of the necessity to preserve the breed.

At present two programmes are being carried out: breed improvement and preservation of the gene pool. In view of the need to preserve the old Polish Red breed type the following action was undertaken:

- a reserve of semen from 39 Polish Red sires was formed (an average of 320 doses per sire);
- embryos were frozen from the most valuable cows (long living, fertile and healthy). Sixty-nine embryos from 19 cow donors were collected (Wierzbowski *et al.*, 1984). It is planned to collect 650 embryos from 50 cows which, according to Smith (1984), may provide a sufficient frozen genetic stock;
- three preservation herds comprising 280 cows were established. The cows were purchased from all the regions where the breed was kept. The male to female ratio is planned to be 1:10 to 1:15. The herds will be divided into groups comprising 10-15 females.

The size of the preservation herd will be constant, thus only a very small percentage of offspring will be necessary for herd reproduction. In order to prevent a decrease in variability, offspring will not be selected. To counteract too much inbreeding only one son per sire will be left for rearing and, if possible, one daughter to replace her mother.

### **3. CHARACTERISTIC TRAITS OF THE POLISH RED BREED**

Environment, and most of all feeding, have not led to high milk Production in Polish Red cows. Natural selection in this breed developed traits which make it possible to adapt to local conditions but which, unfortunately, usually lead to low milk production. A very slight improvement of performance traits through selection was accomplished and so the breed is not specialized and is characterized by a high genetic variability of productive traits. Average milk production of cows in small private farms is about 2500 kg with a general tendency for lactation to be restricted to 200-250 days. The cows whose milk performance was recorded in 1985 produced 3055 kg milk, with 4.21 percent fat and 130 kg fat. In various dairy laboratory analyses it was found that protein content in milk in Red cows reaches 3.5 percent and dry matter content 12.7 percent. The milk, from these cows is highly regarded by the dairy industry due to the higher output and quality of casein coagulum which is necessary for cheese production. Table 8 presents a comparison of dairy industry data from adjacent regions where Polish Red and Red-and-White cattle are bred. To produce one unit of low-fat cottage cheese, less than 6.2 percent milk from Red cows is needed. For high-fat cottage cheese this difference reaches 5.5 percent. Dairy industry technologists feel that the milk from Red cows is the most suitable for the production of noble cheese types, especially emmentaler.

Beef performance traits are rather poorly developed in the Polish Red breed. Young cattle fattened extensively and semi-intensively give fairly good results, but because of the small size of an animal, fattening has to be finished early. Bulls should be slaughtered when their body weight reaches about 400 kg since further fattening is unprofitable because of the early development of a fatty carcass and low weight gains (Szarek *et al.*, 1980). Fattened cattle utilize roughage feed well. Their carcass tissue composition and dressing percentage are good. They do not, however, belong to the highest slaughter classes. Excellent material for fattening is obtained by mating Red cows to beef-type Charolais or Simmental bulls (Tables 6 and 7).

Table 6 BEEF PERFORMANCE OF PR BULLS X CHAROLAIS; PR X RED- AND-WHITE (RW), AND PR X SIMMENTALER CROSSBREDS  
(Szarke *et al.*, 1980)

Trait	Genotype			
	PR	PR x RW	PR x Sim.	PR x Charol.
Mean daily gain from 120-500 kg	720	709	769	733
Consumption of oat feed units per 1 kg gain.	7.3	7.2	7.1	7.3
Dressing percentage	57.6	57.6	58.6	59.5
Meat share in a carcass-side %	68.3	69.6	71.6	70.5
Fat share in a carcass-side %	10.4	9.1	7.8	9.2
Musculus longissimus dorsi section area (cm <sup>2</sup> )	77.8	93.4	92.1	90.2

The investigations of Cieslar and Wawrzynczak (1978) show that when compared with Red-and-White, Polish Red cattle are distinguished by good quality meat properties, i.e. better raw meat consistency, better texture after heat treatment, more tender, juicy and better organoleptic qualities. Meat of Polish Red bulls has the highest indices of so-called total quality.

Table 7 NORMS OF RAW MATERIAL EXPENDITURE IN CHEESE PRODUCTION

Assortment	Breed Region	Producer	Raw material expenditure for production of 1000 kg cheese calculated so-called plasma units of milk		
			Year average	Winter season	Summer season
Low-fat	RW	Bobowa	8 202	8 062	8 342
Cottage	RW	Gorlice	8 112	8 094	8 130
Cheese	PR	Nowy Targ	7 690	7 060	8 320
	PR	Zakopane	7 706	7 566	7 846
High-fat	RW	Bobowa	8 228	8 202	8 374
Cottage	RW	Gorlice	8 364	8 314	8 414
Cheese	PR	Nowy Targ	7 829	7 150	8 508
	PR	Zakopane	7 957	7 690	8 224

Source: 1986 Woj. Zw. Sp. Melecz., Nowy Sacz.

**Table 8 COMPARISON OF SLAUGHTER VALUE OF FATTENED BULLS  
(IN SLAUGHTER CLASS A)**

Breed	No. of animals	Pre-slaughter weight	Dressing percentage	Share of 5 cuts in hot carcass	Share in 5 cuts		
					Meat	Fat	Bone
PR	10	483	53.1	61.6	75.4	6.4	18.2
RW	17	499	53.9	58.0	72.4	9.0	18.6
Sim	8	534	55.9	59.0	75.8	6.5	17.7
PR x Ch.	9	509	57.3	62.0	77.2	6.2	16.6
PR x Ch.	13	516	57.5	58.7	75.4	8.0	16.7

The Polish Red breed has features typical of primitive populations which are well adjusted to local environmental conditions and management. This is expressed in longevity, resistance to diseases, good fertility and good calf-rearing performance. This may be illustrated by the fact that there were no problems in choosing 14-20 year-old cows which were still fertile to be donors of embryos for genetic reserves (Wierzbowski *et al.*, 1984).

The results achieved in test bull rearing stations proved the good reproductive ability of this breed. Only 2 percent Red bulls are culled because of bad semen quality which could not be used for reproduction. In Black-and-white and Red-and-White bulls 9 percent of animals were culled for this reason (Szlag and Nahlik, 1980-1984).

The health of Polish Red cows is much better than that of Friesian cattle. Metabolic disorders, footrot and limb and hoof ailments are practically unknown in Red cows. Udder inflammation is also rarely found. The good health standard of the breed may also be testified by the fact that in a group of 400 cows, mostly old, purchased from several provinces to complete preservation herds, no cases of illnesses, including leukaemia, were officially recorded.

#### **4. PROSPECTS TO UTILISE THE POLISH RED BREED**

It is difficult to foresee at the moment which traits characteristic of the Polish native breed may be utilized in the future. Friesian cattle including Holsteins, although having undeniable production qualities are characterized by lower fertility and susceptibility to numerous diseases and thus their period of production is shorter. As a result even when milk productivity increases, the economics of cattle breeding become unattractive due to the poor results from rearing young cattle. Polish Red cattle have these qualities which highly-productive breeds lack.

Sceptics claimed that it was no use building up genetic reserves since from the economic point of view crossing with low-productive local breeds would not be profitable. In recent years, however, the situation has changed. Due to the development of genetic engineering it becomes possible to use not only the whole genotype or genome, but also selected chromosome fragments which carry particular genetic information. Theoretically, this would make it possible to introduce a qualitatively important trait without the risk of causing a decrease in the performance parameters which could take place in the case of a simple interbreed crossing.

The possible utilization of primitive breeds does exist. In Poland some pastures are not fully utilized because of unfavourable environmental conditions and it would appear that feed reserves both in the north and on mountain pastures could be successfully used by Red cattle.

At present it is difficult to predict the future nutritional diet for ruminants. At present more and more grain feeds are being used. In the years to come it might be advisable to offer cattle feeds which are not suitable for human consumption, i.e. forage, straw and by-products of agricultural production. Animals of the Polish Red type could prove very useful in a production system based on straw feeds complemented with concentrates.

If local breeds are distinguished by some specific production qualities characteristic of a given genotype, there should be no doubt as to the necessity of their preservation. There are some specific examples of local breed utilization for the improvement of production traits, as in the case of crossing Finnish sheep with Romanowska.

It is likely that quality, including taste of products of animal origin will become so valued with time that they will be given economic importance. Then the positive traits distinguishing the milk and beef of Polish Red animals will be appreciated, which could become the basis for wider breed utilization.

Genetic reserves in the preservation herds may also be treated as a control group in the estimation of genetic progress in the active population. Animals from preservation herds may be used in immunogenetic, physiological and nutritional investigations.

Those who are against the active protection of local breeds of domestic animals emphasize the costs of this undertaking. Also, there is no certainty that the protected breeds will ever be useful and therefore they doubt if these activities are justified from the economic point of view. These doubts are difficult to be refuted with valid arguments. However one may certainly talk about reasons of an aesthetic nature, willingness to preserve elements of material culture of previous generations or, simply, saving from complete extinction. We live in times when the views on future development models of civilization on our globe are changing. This change is caused by the shortage of energy and minerals. If it is desired to have the possibility of manoeuvrability in animal breeding, we cannot waste the genetic potential of local breeds.

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### GENETIC ANALYSIS OF THE EUROPEAN BISON POPULATION

Wanda Olech 1/

In 1923, at Poland's suggestion, the International Society for the Protection of the European Bison was created. Its principal aim was to preserve the European bison by planned breeding and reproduction. Stocktaking in 1924 showed that only 54 individuals existed (29 males and 25 females) with a reliable pedigree. The European bison pedigree book was initiated for this species and it is still in operation. For each animal the book contains its sex, number, name, dates of birth and death, numbers of parents and breeding place.

The species was derived from a foundation herd of only 17 animals. Some pairs of ancestors were represented by only one descendant and that is why the gene pool of the species contains only 12 genotypes. It was impossible to prevent inbreeding in this population, and in consequence the inbred animal has a negative influence on viability, fertility and health. The aim of this paper is to show the situation in the population of European bison born before 1985 according to their inbred level.

The European bison is a wild species living in a mostly natural environment, but mating is under control. This is why very interesting material exists for studies on inbreeding and its effects.

For bison born before 1985 the following values were computed: inbreeding coefficient, length of life, and for females also age at first calving, average interval between calvings and number of offspring.

Mean value of inbreeding coefficient for 4509 animals is  $0,202 \pm 0.002$ ; for 68 individuals it is greater than 0.500. Such a high value of inbreeding coefficient can seldom be found in stocks of farm animals. That fact could lead to the conclusion that the population of bison has degenerated. This is not true: bison are very well adapted to their living conditions, they are healthy and their reproduction level is satisfactory. It was noticed that only young animals were sensitive to a high inbred level. With the growth of inbred level the percentage of juvenile deaths increases. The chi-square test showed that this influence is highly significant. Table 1 presents percentage of juvenile deaths (in to the age of two years) in groups with a growing value of inbreeding coefficient.

Correlation between inbred and some reproduction traits was estimated, and the results are presented in Table 2. Correlation coefficients are rather low, the only significant fact being that inbreeding increase: the average interval between calvings and the age at first calving and indirectly decreases the number of offspring. This influence is highly significant but still rather low. If parents have high inbreeding coefficients, the smaller number of their offspring takes part in further breeding (i.e. have offspring themselves). On the whole,, such a low influence of inbreeding on reproduction traits is surprising.

**Table 1** PROPORTION OF JUVENILE DEATHS ACCORDING TO INBREEDING COEFFICIENT VALUE

Inbreeding coefficient value (%)	Number of animals	Percentage of juvenile deaths
0-3	608	21.55
3-10	616	25.00
10-17	690	22.61
17-24	744	20.57
54-30	779	21.57
30-37	528	25.76
37-44	306	25.16
44	238	29.41

**Table 2** CORRELATION COEFFICIENTS BETWEEN INBREEDING COEFFICIENT AND SOME REPRODUCTION TRAITS

	Females	Males
Age at first calving	0.14 xx	
Average interval between calvings	0.15 xx	
Number of offspring	-0.116 xx	0.022
Proportion of offspring for breeding	-0.070 x	-0.097 x

Percentage of genes of each of the 12 ancestors was estimated for all bisons born between 1980-1984 (876 individuals). The results obtained were almost the same as given by Slatis (1960) for animals living in December 1954 (Table 3). The proportion of ancestral genes has practically remained unchanged in 30 years. Unchanged genetic contribution proves that variability of the population was preserved, which is rather difficult to obtain in inbreeding.

Table 3 PROPORTION OF ANCESTOR GENES FOR BISON BORN BETWEEN 1980 AND 1984.

Number, name and of ancestor	sex	Proportion for bison living in 1954 (Slatis)	Proportion for bison born between 1980-84
15 Begriinder	M	7.05	8.2
16 Plavia	F	7.70	9.1
35 Plevna	F	3.23	2.7
42 Planta	F	19.30	18.8
45 Plebejer	M	27.03	26.4
46 Placida	F	1.33	0.9
87 Bill	M	7.71	7.2
89 Bilma	F	10.09	9.6
95 Garde	F	3.51	3.8
96 Gaczyna	F	5.68	6.3
147 Bismrck	M	0.62	0.9
100 Kaukasus	M	6.74	6.1

The reconstitution proved to be successful because the genetic variability has not been lost. The inbreeding depression has rather small effects on adults but results in lower viability of young animals. It is probably an indication of natural selection, the intensity of which is directly proportional to the inbreeding coefficient.

The reconstitution was successful due to several reasons:

- great number of breeding places (thus subpopulations were formed);
- loss of artificial selection - only natural selection which favours healthy and vital animals;
- keeping animals in their natural environment, which avoids development of physical sensibility.

### **THE ROLE OF SHEEP AND GOAT GENE RESOURCES IN PRODUCTION, NATURAL ENVIRONMENT CONSERVATION AND IN OTHER ACTIVITIES**

L. Veress 1/

#### **1. INTERNATIONAL TRENDS IN SHEEP AND GOAT BREEDING**

There are two trends in modern sheep and goat breeding: to compete with other branches of agriculture, producers strive to increase products per animal and thus decrease production costs. Of necessity, sheep and goat breeding becomes intensive (Veress, 1984).

The rural population will leave areas unfavourable for agricultural production, arid and semi-arid steppes and mountain regions if sheep and goat breeding is not supported by the state and consequently these lands will become unused (Veress, 1984). The examples are some mountain pastures in Yugoslavia and Slovakia, where the number of sheep has greatly diminished. In UK, the Soviet Union and a number of other countries sheep and goat breeding is supported by the state in such regions to retain the population and protect the environment.

Ancient breeds have mostly survived in regions having unfavourable conditions where views on breeding and economy are more conservative. It is also in these regions where efforts are made to preserve them.

Unfortunately breeding in farms of these regions is carried out with the help of their own gene reserves, which diminishes their chances of making a profit. This process in itself therefore does not guarantee the prevention of further decreases in the population and the immigration of genes. The creation of the "Rare Breeds Survival Trust" in UK is considered an important step on an international level. This Trust gives further support to preserve breeds that have a less than 20 percent ratio from outside the breed. It is firmly believed that the ancient breeds can only be preserved if state aid is accompanied by social unity together with financial support.

This conviction led us in 1982 to establish the Society of Hungarian Racka Breeders whose members are mostly private breeders. Breeding and further improvement of Racka sheep are carried out by the members partly through a sense of patriotic duty to preserve this noble and well-composed breed. Apart from the fact that this activity gives pleasure, it is also a useful hobby.

The leaders of the Society were elected by the members and they do their jobs unpaid. Since the Society was founded, interest in Racka breeding has increased, the stock has also multiplied and breeding animals have also been sold abroad. Meetings and consultations are held on workdays but out of working hours.

## **2. WHAT ARE THE REASONS FOR PRESERVING ANCIENT BREEDS?**

It is well-known that local breeds are well-adapted to local conditions, in many cases with an unfavourable climate, and that they utilize the less attractive vegetation better than culture breeds. For example, the main feed of the North Ronaldsay sheep are the mosses washed onto the sea-shore (Alderson, 1981). In fact, crosses with culture breeds will not improve, but in certain cases decrease, the productivity of the population (Hodges, 1984).

Several local breeds seem able to resist certain diseases (piroplasmosis, scrapie, etc. - Rendel, 1981).

Growth rates of several local breeds remain stable in poor feeding seasons, but these are fully recuperated on spring pastures. Other breeds such as fat-tailed and fat-rumped sheep endure thirst and hunger excellently, and use their fat deposits to satisfy their needs.

Especially at the turn of the 19th and 20th centuries, experts aimed at a thicker skeletal conformation of culture breeds. They supposed that the animals might grow stronger this way. The clumsy, usually diploe-skeleton resulted in difficult lambing. The unrefined breeds are usually characterized by finer skeletons and easy lambings.

All over Europe breeders nowadays are forced by the slaughter animal trade to produce animals that are not far from the phenotypes of the so-called terminal breeds. The outcome is that within the English Down breed type, mature weight differences between the early maturing Southdown and Dorset Down types and later maturing Oxfordshire Down and Suffolk breed types diminish, or more exactly body weights in both breeds become higher (e.g. American Suffolk). A similar case can also be seen with mutton Merinos, since their mature weight has increased by about 40 percent in 30 years. I consider it to be even more irrational that milk Friesians are selected for mutton in Western Germany (Luke and Müsch, 1983). The body weight of the Finnish breed known for its prolificacy increased to an even greater extent than that of the German mutton Merinos. It is an aim in Romanov stock sheep farms to increase body weights and wool production. At the same time the frequent lambings which are characteristic of this breed have in many stock farms been reduced to one lambing per year. In broiler production it was made clear a long time ago that it is possible to have the least expensive and at the same time a very good quality slaughter chicken by crossing a prolific mother line having a small body weight with a less prolific but heavy and well-muscled cock line. Increases in body weights in reared sheep and goat lines decrease the number of population per given (and at the same time non-increasable) land unit and so the number of lambs possible to include in this unit also becomes fewer. It is well known that the bulkier breeds

demand for feed is greater. I would like to mention one Brittany breed as a rarity whose mature body weight does not exceed 10 kg (J.M. Elsen, 1985, personal communication).

Another, also poorly studied topic, is mutton quality. In Europe, mutton containing less total pigment is regarded to be of better quality because it is supposed to be less mature. Nevertheless, in UK the more finely muscled Herdwick breed having a smaller body, and in France the Massif du Central breed, also with a small body and mutton of a darker colour, give the tastiest mutton. At the permanent agricultural exhibition in the USSR lambs of the same age from 20 different breeds were slaughtered and given to the best known sheep breeders of the country to taste. The meat of finely muscled Romanov breed with high total pigment was most favoured (Kovnerev, 1978, personal communication).

In New Zealand, the question as to which breed tastes best was answered by the most authoritative Romney breeder, A. McGregor (1985, personal communication), who said it was the meat of the Merino because its mutton is less fatty, more finely fibred and pigmented. It is well known in Hungary that the mutton of the Racka breed is much tastier than that of Merino. The ancient sheep breeds having lighter body weights usually have tastier mutton than the mass-produced mutton breeds whose muscles contain more insoluble connective tissues.

In most culture breeds the aim is to select a white stock despite the well-known fact that it is the fleece of pigmented crossbreed types that gives the best hides (e.g. Romanov). A couple of years ago several scientific articles from Iceland claimed that the local pigmented breeds had a higher fecundity and a longer, more favourable heat season (Adelsteinsson 1970; Dyrmondsson 1978; Dyrmondsson and Adelsteinsson 1980). More recently Maijala (1981) also put forward a proposal to preserve the earlier colour variants in Finnish breeds. In a smaller sized Merino Landschaf selected for the highest possible litter size and lambings in every 7 or 8 months more and more frequently smaller or bigger pigment spots appeared on the heads and legs (M. Burgkart, 1981, personal communication). A similar case was observed in Booroola Merinos.

In the Kazahstan region of the USSR Butarin (quoted by Litovcsenko and Esaulova, 1977) has for the sake of better acclimatization crossed the Argali breed with Merinos. Mason (1981) gives an account of crosses with moufflons in Cyprus. The experiments made with crossing dedomesticated goats and angora goats in Tara Hill by the Invermay Agricultural Research Institute are also of great interest (J. Allison, 1985, personal communication). However I must agree with the earlier standpoint of Cunningham (1980) and Bodó (1982) that the carefully studied local breeds seem more suitable to create new synthetic breeds.

So long as a breed consists of a small population inbreeding cannot be avoided (Bodó, 1982). The low variability seen in immunogenetical examinations of pure-bred animals also points to this fact (Fésüs, 1981). The black variant of the Hungarian Racka sheep was conserved for more than 30 years by one of our members who rarely bought rams from other stocks. Lambs from the inbreeding of the Romanov breed, which has a relatively small population, gave more favourable results in body weight increase and fecundity rate than the ones from top-cross matings. Only the lambs from very loose inbreedings ( $R = 0.25$ ) had a significantly higher mortality rate (Arszeniev, 1982). This points to the fact that the probability of lethal and sublethal genes appearing is greater in breeds having a small population than in the highly populous ones.

### **3. MEASURES TO BE TAKEN IN THE FUTURE**

Many excellent proposals to preserve breeds have been advanced by others (Bodó *et al.*, 1980; Barker, 1980; Alderson, 1981; Maijala *et al.*, 1984) and two of these only will be repeated: in breeds likely to be utilized in gene reserves, at least 500 ewes and 7 or 8 ram lines have to be conserved in every colour variant. So as to preserve a wider possible range of gene frequency in breeds it is advisable to deep-freeze semen from excellent rams and zygotes from outstanding ewes. St. Salamon (1985, personal communication) had a 60 percent fecundity rate through direct endoscopic insemination into the uterus with ram semen stored for 15 years.

As far as possible the intervals between generations have to be widened, i.e. animals with great life productions and a solid body frame have to be kept for breeding for possibly longer periods.

The fashion of crossing for its sake alone has to be abandoned. Local breeds must be entered in international flock books (Dohy 1984). Apart from state support national collaboration is also essential. National funds are needed to preserve, individually register and mate breeds. In addition the hobby of breeding ancient breeds has to be popularized in areas where herds can be put on common pastures in summer and can spend winter around houses surrounded by large sites.

The tastier mutton of local breeds has also to be popularized to increase its demand which would lead to higher purchase prices of animals for breeding and for slaughter.

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### **FUTURE PROSPECTS ON THE USE OF POLISH NATIVE SHEEP BREEDS**

S. Zalewska, S. Jankowski 1/ and M.J. Radomska 2/

Several native breeds of sheep could be distinguished in Poland before World War II. The most important among them were the following:

- |           |   |   |
|-----------|---|---|
| Zackel    | - | white and dark varieties - in the Carpathian mountains in the south of Poland |
| Fagas     | - | along the Baltic Sea shore  |
| Karnówka  | - | central northern part of Poland   |
| Krukówka  | - | south eastern part of Poland  |
| Swiniarka | - | central part of Poland  |
| Wrzosówka |   |   |

Most of these local breeds were described in the outstanding book of M.L. Ryder, "Sheep and Man" (1983).

These native breeds were either improved later by means of crossing with cultural European breeds or they completely disappeared. However the sole native breed which now exists was recently conserved as a gene resource, viz. the Wrzosowka or Polish Heath sheep. This is a very old native breed of small, grey fleeced sheep, once forming a numerous population which is very well adapted to the extensive system of feeding and management. It expanded over into the north-eastern territories of Poland within her former borders.

In the late 1920s, in the centre of this region, the Polish Government established an experimental station in Swiskocz (actually in Belorussian SSR) with the main task of studying the local native breeds of farm animals. The present authors are fortunate in being able to compare the actual data on performance of the Wrzosówka sheep with the report on this breed by Czaja (1937), who was director of the experimental station in Swislocz at the time.

The situation changed during World War II, but we still have within our borders a large strip of land formerly occupied by the Wrzosówka breed.

In the 1950s and 1960s the Wrzosówka population rapidly decreased in favour of more productive breeds of sheep. In 1970 it was nearly extinct, at which point the conservation programme started. At present (1986) we have about 1000 breeding ewes registered in the Wrzosówka flock book and several hundreds in commercial flocks of this breed. The breeding scheme adopted is based on a model elaborated in New Zealand: 1 nuclear flock and 10 affiliated flocks, introducing rams from the nucleus and sending some replacement ewes there.

The Wrzosówka fleece is a coarse one, consisting of numerous and rather long down fibres supported from inside by comparatively short, stiff, medullated hairs. The fleece as a whole is downy. the skins are thin, light and show a good tensile strength. A short tail is characteristic for Wrzosówka sheep. This trait together with the

type of fleece and body conformation are important indicators of the mouflon origin of the breed, which is usually classified as belonging to the North European, short-tailed group of sheep. As such it is a close relative of the Romanov breed, but there are apparent differences: it is smaller, its body is more compact and its nutrient requirements are by far lower. A very important trait of the Wrzosówka breed is its good reproductive performance level (see Table 1). Its breeding season extends nearly all the year round First matings of ewe lambs can be successfully done at the age of 8 months. Average litter size in adult ewes ranges up to 1.75-1.82. Good results were obtained with Wrzosówka ewes in a frequent lambing system (see Table 2).

Wrzosówka sheep can be kept in pure-bred flocks, especially in areas where extensive, poor grazing on light sandy soils is available. Its wool can be best utilized for hand-made folklore type carpets. Its skin is an excellent material for making coats, which are light and well insulated from the cold.

**Table 1** PERFORMANCE LEVEL OF POLISH HEATH OR WRZOSOWKA SHEEP  
In once per year lambing system  
(according to Zelewska *et al.* 1985)

Age group of ewes	Total number of ewes put to ram	Lambing period	Fecundity %	Litter size at birth	Number of lambs weaned	
					per 100 lambs born	per 100 ewes put to ram
Ewes over 1 year old (mixed age)	1 541	Jan-Mar	84.2	1.71	91.2	131.0
		July-Aug				
		Nov-Dec				
		1975-80				
Ewes over 1 year old (mixed age)		Jan-Mar 1981	92.5	1.50	89.0	123.8
		Feb-Mar 1982	90.6	1.38	92.0	115.3
Average			86.0	1.64	90.9	128.5
Ewe lambs bred when 8 mths old	57	Jan-Feb 1983	93.0	1.36	90.3	114.0
	43	Feb-Mar 1984	97.7	1.48	100.0	139.5
Average for ewe lambs			95.0	1.41	94.8	127.0

**Table 2 PERFORMANCE LEVEL OF POLISH HEATH OR WROZOSOWKA SHEEP**  
**In frequent lambing system**  
 (according to Zalewska *et al.*, 1985) Mixed age of ewes, all over 1 year old.

Lambing period	Interval between previous to present lambing	Total number of ewes put to ram	Fecundity %	Litter size at birth	Lambs weaned per 100 lambs born	Number of lambs weaned	
						per 100 ewes put to ram per one lambing	per 100 ewes put to ram per year
Nov-Dec 1982	9 months	173	87.3	1.46	93.7	119.7	159.6
Oct-Nov 1983	11 months	175	92.6	1.64	96.2	146.3	159.6
May-June 1984	7 months	161	93.8	1.82	95.4	154.0	264.0
Feb-Mar 1985	9 months	196	94.9	1.69	92.4	148.0	197.3
Average	9 months	92.2	1.65	93.1	142.0	189.3	

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## OLKUSKA SHEEP - A HIGHLY PROLIFIC POLISH SHEEP

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In the region of Olkusz a local type of sheep is known for high litter size (triplets and quadruplets). It has never been acknowledged as a breed but is known as the Olkuska sheep. At present the old type of Olkuska sheep is endangered as a result of crossing with rams of different breeds, e.g. Romney Marsh. Compared to 10 000 Olkuska sheep in 1960 the number of today is estimated at no more than 200. It can be found on small private farms, usually numbering from one to five. Ewe lambs are mated for the first time at the age of 10 months. Ram lambs as well as part of the ewe lambs from multiple litters are slaughtered for their skins in the autumn.

For several years studies have been conducted by the Department of Animal Genetics and Breeding, Agricultural University, Krakow, on the old type of Olkuska sheep in the "Domana" flock of about 50 ewes, owned by W. Grabowski, graduate of the Agricultural University. Observations show that the Olkuska ewes attain a body weight of about 60 kg, display high litter size (Table 1), good milking performance and mothering ability. It is exemplified by the ewe "Greta", which up to the age of 7 years gave birth to 28 lambs, including 26 weaned, and by the ewes "Kaledonia" (Table 2). Studies are also carried out by the Institute of Animal Genetics and Animal Breeding, Polish Academy of Science, on inheritance of high litter size (Olkuska rams are crossed with Merino ewes). The F<sub>1</sub> ewes aged one year have shown high fecundity, unusual in Merino (Table 3). We consider that the Olkuska sheep is suitable for developing synthetic fertility lines.

The need to preserve the genetic material of Olkuska sheep should be officially recognized otherwise it will be completely lost since it is a sheep typical of small private farms which with time is becoming less and less numerous.

**Table 1** PEDIGREE OF SIRE KORLEONE FROM DOMANA FLOCK

♂KORLEONE																																			
♂Tobiasz							♀Brahma			3x3																									
♂Babinicz				♀Tenka		3		♂Alik				♀Babka		4																					
♂Alik			♀Babka		4		♂Alik		♀Szatana		4		♂Graca		♀Asi		5		♂NN		♀NN														
♂Graca		♀Asi		5		♂NN		♀NN		♂Graca		♀Asi		5		♂NN		♀NN		♂NN		♀Greta		6		♂NN		♀NN							

Maximum number of lambs in a litter born by each ewe is evident.

**Table 2** REPRODUCTIVE PERFORMANCE OF EWE KALEDONIA BORN IN 1982

Year	Successive lambing	No. ♂	of ♀	lambs Total	Litter weight (kg)	Body weight and sex of the smallest lamb (kg)
1983	I	1	-	1	-	-

1984	II	1	2	3	11.90	3.65
1985	III	1	1	3	16.95	4.75
1986	IV	1	2	4	16.55	3.45

In 1984 body weight of ewe Kaledonia was 63 kg.

**Table 3** FECUNDITY OF EWES ( $F_1$ ) OBTAINED BY CROSSING OLKUSKA RAMS WITH MERINO EWES

Ram	Daughters No.	Mean litter size $\bar{X}$	Litters with triplets No.
Tobiasz	9	1.60	1
Godymin	5	1.40	1
Babinicz	7	1.30	-
Graca	9	1.77	-

Notice: age at first lambing - 1 year.

### UTILIZATION OF EQUINES MAINTAINED AS A GENETIC RESERVE IN AGRICULTURE, TRANSPORTATION, MEAT PRODUCTION, SPORTS AND OTHER ACTIVITIES

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France as well as European countries have kept and still keep an outstanding wealth of equine genetics formed by centuries of service to man especially for traction or transportation. The progressive suppression of these uses since the beginning of the 20th century has caused a decline in some of them, and an increase in others, and in all cases, it has caused deep mutations of the equine population, involving threats upon this wealth. What are the prospects for exploiting equine breeds as genetic reserves?

#### 1. PRESENT MUTATIONS OF EQUINE PRODUCTION

A close look at world stocks over the last 30 years shows a drop of about 17 percent in horse numbers (FAO, 1985). This downward movement is gradual compared to France over the same period: 85 percent (Rossier *et al.*, 1984) In compensation, during the same period, an increase of about 14 percent of the number of small equidae (donkeys and mules, Table 1) can be observed, especially in developing countries. The main reason for these movements which have slowed down in recent years, is the intensive mechanization of agriculture and transportation.

**Table 1 EVOLUTION OF THE NUMBER OF HORSES AND SMALL EQUIDAE IN THE WORLD FROM 1950 TO 1984**  
(‘000 head)

Year	Horses	Small equidae (donkeys and mules)
1950	79.7	48.4
1960	67.2	54.9
1965	67.0	55.8
1970	66.8	57.2
1975	65.8	55.7
1980	61.0	54.0
1984	63.9	55.2
Evolution 1950-84 (%)	-19.8	+ 14.0

Source: FAO, 1985.

In developed countries, the present large decrease in equine production must be analysed more accurately. In fact, two opposite trends are noticeable: a slow but steady increase of racing, sport and pleasure horses but not enough to compensate the rapid disappearance of draught horses, threatened with extinction. Therefore, husbandry is more oriented toward pleasure activities than to food production (horse or small equine meat), and more rarely toward keeping some for draught purposes. This is verified in most of the western and northern European countries (Bjarnason 1973; Graaf; Hulsbergen, 1984; Jansson, 1984; Leuenberger, 1984; Rasmussen, 1974; Stelzer, 1973).

Of course, the situation varies with the country: United Kingdom or Germany have almost no draught horses left; in France, these breeds still form almost half of the population (Boue and Rossier, 1979; Bour and Rossier, 1982; Rossier, 1985). The number of small equidae is particularly high in southern Europe: Greece, Italy and Spain (Zafrakas, 1985; Gougoud, 1984); they are almost inexistent in northern countries. Can this be explained by the movements of both horses and donkeys throughout history? Horses would have touched northern Europe through Asia, while the donkey, probably from Nubia, had two routes, one to southern Europe, the other to northern Africa, spreading across the Middle East and the Mediterranean (Poplin, 1985).

We can therefore see a development of highly specialized racing breeds, strong consumers of feed and needing much equipment and various infrastructures, such as the Thoroughbred for flat racing or the trotting breeds for trotting races. In the same way some special lines of saddle horses for jumping, three-day events, dressage or driving have progressively been established. On the other hand, the old specialized draught breeds are changing, at least in France, Belgium and Netherlands, to produce meat. Finally, strong development of pony breeds has been observed.

Deep changes, both structural and geographic have occurred in the populations of these countries, in the composition of stocks and in their uses. With time these changes tend to make these species marginal, compared with the main objective of animal production (Rossier, 1985). This is, without any doubt, one of the difficulties in saving these breeds.

In developing countries, mechanization, even if well introduced, still leaves a large place to animal traction (Rossier, 1984b). This probably explains the increase of the world stock of donkeys and mules (Audiot, 1982).

Rustic animals, with small maintenance needs, seem particularly well suited in this case. Thus, we note the use of local breeds, which can utilize profitably with low costs, local natural resources.

Equine production in the world and in particular in Europe, is therefore tending to develop:

- in rich areas, toward an elaborate adaptation to pleasure activities, with a steady diversification;
- and in poorer areas, towards rustic animals, able to utilize roughage and scarce feed, which would otherwise be unused.

## **2. PROBLEMS TO PRESERVE EQUINE GENETIC MATERIAL**

The changes undergone by our societies which are mentioned above and which are sometimes extremely rapid, endanger many potentials (such as the genetic types of domestic animals) often heavily and sometimes irrevocably. In general it is not known if there will be a need for them in the future.

In fact the current difficulties in marketing some products, in particular in Europe and EEC with 12 members, and the new constraints they dictate in connection with world markets, cause the emergence of new production systems which may be more economical than during past decades. These systems are not yet very well known, and we should treat our animal genetic material with great care.

The evolution of animal product demand arising from new knowledge in dietetics, the increase in the standard of living, new fashions, more quality requirements, the need to reduce production costs and from environmental changes, strongly encourage the fight against the loss of genes (Maijala, 1970). We must try to conciliate the imperative needs of the present and the possible needs of the future, i.e. in operating and selecting the animal populations in the current economic context, we must preserve their genetic resources and their capacity for future evolution (Vissac, 1972).

In the equine breeds, we are becoming increasingly aware of these problems in relation to the very different uses of these breeds. Some preservation measures are created, such as museums, animals and documentation collections, natural reservations, national and regional parks. Numerous documentation coming from old manuals, local papers, postcards, interviews, calendars, fairs or travel reports, etc., enable the collection of traditional knowledge, but do not always ensure the preservation of the breeds themselves (Society of Ethnozootechny, 1982).

These preservation measures, in some breeds with populations from one to ten head, can even include the freezing of semen of remaining stallions (Bodó and Pataki, 1984), such as of the Dutch breeds, Groningen or Gelderland (Buis, 1984). In France, an "Office of Genetic Resources" has been created in the Department of Research, to coordinate action in this field.

As an illustration, the existence should be mentioned of Poitou donkeys in the zoo of the "Museum d'Histoire naturelle" as well as the creation of a state "donkeyhouse" by the Regional Natural Park of the Marais Poitevin, to restore quality stock by continuous crossbreeding.

The difficulty of these actions is however more often in their mode of financing, in addition to the human factor. Our economies essentially aim at profitable investments and the long-range is never more than 5 years. It seems that the general increase of people's availability for activities other than directly productive (development of the tertiary sector involving state incentives, civilization generally qualified as a "leisure civilization" allowing the development of new activities) can bring solutions and help conservation. In the horse more than in other species, the preservation of the old and even current genetic types is closely dependent on maintaining their specific utilization and breeding techniques.

The horse is the domestic species showing the biggest polymorphism in development (adult weight ranging from 1 to more than 10), in capacity (draught horses, pack horses, gallopers, trotters, jumpers and walkers) (Langlois, 1973) and above all in adaptation to the most varying and difficult natural environments. This variability which man has used in different ways in various epochs, has been preserved almost undamaged until today by the multiplicity of uses for leisure of the horse. It enabled some breeds to escape the death threat which struck them all in the 1950s.

However, preservation problems arise from local breeds threatened by absorption by some higher performing genetic types, but essentially for specialized breeds whose traditional market has disappeared.

The disappearance of local breeds which were numerous during the 19th century (such as the pony of Corsica, France mentioned by Tertrais, 1982) is a classic feature. It is not specific to the horse and does not always correspond with a loss of potentiality. It is not possible to keep everything, and some choices are necessary.

Conservation or promotion of local varieties is most often only justified by their adaptation to particular and difficult breeding conditions. For instance:

- The French horse of Merens: found in the wild and isolated mountains of Ariège (Pyrenees), protected by people strongly attached to tradition. It has its homogeneity, which is a zootechnical curiosity, because mating occurs freely in the range (Prunet, 1956; Thevenin, 1982).
- The Pottock: perpetuated by the maintenance of a very old method of environmental management, used in the wild hills of the Pays Basque and considered by the regional farmers as a standard part of their economic system, a product to be harvested (Lizet, 1976, 1983). The same situation occurs across the border, in Aragon (Spain) and for the Asturian and Galician ponies.
- The breeds of native horses and ponies in Greece; as for instance the ponies from Skyros, Pindos, Peneia, or from Kefalonia island (Menegatos, 1985a and b).
- Some particularly rustic pony breeds from the United Kingdom: Exmoor, Dartmoor, New Forest, Highland, etc. (Boue and Rossier, 1979) or from other countries: Iceland, Norway (Fjord) and Germany (Dulmen).

In these conditions, even if submitted to crossbreeding with improved breeds, they are most often preserved by themselves. A good example is the Corsican horse through breeding traditions adapted to the hard and frugal environment (essentially based on two principles "freedom" and "no human intervention on the territory"), they survived by progressive and continued elimination of the so-called "improving" genes which were not compatible with breeding methods (Tertrais, 1982; Audiot and Flamant, 1982). The Corsican horses, submitted to a harvest system, must find their feed in winter in a vegetation where only the cellulose-rich parts remain.

The crossbred products, which are more demanding, must be bred more carefully otherwise they develop badly and are quickly eliminated. The conservation of local varieties depends much more on biotope preservation and breeding methods than on the conservation of the animals themselves (Audiot and Flamant, 1982). The breed of Camargue in southern France is also a good example of this situation: the homogeneity of the type is preserved by natural selection, despite the various choices made in every "manade" (herd) by the breeders (Langlois, 1977).

The initiation of horse husbandry in hilly areas, in often very simple maintenance conditions, should promote some genetic types well suited to this environment. The recent development of draught horse breeds of Breton-type or Comtois-type in the mountains of southern France is an outstanding example of the convergence between an animal production objective (contributing to the protection of a threatened patrimony by finding another end purpose and low cost breeding methods) and the utilization of difficult areas, which are becoming increasingly deserted and damaged. The horse appeared as a very good instrument to utilize and manage land

areas (Coleou and Rossier, 1986). Otherwise, breeding methods must be improved; this is only possible if economic conditions exist. As for the pony breeds, the appearance of an interesting market, through youth riding, has led breeders to put more care in their husbandry. This enables them to use improved breeding stock and to increase the quality of their production. However, this trend does not lead to the disappearance of the rustic types, constituting the biggest part of these populations but permits more value to be obtained from more economical animals, with less obvious but more varied performances, well suited to the taste of the public as useful and durable products.

On the contrary although traditional markets have not completely disappeared for draught horses, they have decreased so strongly that the breeds concerned are threatened with disappearance (Bougler *et al.*, 1983). The classical symptoms of the dangers threatening the breed's with small populations are appearing: dissemination of the population, inbreeding, genetic drift, disappearance of coordination structures and advanced age of the remaining breeders. This is proved by recent studies made on some French breeds of draught horses: (Breton: Treguer, 1980; Comtois: Guillon-Dubeuf, 1981; Cob: Gorioux, 1982; Boulonnais: Rossier *et al.*, 1983) or foreign breeds (Danish breed of draught horses from Jutland: Johansen, 1984):

The average number of mares per farm does not exceed two in each case.

According to the authors, the average coefficients of inbreeding, in general still low except for the Boulonnais (Table 2), have increased during recent years. This situation is especially disturbing as the highest coefficients are shown by the youngest animals. The situation is the same for the "Baudet du Poitou": Audiot (1977) computed an average inbreeding coefficient of 1.5 percent. The case of the Danish Jutland breed is still more serious with an average coefficient of 14.2 percent (Johansen, 1984).

**Table 2 AVERAGE COEFFICIENTS OF INBREEDING OF VARIOUS BREEDS OF FRENCH DRAUGHT HORSES**

Breed	% of inbreeding	Author
Breton	0.7	Treguer, 1980
Cob	0.4	Gorioux, 1982
Comtois	1.2	Guillon-Dubeuf, 1981
Boulonnais	4.6	Rossier <i>et al.</i> , 1983
Bandet du Poitou	1.5	Audiot, 1977

The breeders are on average older than the breeders of any other animal species. In UK 85 percent of the breeders are more than 40 years old, the average being 50.2 years old; 77 percent of the Comtois horse breeders are more than 40 years old. Among the Boulonnais breeders, almost 80 percent are more than 45 years old. The succession of the oldest is not always ensured.

This could be stopped only by a strong increase in draught horse production for meat (see below), and/or by the appearance of a "leisure" husbandry, carried out by amateurs attracted by the originality and rarity of these animals. These are other ways of utilization. Some preservation associations, more or less regional, can be created, state or private funds can be collected, new activities can be promoted or old activities can be reorganized (driving, ploughing, breeding shows, draught horse races as in numerous foreign countries: USA, Canada, Japan, Germany, UK, etc.). Such races are now organized in France, on the Japanese racing model.

But often, the type of breeder is changed. In these new uses and in the production of milk, hormones or serum, the true problems come from the coexistence between traditional and amateur breeders. The conservation of the breeds does not have the same meaning for both.

### **3. DRAUGHT HORSES: AN EXAMPLE OF THE CHANGE-OVER FROM AN ANIMAL FOR SERVICE TO ANIMAL FOR PRODUCTION**

#### 3.1 The Consumption of Horse Meat - An Opportunity to Retain Tradition

The consumption of horse meat offers an additional market for the heavy breeds. Moreover it offers the opportunity to utilize rustic breeds as a part of territorial planning, and particularly in the planning of marginal areas (Langlois, 1980; Audiot and Flamant, 1982). The case of France is representative: it is a traditional horse meat consumer, and has therefore kept a large population of heavy horses. Thus, France will be taken as an example, although in the EEC, Belgium, Luxembourg, Denmark, Italy and Spain are also consumers, as well as some other European (Switzerland and Sweden) and eastern countries.

The high consumption of horse meat evolved in France at the end of the 19th century, among the lower classes, such as workers and employees. This meat was considered healthy, tender tonifying, low in fat, red and cheap. It was widely consumed in families with children. Most of these remarks are still true, except perhaps regarding price.

Today, the situation has slightly altered. Retail prices have considerably risen and tend to be equal or above the prices of beef meat. French production cannot supply red meat, except for slaughtered blood horses: production is orientated toward the production of young animals with white meat (6-8 months old) or especially pink to dark pink (foals of 10 to 24 months old) (Rossier, 1984a).

Horse meat still keeps a very good image, and its consumption progressed until around 1980, in part due to the better type and location of sales points; after that year, higher retail prices have discouraged buyers.

Horse meat consumption, under various forms (not only steaks or hamburgers, but also as a delicatessen), essentially depends on the efficiency of the delivery network. It is possible that some other countries might be encouraged by this trend, in particular if they want to better utilize their slaughtered blood horses.

Can this consumption really help to create a production system? This is a difficult question, but the description of the economic situation of this production in France can highlight some facts.

#### 3.2 Economic Situation of Horse Meat Production in France

France consumes around 70 000 tonnes (carcasses) per annum of horse meat, but they produce only 20 percent and import 80 percent.

Production, which was sufficient to meet French consumption in 1955 has continually decreased since this period with disappearance of animal traction. Currently, the relative part of slaughtered blood horses is increasing: 48 percent of national production. Draught horses, whose breeding stocks are now stabilized and are even increasing again, supply the remainder, either through slaughtering, or by specific foal meat production.

The deficit in production was first filled by imports of living animals from eastern countries. As the deficit worsened frozen meat from the USA appeared on the market. In 1984, out of 100 kg of consumed horse meat, 20 kg came from French horses, 19 kg from horses imported alive and slaughtered in France, and 61 kg from frozen meat.

Therefore, since 1972, and especially since 1979, action has been taken to reorient draught horse husbandry toward meat production: incentives to breed young mares, market clarification and organization, production

organization by producer groups, increase of prices at production, development of research and application of results in the field, especially in reproduction (control of cycles, better mare management, echography, pasture exposure, artificial insemination, etc.) But there was no desire of conservation in these measures: they only arose from the economic situation.

The most worrying problem remains the small number of our breeding stock, with the low fertility rate of this species which is the main restrictive factor for the organization of effective production.

Consumption of 70 000 tonnes represents 21 000 slaughtered horses with an average carcass weight of more than 330 kg. This corresponds to the production of around 420 000 mares or to the slaughter of 2 million horses approximately, used on average, for 7 to 8 years. This is much over the present capacity of France's equine stock and the need to import is clear. These compulsory imports do not encourage the progress of national production and had until a few years ago even caused a decline. However, this type of production has some valuable resources and it must develop them: nine breeds, which are a genetic patrimony unique in the world; some additional income possibilities if associated with another type of production utilization i.e. cattle; of misused or no longer used ranges and of unfavourable areas; important productivity gains; a possible export market for breeding stock; a potential power supply; and also a consumption market based on organoleptic and dietetic qualities of this meat.

It is evident that national production which supplies a white or light pink meat, must be clearly differentiated from the imported product (red meat from slaughtered animals). With a particular "label", promotion of the product, based on a policy of quality, becomes possible.

Two types of production can be distinguished:

- the traditional areas, so-called "berceaux de race" (cradle of the breed); all of them are located in northern France, in a relatively intensive farming environment;
- the so-called "production or multiplication areas", relatively recent, located in southern France and especially in the Massif Central, Pyrenees, the Alps and Jura mountains.

The first case includes the residue of draught husbandry; its evolution toward meat production requirements is necessarily slow. The costs are high and productivity is still low: draught stallions traditionally breed the mares in stations or in "breeding trucks"; land prices are high and horse production is in competition with other more profitable ventures. There is therefore little or no production payback, which implies reducing stock. This is only stopped by subsidies and by traditional selection means, such as breeding shows, considered as rural animation. In 1984, draught mare stock bred in these conditions was only about 18 000 head; the total registered breeding mares are around 40 000 head. Draught breeding, which still has a small market, especially for export, is supported by the Government and by a kind of leisure activity breeding shows; these have a place in the more general policy of rural animation. This type of production can be encouraged, if economic conditions are suitable, only by the development of intensive or semi-intensive fattening units for heavy foals.

On the other hand, in the mountainous areas of central or southern France, there has been a tendency in recent years to settle horses on little productive and increasingly deserted agricultural areas. In these conditions, the use of ranges together with cattle, leads to greatly reduced production costs. The herds are bigger and pasture lands can be better utilized. Animal size is, in general, smaller than in the "berceaux de race", and in some valleys of the Pyrenees, it can even be of pony size. The stallions used are of a semi-heavy type: they are almost exclusively Bretons, Comtois, or Ardennais. The attempts to introduce larger-sized breeds such as Percheron or Boulonnais, do not seem to be successful. Breeding conditions, often very primitive, are without any doubt at the origin of this failure.

### 3.3 Future Prospects and Possibilities of Action

As can be seen, the existence of an important market for horse meat, that could justify the production of around 300 000 horses a year (current total horse population in France), will delay, but cannot stop the progressive disappearance of draught breeds.

However, the combination of draught horse breeding with mountain agriculture, has, without doubt, been a wise choice; this is proved by the sometimes explosive increase in this type of husbandry in some areas. But this development cannot balance the loss registered in the "berceaux de race" .

If this deficit is to be stabilized, either we have to decrease consumption, which could risk destabilizing the whole sector, or we have to increase all breeds of breeding stock.

Whatever the proportion between blood mares and draught mares, a way must be found to produce these 60 000 horses per year, if only to maintain the current production level. In 1984, there were approximately 50 000 blood mares and 40 000 draught mares, or a total of 90 000 breeding mares. They will produce only 43 000 to 48 000 foals. In these conditions, our meat deficit can only increase. Therefore, our objective is to stabilize at an annual production of 45 000 foals, or around 15 000 tons of meat, and a self-sufficiency rate of 20 percent. Every breeding mare, whatever the breed, will have to be kept.

The racing sector does not show a visible increase in breeding mare numbers. The momentary increase of trotter mares balances the decrease of Thoroughbred mares, and their production, for the main part, is flowing into the pleasure sector. This field has, for some years, increased considerably. Will this expansion balance the regularly registered losses of the draught mare breeding stock in the "berceaux de race"? Will the rise of draught horse production in the production areas continue? The achievement of the previous objective will depend on this factor.

### 3. 4 Possible Action

The conservation of draught horse stocks starts with a market organization which protects the producers from uncontrolled fluctuations in production price. Otherwise, the draught breeds will disappear from France, as well as from other European countries with only residual populations, in general less than 5 percent of the total.

If this economic plan continues and strengthens meat production could be considered from draught breeds in both existing breeding situations: "berceaux de race" and production areas.

a. In the "berceaux de race" two types of action are taken: to conserve and to promote.

As a conservation activity the continuance of the breeding shows can be mentioned and traditional breeders are strongly attached to them. This social and historical aspect is very important and should not be forgotten. Servicing in "breeding trucks" has been developed and financed to breed mares which are becoming increasingly scattered in country areas. Less and less mares are bred per stallion, but the latter are kept in service to avoid reducing the remaining mares, by their disappearance. Stallions are changed frequently enough, giving this type of production an additional market for its stallions. Traditional husbandry structures are maintained through this commercial stallion channel.

In about 1961, some attempts were made to stimulate horse traction; they resulted in new equipment (AVTRAC) which was more competitive than the old type and was sometimes fitted with auxiliary motors. At this time, however, these attempts failed. Today, with energy savings, the concept of the horse as a supplier of energy is not completely Utopian: the use of horse traction is expanding again in some farms and for some functions.

However, the genetic situation of French draught horse husbandry in these areas is still alarming, even though a small increase of breeding mare stocks is noted. Programmes for genetic management should be set up as soon as possible for some breeds at least to limit the effects of inbreeding and genetic drift. Stud books need to be

reorganized and their structures and rules renovated to equip them with the necessary means for a successful genetic policy. The most important step has been the setting up of a unique identification procedure for all animals and a unique production information channel (Bougler *et al.*, 1983). This unique identification procedure is not operational in France.

As a promotional activity, the incentive of setting up intensive or semi-intensive fattening units and the development of better techniques in meat production can be mentioned. Some experiments are undertaken to improve stock productivity: artificial insemination, protocol of compensatory breeding for the mares found not pregnant (by echography) at the end of July, and experiments for growth and sexual control of draught stallions (in testing stations). Some advertising is made in foreign countries to export these breeding horses.

b. In the production areas, it has been recommended to settle the horse again in some underused grazing areas. As a complement to cattle, this action is justified in pasture utilization and in breeder income, independent of its own return.

In these conditions, the horse does not rival cattle. On the contrary, it enables the recovery with low costs, of some deserted pastures. Maintenance costs during winter seem the only constraint to its development. In this system, when the horse does not cost, it pays back; but then, it must be able to resist rigid environmental conditions. If the animals are not well suited to regional production conditions, there is a great risk that bad foals for meat and bad horses for riding will be produced. The development of local breeds which have disappeared since the 19th century can constitute an important organizational factor in this type of husbandry from the technical as well as the commercial aspects. In addition, the definition of various regional policies would be useful, because of the uncertainty of future production. Several ways are possible depending on the areas and the evolution of the economic situation follows:

1. Heavy foal prices at production will be increased and stabilized: this action would then tend to create important "closed herds", to improve technical control of pasture use and to try to extend these pastures to permanent "open herds", for instance in breeding stations. As far as feeding and breeding techniques are concerned the most suitable levels and periods of optimal supplementation in a system are usually sought which require the least investment. In the genetic field, the typing of our draught breed characteristics leads to the improved use of the variability between genetic types in crossbreeding. The definition of "sire breed" (growth potential, meat ability) and "dam breed" traits (size, milk ability, rusticity) becomes more important (Langlois, 1984).
2. Prices at production cannot be stabilized: draught horse husbandry will be retained only if it is impossible to replace it by type of production which is sometimes the case. Then, the promotion of rustic types, clearly defined by region, can be considered. Some mixed solutions, "meat-saddle" are even possible but in this case regional mare breeding stocks must be defined, organized and homogenized and both potentialities (cob type) must be preserved. Some other radical solution, such as the use of mares, can also be studied based on the model of Jersey cows crossed with Charolais bulls. There would appear to be some important and unexplored potentialities in horses, although these have been well known for a long time.
3. If heavy foal production completely disappears, the only way to produce a minimum of meat would be through the strong promotion of pleasure riding in all its forms by a policy of crossbreeding with any kind of French horse. To reduce our deficit, it is better to import horses to breed them, rather than just to consume them. A coordinated import policy of rustic breeding mares should be considered.

#### 4. CONCLUSIONS

Perhaps in this paper, we have given more emphasis to the draught production for meat. However it is a good illustration of utilizing a small horse population.

The extraordinary diversity of existing breeds has been noted as well as the large variety of possible uses, for agriculture, meat production or leisure activities. Without doubt, this wide variety, in addition to an excellent adaptation to hard environments, has enabled the continuance of all these horse breeds up to the present time.

Today, choices need to be made and perhaps we are better armed to make them. However, the human factor might be the most difficult problem to solve.

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**FUTURE USE OF THE POLISH NATIVE BREED, KONIK POLSKI, AS A  
DRAUGHT HORSE IN AGRICULTURE AND AS A RIDING HORSE  
FOR SPORT AND RECREATION**

Tadeusz Jezierski 1/

The Polish Primitive Horse (Konik) derives from the Tarman wild horses which inhabited Eastern Europe in the Middle Ages. In the 18th century the wild horses in Poland were already becoming rare and valuable animals and received special protection in zoological gardens belonging to wealthy people. At that time the Tarpans were considered unsuitable for any kind of work because of their inherited wildness. Due to their wildness and courage the Tarpans were sometimes used in show-fights with predators. Some of the wild Tarpans were brought into a private zoological garden near Bilgoraj belonging to the Count Zamojski. At the beginning of the 19th century the horses, which had so far lived free in that garden, were captured and distributed among the peasants of the neighbouring villages and were tamed and crossbred with the local mouse-grey peasant ponies, though a considerable number of them retained the pure blood of their wild ancestors. The Bilgoraj region was poor and backward, isolated from other parts of the country, thus the type of primitive horse originating from the old wild horse survived until the 20th century. They were 110-130 cm tall, mouse-coloured with a dark dorsal streak, highly resistant to severe environmental conditions and able to find their feed in forests, wasteland and marshes.

For a long time no interest had been given to these small and primitive horses - descendants of the wild Tarpans. In 1914 Grabowski and Schuch described primitive horses from the Bilgoraj environs. Since then many horse breeders under the guidance of Prof. Vetulani began to take interest in primitive horses and to rescue them from extinction. In the inter-war period Prof. Vetulani bought from the peasants in the Bilgoraj environs most of the typical primitive horses and placed them in a forest reserve at Bialowieza in order to breed them back to their wild state. In addition, some studs of Polish Primitive horses, which Vetulani named "Konik", were established.

At present there are five state farms which breed the on the Konik (Table 1). The population of the Konik in state farms has increased during the last few years, but the situation in private breeds is less optimistic. Although there are about 100 breeding mares in private hands, the breeding material is dispersed and practically out of control.

The measurements of the Konik are given in Table 2. According to Kownacki (1963) the height of the Konik has not changed much since. 1920. On the other hand, the forechest girth, cannon girth as well as the body weight have considerably increased mostly due to better feeding. The Konik are characterized by an excellent ability to adapt themselves to local environmental conditions, utilize cheap feeds very well and resist difficult weather conditions. Young Konik horses are able to compensate for slow growth caused by insufficient feeding in some periods. In the subsequent more favourable period their growth is accelerated. Having small feed

requirements, the Konik do not tolerate intensive concentrate feeding. They display behavioural traits such as distinctly marked social hierarchy, vitality and cleverness which are characteristic of primitive breeds of animals. Excellent physiological characters of the Konik strong constitution, good health, fertility, long life cycle and hardiness make them especially suitable for keeping outdoors.

Table 1 POLISH PRIMITIVE HORSE (KONIK) AT STATE STUDS AND FARMS (1985)

Stud or Farm	Number of Stallions	Number of Mares
Polish Academy of Sciences		
Experimental Station (reserve)	3	14
Popielno (Suwalki province) (stable)	6	12
State Stud		
Racot (Leszno province)	4	34
State Stud		
Sierakow (Poznan province)	4	26
State Farm		
Dobrzyniewo (Pila province)	3	15
Roztoczanski National Park		
Zwierzyniec (Zamosc province)	3	5
Bialowieski National Park		
Bialowieza (Bialystok province)	1	4
Total breeding material	24	110

Table 2 BIOMETRIC MEASUREMENTS OF THE KONIK (according to Kownacki, 1984)

Measurement (cm)	Stallions		Mares	
	x	(min-max)	x	(min-max)
Height at withers	136.3	(134-140)	134.2	(127-144)
Height at sacrum	140.3	(135-144)	137.1	(131-146)
Trunk length	139.5	(132-155)	147.1	(141-153)
Chest girth	182.5	(174-190)	170.5	(160-180)
Chest depth	65.7	(63-67)	64.9	(57-76)
Chest width	44.0	(41-47)	38.5	(35-44)
Foreleg length	70.7	(68-73)	69.3	(62-75)
Cannon girth	19.1	(18-20)	17.5	(16-19)
Width of hips	50.0	(46-54)	49.3	(44-52)
Length of head	56.2	(52-61)	53.5	(50-59)
Body weight (kg)	420.0		450.0	

The ability of the Konik as a working horse should however be supported by systematic performance tests and selection. Unfortunately, so far, performance of the Konik horses, especially those from state farms, has tended to decrease in recent years. At state farms the horses are first of all selected for body conformation and not for working ability. It is an undesirable tendency because the Konik can lose its remarkable hardiness and endurance as an economic working horse.

Table 3 RESULTS OF VARIOUS PERFORMANCE TESTS OF THE KONIK

		Long-distance draught trials					
Author and year	Total distance (km)	Mean distance per 1 day (km)	Maximal distance per 1 day (km)	Mean speed (km/h)	Weight of carriage (kg)		
Vetulani, 1928	576	43.6		6.83	610		
Zwolinski, 1968	1 000	48.0	62.0	5.20	840		
		Draught per format tests					
		Maximal draught power in % of body weight		Mean time for 1 km (in min and sec)		Mean length of steps (cm)	
		Stallions	Mares	Walk	Trot	Walk	Trot
Vetulani, 1951		83.6	86.6	10'04"	4'03"		
Zwolinski, 1953		79.2	86.2	11'31"	4'27"		
Kownacki, 1962 <a href="#">a)</a>			64.8	11'32"	3'49"	137	232
Kownacki, 1962 <a href="#">b)</a>			65.2	9'54"	3'51"	150	258
Kapron and Soltys, 1983			47.3	12'05"	4'28"	132	222

a) Popielno Stud

b) Stubno Stud

During the last two years an attempt has been made to establish systematic training and draught performance tests for young stallions breeding mares should undergo in future a proper performance test before they are included into the stud. In 1982 and 1983 experimental saddle horse training of Konik stallions was conducted. The Konik have never been selected or intensively used for riding. Their body conformation i.e. poorly marked withers, short and straight shoulders as well as a' short gait, strong social instinct and sometimes stubbornness are not desirable in riding. Saddle-horse training has revealed however, that the riding ability of the Konik can be improved. Some riding performances of the Konik are given in Table 4.

Table 4 SOME RIDING PERFORMANCES OF THE KONIK

One-hour distance in walk	6 496 m
One-hour distance in alternate gaits:	
5 x (8 min walk + 3 min trot + min canter)	12 200 m
5 x (9 min walk + 3 min trot)	8 000 m
Maximal speed in canter	666 m/min
Mean speed on a distance of 20 km	8.2 km/h
Mean time for 10 km	1 hr 20 min
Mean time for 30 km	4 hr 20 min
Free jump	130-140 cm
Jump with ballast 13-15% of body weight	115 cm
Ballast allowed for cross-country riding (in % of body weight of horse)	23%

At present the state farms have no difficulty in selling young Konik horses. According to an enquiry published in agricultural periodicals, 191 private breeders, 18 agricultural schools and 14 riding clubs are interested in buying the Konik. The demand for the Konik was estimated at approximately 506 animals. Since not all potential buyers have responded to the enquiry, this figure seems to be underestimated. The state farms can offer for sale about 30 mares and 30 geldings a year, i.e. far below the demand. Most of the buyers intend to use the Konik for two or three purposes (Table 5).

**Table 5 PLANNED USE OF THE KONIK BY BUYERS**  
(according to Sasimowski et al. 1984)

	Purpose	Horse breeders		Horse users	
		Number	Percent	Number	Percent
Private buyers	Work in the field	108	81.2	19	90.5
	Transport	94	70.7	19	90.5
	Horticulture	19	14.3	3	14.3
	Riding	49	36.8	4	19.0
	Other use	20	15.0	2	9.5
Experimental farms of agricultural schools	Work in the field	5	55.6	2	20.0
	Transport	2	22.2	2	20.0
	Horticulture	3	33.2	5	50.0
	Riding	2	22.2	-	-
	Other use	1	11.1	-	-

So far the Konik has not been intensively used for crossing with other breeds to transmit their outstanding qualities. Some crosses were made with pure-bred Arabian and Anglo-Arabian horses. Crosses with Anglo-Arabian are good saddle horses for recreation. Crosses of the Konik with heavy draught breeds, suitable for harder work, are needed by the farmers.

The Konik stallions were also exported to countries of Western Europe. Among others, some Konik stallions were bought by Herzog von Croy for his herd of primitively-kept wild horses in Dulmen (Federal Republic of Germany).

In conclusion it can be stated that the Konik is a native breed of small-sized working horses suitable for small farms. It can be also used for carriage, sport, recreation and distance riding.

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### PROSPECTS OF UTILIZING HUCUL HORSES IN AGRICULTURE, SPORT AND RECREATION

Erazm Brzeski, Maciej Jackowski 1/

The Hucul horse holds a special place in Poland. In April 1979 a resolution was passed by the Horse Husbandry Team of the Research and Technical Council, supervised by the Minister of Agriculture, on preserving the Hucul horse together with its valuable genetic traits which have been handed down over many generations and are typical of this breed.

The Hucul horse of today is characterized, among others, by its relatively large head, low-set neck of middle length, long, wide and deep thorax as well as short and strong legs. It has a remarkable uniformity in build, is highly active, of extreme docility and longevity, has a perfect feed utilization, is easy to house and resists diseases.

The Hucul horses are by no means big animals. Their dimensions are within the following range:

Table 1 MEASUREMENTS OF HUCUL HORSES

	$\bar{x}$	Min.	Max.	$\bar{x}$	Min.	Max.
Height at withers	137.5	133	142	137.0	130	145
Chest circumference	173.0	162	188	180.6	167	192
Cannon circumference	19.0	18	19.5	17.9	17	19

The Hucul horse originated in the Carpathian mountains. The rigid mountain conditions often forced the horses to cover long distances and the harsh environment with scarce feed has toughened them over many generations. Their descent is not fully elucidated in spite of great interest shown by many investigators.

According to Prawochenski, "as early as 1603 K. Dorohostajski, the author of "Horse-riding" knew the Hucul horse and considered it perfectly adapted to its existence as a mountain horse".

The first Polish scientist who emphasized the need to give particular attention to the Hucul breed, as being economically valuable, was Prof. Karol Malsburg (1895).

Since this breed has a long history, only some names of the most Prominent Polish hippologists can be mentioned, such as S. Bojanowski, E. Hackl, M. Herrmann, M. Hollander, Z. Sosnowski, T. Starzewski and K. Ostaszewski .

In the inter-war period much consideration was given to Hucul horse deeding. In 1925 the Association of Hucul Horse Breeders was established with E. Bohosiewicz, a noted breeder of the Malopolska district, as chairman.

At that time the Hucul breeding stock was purchased in Poland by Bulgaria, Czechoslovakia, Greece, Luxemburg, Germany and Hungary.

Following World War II Hucul horses were scarce due to heavy losses suffered during the war. And it is only thanks to the unselfish work of many people that the breeding of Hucul horses is now steadily developing. Mention should be made here of: Zdzislaw Hrobni, former chief of the Department at the Ministry of Agriculture; Eugeniusz Skucinski, former Inspector of the Polish Horse Breeders Association; and Kazimierz Gajewski, animal scientist in the Union of Animal Breeding and Trade.

At present the breeding of Hucul horses is located at:

1. Siary state stud farm near Gorlice, with 50 mares (dams) and young stock. Director: mgr Jan Barzyk.
2. Zootechnical Experimental Station of the Institute of Animal Science at Rymanów, with 10 mares (planned to be 20 mares). Director: dr Stanislaw Kolat.
3. Klikowa stallion depot near Tarnów, with 15 stallions. Director: mgr Adam Niedzialkowski.
4. Private breeders, members of the Polish Horse Breeders Association. The total number of the Hucul horse population amounts to 25 sires and 75 mares.

Pedigree horses are derived from 7 male and 11 female lines. Mean inbred index for mares is 0.014 (in the range 0.000-0.250) and for stallions 0.0127 (in the range 0.000-0.127). Mean inbred index for state mares and stallions is 0.1111.

In 1962 Miss Elisabeth Broad purchased 9 Hucul horses in Poland, which were then transported to the United Kingdom. They became acclimatized very easily and were then successfully crossed with English Thoroughbreds and purebred Arab horses. In the 1970s 3 stallions and 3 mares were sold to Finland.

Despite their low height, the ways of utilizing Hucul horses are manifold: as pack horses, saddle horses and draught horses. For long they have been used as pack horses displaying *an* ability to move in very rough field conditions. They are noted as being able to overcome carefully and quietly precipices or rapid streams as well as perfectly jumping over natural obstacles with innate agility.

Holländer found them useful as draught horses. Sasimowski *et al.* have shown in their studies an easy adaptability of the Hucul horse to supplement mechanical traction in field work. They established the normal pulling force for the mare to be 50.14 kg and for the stallion 56.84 kg. Studies on working ability and suitability of the Hucul horse to field work in the region of the Carpathian mountains in Poland were conducted by Krzysztof Bilil. His estimates of normal pulling force for horses were higher and amounted to 57.54 kg for mares and 61.6 kg for stallions. For many years horses were selected among others for their suitability as draught horses. An inquiry among horse breeders and individual users has revealed that the horses are greatly appreciated, being used for light work as a supplementary force to that of a tractor or being kept in large industrial farms of an advanced standard.

As early as 1874 Czapski reported that the Hucul horse was excellent for riding. Gregorowicz (1898) pointed out its ability to overcome obstacles with a rider on horseback. At present they are being kept as riding horses in the Siary stud, and frequently used by holiday makers or scouts during summer holidays.

Wherever the Hucul horse is used, it displays three very positive characters: intelligence, obedience and productivity. Mention should also be made of an important economic aspect - small feed requirements and very low maintenance costs compared to other breeds.

Under the project R-II-8, coordinated by the Ministry of Science and Higher Education, the Agricultural University at Krakow has elaborated a long-term plan (by the year 2000) to preserve the Hucul breed. All Polish experts in horse breeding were involved in preparing the plan which was partly presented at the 4th International Symposium in Leipzig and as a whole was discussed at the following International Symposium in Lublin.

The plan provides, among others, the development of breeding work aimed at the preservation of the Hucul horse in the state sector involving 70 mares (dams) and 15 stallions. This sector will be supplemented by the individual breeder sector involving 30 mares and 15 stallions. Basic aims are pure breeding with much consideration to male and female lines. A preliminary mating plan has been worked out for the next 49 years aimed at preventing an undesirable increase in inbreeding and too close relationships. It was suggested to use a selection method of independent culling levels, and to keep the present biometric standard.

Regulations concerning performance tests, peculiar characteristics of the breed and utilization of Hucul horses in field work and recreation are under elaboration.

The Hucul horse should preserve the valuable traits which have been accumulated as a result of many years' breeding work and coded genetically. We do believe it will perfectly supplement mechanical traction as well as serving the purpose of recreation.

New prospects are open of cooperation with Czechoslovakia, Romania and the Soviet Union in the field of Hucul horse breeding.

In a long-term breeding plan aimed at preserving this breed much consideration is given to the staff working with the animals. Great successes can be expected only when all breeding work is conducted according to the principle of "The right man in the right place".

### **POLISH XDNIKS IN THE ROZTOCZE NATIONAL PARK**

E. Sasimowski 1/ and J. Slomiany 2/

The breeding of Polish Koniks in the Roztocze National Park (RNP) in Zwierzynice (Figure 1) was started in 1982 at the initiative of Professor Miroslaw Kownacki. Four mares and one stallion which had been kept in stables and bought from the National Stud in Racot composed the initial material. Their names showing relationship and inbreeding are given in Table 1.

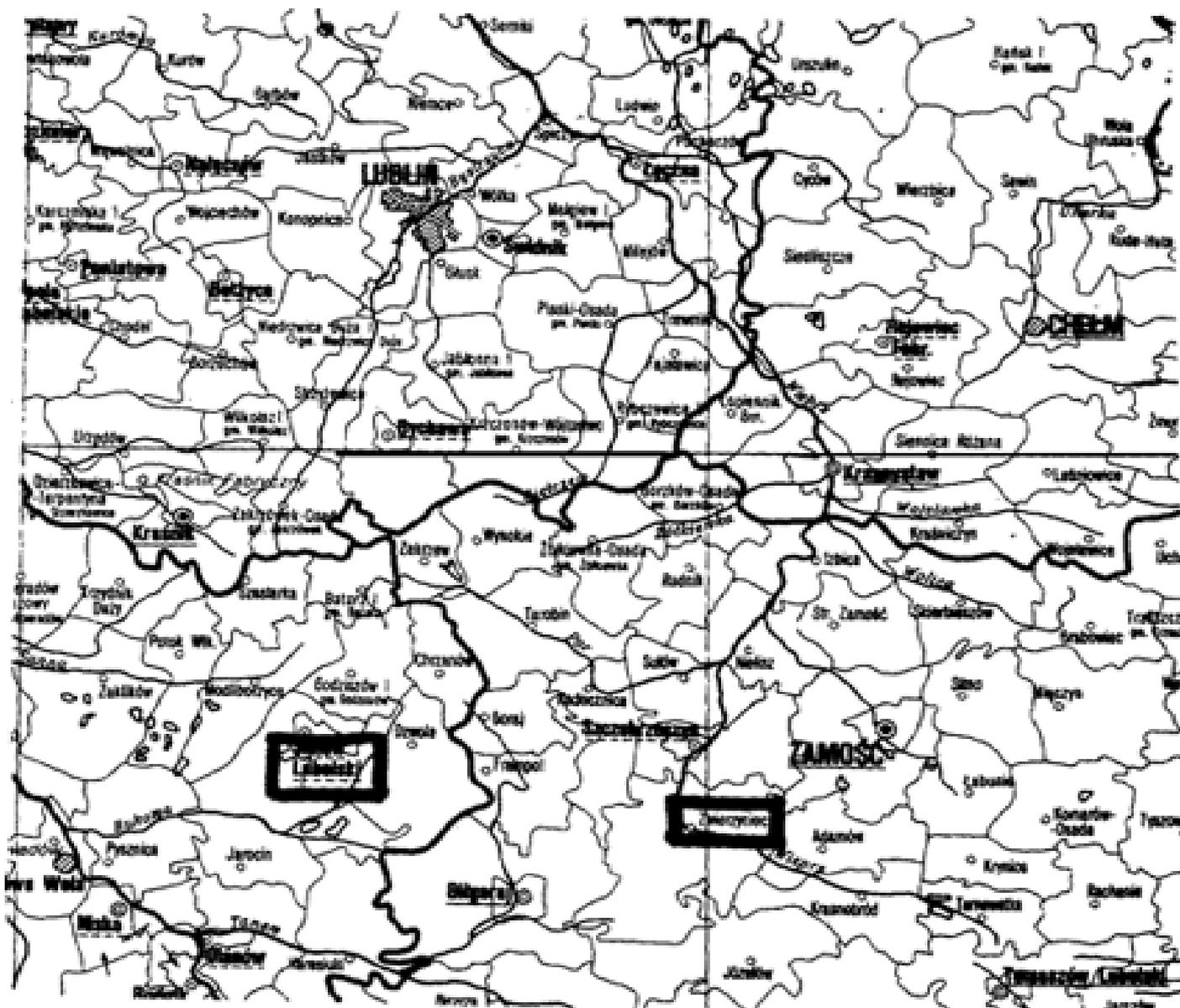


Figure 1. Location of Zwierzyc and Janów Lubelski.

**Table 1 THE INITIAL STUD OF KONIKS - COEFFICIENTS OF RELATIONSHIP ( $R_{xy}$ ) AND INBRED ( $F_x$ )**

Horse - sex		$R_{xy}$				$F_x$
		Mohacz	Husaria	Moda	Tuba	
1. Mohacz - sire	–	5.93	19.87	7.58	11.49	6.250
2. Husaria - dam	5.93	–	12.37	11.30	12.68	7.81
3. Moda - dam	19.87	12.37	–	28.86	30.73	2.15
4. Tuba - dam	7.58	11.30	28.86	–	29.16	5.76
5. Hanula - dam	11.22	12.68	30.73	29.16	–	5.66
Jointly $\bar{x}$	11.22	10.57	22.96	19.22	21.02	5.52

At present the stud consists of one sire, five dams (one three-year-old dam of own breeding with foal) and 14 foals and young of different ages; four-year classes of foals have been obtained so far. The stud is under the care of mgr ing. Jan Slomiany of the RNP and co-author of the present article. Research is supervised by the Zootechnical Science Committee of the Polish Academy of Sciences and directed by Professor E. Sasimowski (co-author).

The habitation of the Koniks embraces an area of about 100 ha forest and pasture which is enclosed by a wooden-poled fence. A stream and ponds on the grounds provide a watering-place all the year round.

This area is almost exactly on the spot where at the turn of the 19th century the last heir of the Zamoysky family had his reserve of wild hunting animals - among others Tarpan. When the reserve was disbanded the Tarpan were distributed to neighbouring farms and up to the present horses with some characteristics of Tarpan - e.g. mouse colour - are seen in this region. It seems reasonable that the breeding of Koniks in the RNP should aim at creating a population which is well accustomed to the natural environment of the nature reserve which is also useful in improving the stock of this breed kept under stable conditions mainly in the neighbourhood.

In this instance the improvement of the Koniks in the reserve could be compared to that of Thoroughbreds and Purebred Arabians in breeding and producing half-bred horses. Thoroughbreds and Arabians are selected by races which test their vigour and physical efficiency; the Koniks in the RNP are similarly tested - a good adaptation to severe conditions without stabling and concentrates is the basic test of desirable properties. It can be acknowledged as a sufficient selection factor for dams - with attending maternal care - but it appears insufficient for selecting stallions among others because movement is less intensive.

Observation continued day and night (Table 2). Both the gallop and trot portions were relatively small. The distance covered in these gaits and walk jointly averaged 5.6 +2.5 km. Moreover, in this movement there is a lack of such elements as jumps which play a significant role in the case of walk saddle horses and as surmounting resistance which is of main importance in harness.

In this connection in the previous year three two-and-half-year-old stallions were excluded from the stud and trained under saddle and in harness. This year when training was completed a performance test was carried out. It enabled us to determine many significant indices (Table 3).

**Table 2 FRACTIONS (IN MIN) OF PARTICULAR GAITS IN THE OVERALL MOVEMENT OF KNONIKS AND THE DISTANCE COVERED DURING DAY AND NIGHT (IN KM)**

		Walk				Trot				Gallop				Way passed			
Horses	n	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S	$\bar{x}$	Min	Max	S
Sire	7	72.9	42.1	125.9	26.4	5.0	0.3	14.4	4.5	1.4	0.1	7.7	2.8	5.9	3.3	10.9	2.7
Dams	28	67.7	42.3	93.7	16.6	3.4	0.3	9.2	2.9	1.2	0.2	6.8	2.3	5.4	2.7	11.8	2.5
Two-year-olds (born in 1983)	8	78.6	36.8	124.9	26.5	3.8	1.2	6.7	2.4	0.3	0.2	0.7	0.2	5.6	2.5	8.0	1.5
One-year-olds (born in 1983)	20	65.2	41.3	96.5	16.5	3.0	0.3	10.4	5.1	2.0	0.2	7.3	2.6	5.4	2.5	9.7	2.3
One-year-olds (born in 1984)	8	74.0	40.8	106.7	22.3	3.9	1.2	6.3	2.1	0.2	0.2	0.5	0.1	5.3	3.0	6.8	1.2
Sucklings (born in 1984)	16	98.6	57.7	133.7	25.2	3.5	0.3	18.0	4.2	2.6	0.5	18.0	4.2	7.8	4.4	19.0	3.4
Sucklings (born in 1985)	2	150.8	138.5	163.1	17.4	7.6	6.6	8.6	1.4	5.1	1.0	9.1	5.7	12.8	10.1	15.5	3.8

Table 3 RESULTS OF PERFORMANCE TESTS OF STALLIONS (MIN-MAX)

Efficiency of movement during one hour under saddle:		
- 5 x (8' walk + 3' trot + 1' gallop) - 8320 m - 9072 m		
Efficiency of movement during one hour in harness with a resistance of 8 percent body weight:		
- 5 x (9' walk + 3' trot) = 6558 m - 6666 m		
Maximum pulling power:		
248 - 252 kg (2433 - 2472 N) - 73% - 89%		
Speed at a distance of 1 km,	in walk:	11.21'-12.53'
	in trot:	4.30'-4.55'
	in gallop:	2.00'-2.50'
Size of obstacles passed at liberty:		95-115 cm
Size of obstacles passed under rider		80- 90 cm
Length of jumps:		250-300 cm
Length of step in walk	- in hand:	143-166 cm
	- under rider:	141-155 cm
	- in harness:	121-151 cm
Length of step in trot	- in hand:	210-240 cm
	- under rider:	200-210 cm
	- in harness:	180-224 cm
Length of foulée in gallop	- in hand:	224-272 cm
	- under rider:	310-330 cm

All these indices make it possible to compare the stallions observed among themselves and with the results of experimental training and performance tests carried out on three-year groups of Koniks by Dr. S. Siudzinski at the Agricultural Academy in Poznan and Assistant-Professor R. Tomczynski at the Agricultural-Technical Academy in Olsztyn. The tested stallions can also be compared to the whole population of Polish Koniks.

This year one of the three-year-old tested stallions will become a new sire of the stud.

These tests are also useful as the stallions which cannot be included in the stud or those eliminated from the main herd are immediately used for saddle or harness. In winter during their stay in the reservation, they are even used for transporting hay which is indispensable as additional feed for the stud. They can be used for transport in the area of the RNP and can also be tried as saddle horses for the tourists resting in Zwierzyniec and in teaching local children to ride.

Observations so far demonstrate that rearing the Koniks in liberty in the pasture-forest reservation assures optimal health. Even during the recent very frosty winters when the temperature often dropped under 30° C no symptoms of cold appeared either in adults or in foals. There were also no disorders of the alimentary canal, except for worms which require" systematic treatment (deworming) twice a year - in spring and autumn.

Simultaneously, the hooves must also be trimmed as they do not wear sufficiently on the relatively soft ground and due to not very intensive movement.

Reproduction and rearing are not disturbed and are interesting to observe. Research results of behaviour, stud hierarchy, growth and development of foals controlled by weighing, biometric measurements and haematological tests are also interesting. The latter and the examination of coat and hoof horn structure also include adults.

The results of environmental research - phytosociological, hydrobiological and animal health are important in breeding. Some of them have already been reported and are now being published. The rest are now being prepared and completed by a greater number of new observations.

It is worth mentioning that the authors are actually cooperating with breeders in another herd of Polish Koniks in Janów Lubelski placed about 50 km from Zwierzyniec and 80 km from Lublin, in the Partisans' Park of National Memory. The initial material consists of local mares, i.e. the Bilgorajski horses which have the Polish Konik blood. The results arising from this research are also of interest.

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**APPENDIX 1**  
**ADDRESS OF WELCOME**

Dr. H.A. Jasiorowski  
Director, Animal Production and Health Division, FAO

Mr. Minister, Mr. Chairman, Ladies and Gentlemen,

I am pleased to welcome you here on behalf of the Director-General of FAO and the Executive Director of UNEP to the second meeting of the joint FAO/UNEP Expert Panel on Animal Genetic Resources Conservation and Management and I am especially happy that the meeting is taking place in my own country, Poland. It is

very gratifying that we have such a distinguished group of scientists from all over the world gathered here to address the important work of this meeting.

This Expert Panel was established in 1983 to 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 two Organizations have now established a commendable record of joint activities in this field, starting shortly after the establishment of UNEP in the early 1970s and continuing the pioneering work in animal genetics initiated by FAO soon after it was created 40 years ago.

Cooperation between FAO and UNEP has grown considerably during the last twelve years. It now embraces not only specific national projects, but also sub-regional interests and the development of regional and global infrastructures for the support of animal genetic work. The joint activities have included surveys of indigenous breeds, improved use of animal genetic resources for the production of meat, milk fibre and draught animal power, training activities for developing country scientists, publications, expert consultations, plans for the establishment of data banks and gene banks and plans for the preservation of endangered breeds, especially in developing countries.

The importance our host country, Poland, attaches to the subject of this Panel is clearly shown by the presence here of the Minister of Agriculture, Dr. S. Ziemia, the Deputy Minister of Environment Preservation, Dr. Michna, and the Permanent Secretary of the Ministry of Higher Education, Science and Technology, Dr. Kurowski. I wish to welcome them here and to thank them on behalf of all those participating in this meeting. I am sure we can consider their presence here as a sign of the support and interest this country is giving to FAO's activities.

I also wish to welcome the President of the Polish Society of Animal Production, Professor E.A. Potemkowska, and the Rector of the Warsaw Agricultural University, Professor M.J. Radomska.

Both FAO and UNEP attach much importance and expectations to the advice received from this Expert Panel. As you know, the focus of concern for the Panel covers all aspects of animal genetic resources which is a wide field. It includes both the improved utilization of animals and also the preservation of those animal breeds which have unique traits developed during the long process of domestication. The latter of these two objectives, namely preservation, received prime attention at the first meeting of the Expert Panel in 1983. We expect that during this meeting you will also devote attention to the problem of the improvement of utilization of genetic resources which is especially important to the developing countries where during the last decades we have observed in some cases a decline in animal protein production per caput, stagnation of livestock productivity and an increasing dependency on imported animal products. Improvement of productivity and preservation of indigenous breeds is one of our main goals in developing countries.

If mankind were still using the local indigenous breeds of animals in each place where they have been used for thousands of years, there would be no need even to consider preservation. However, we are in the middle of a huge revolution of animal genetic resources utilization which started at the beginning of this century and which has gained momentum during the last 30 years. The first impact of this revolution is concerned with breed substitution on a grand scale. It has swept through Europe, where there were old established traditional breeds in each locality until this century. Many of these have gone and have been replaced by the more productive and economically viable breeds.

The domination of milk production by Black and White cattle in Europe which has recently been improved by crossing with Holstein-Friesians from North America is testimony to this change.

Europe has responded to the need to preserve the older local breeds relatively late but in a positive way by trying to keep them where possible, as small populations of live animals which are often open for the public to

visit in natural settings. Where this is not possible, or indeed as an additional means of preservation, the European countries have also deposited semen and embryos in cryogenic gene banks for posterity. Even in highly developed countries the funds for animal genetic preservation are not easily available.

Some people view these activities as luxuries. They feel it is impossible to predict when the economic benefit of preservation will occur, and indeed there may never be such a time. On the other hand, some people regard these preservation activities as having a moral basis and obligation upon mankind, to prevent the total loss of genetic variation which is unique and cannot be replaced. We in FAO and UNEP wholeheartedly support the latter attitude.

When we turn to the developing countries we find similar principles at work, but with some special angles. First, the replacement, of the local breeds by those of higher economic value is under way. But, it is not so much a matter of breed substitution as gene substitution, through crossbreeding, since it is rare in the tropics to be able to introduce temperate breeds as purebred animals without a high level of feeding, special management and high investments and risks.

Mass crossbreeding with local animals to combine their adaptation and disease resistance with the higher production of exotic breeds is the most frequent situation in developing countries. This places a special demand upon the indigenous breeds. They are needed initially for the production of crossbreds and perhaps even over the long term if it is not possible to create a stable self-perpetuating crossbred. Yet at the same time, the indigenous breeds are becoming even more obviously uneconomic in their performance levels and farmers are reluctant to keep them. Therefore, there is evidently a need to combine the approach of improved utilization which must have priority in developing countries, with the to conserve the local animal genetic resources for the present and future use.

I am glad that it was possible to arrange this meeting of the Expert Panel on genetic resources in association with the European Association of Animal Production Symposium which is being arranged by the Polish Society of Animal Production on a similar subject.

The EAAP/PSAP Symposium is addressing particularly the issues of the use of small populations in the European context. There will be excellent opportunities therefore for members of our Expert Panel and the Polish and visiting European scientists at the Symposium to gain from each other's experience and also, I hope, to produce more than either would have produced alone.

Some of you were present at the first meeting of the Expert Panel in 1983. You will recall that much of the agenda was devoted to the topics of data banks and gene banks for animal genetic resources. I am pleased to be able to tell you that the recommendations you made at that meeting have been followed with some success by FAO and UNEP. On the subject of data banks we were able to carry out trials for two years in several countries in Africa, Asia and Latin America. As a result, we were able to design a methodology which has been adequately tested and proven in the field. We are publishing the methodology which includes the first comprehensive descriptors of the major species of domestic animals and poultry.

We trust that when the publications are to hand, we shall be successful in seeking funds for the establishment of regional data banks for animal genetic resources. But data banks should be considered as an introductory phase to the practical programmes of genetic resources preservation. Here more funds will be needed for developing countries and they may be difficult to obtain. Your advice and clear recommendations on this subject are expected.

In looking ahead to the improved use of animal genetic resources in the next years, we are aware of the great need and responsibility to rapidly improve the utilization of animals and to increase their productivity in

developing countries. We feel the need to apply the rapidly advancing science of genetic engineering to animal production also in developing countries.

It seems likely that the rapid advances towards the creation of transgenic animals may eventually have a special contribution to make to the problems of joining the productive potentials of the temperate breeds to the adaptive advantages of the indigenous breeds of the Third World. Harnessed to the existing techniques of A.I. and the growing flexibilities of Multiple Ovulation Embryo Transfer there are entirely new opportunities for us to break away from the conventional methods of field testing large numbers of animals to calculate breeding values. We know that the creation of the desired infrastructures of field testing schemes in the tropics has been a task of formidable difficulty. Rarely has a developing country been able to set up a livestock improvement scheme comparable to those of the developed world. It is exciting to look forward to the possibility of bypassing these obstacles and to implementing genetic improvement by the use of biotechnology. In this way the developing world will not fail to benefit from the advance of science which otherwise threatens to widen the technological gap rather than to diminish it between the north and the south. You may wish to advise us on this important policy question.

We are pleased that today here at the Expert Panel meeting, while you are attending in your individual capacity as scientists, you are also representing the different regions of the world in which FAO and UNEP are working. We are glad, too, that you represent many of the regional and sub-regional institutions concerned with animal breeding and genetics. We also invited a small group of Polish geneticists to attend this meeting. I am sure they will benefit by listening to your discussions.

Finally, may I convey good wishes to you for success in the meeting not only from myself, but from all your colleagues in the Animal Production and Health Division. We thank you for coming. We look forward with great interest to your recommendations on this important subject of animal genetic resources.

Dr. Hamdallah Zedan  
United Nations Environment Programme  
Nairobi, Kenya

It gives me a great pleasure and is my privilege to be with you on this occasion.

The United Nations Environment Programme (UNEP) is most grateful to the Secretariat of FAO for planning and organizing this consultation and to the Government of Poland for hosting it. I wish also to express our gratitude to Dr. Hohn Hodges (FAO) and Dr.- J. Kwiatkowski (Polish Institute for Cattle Breeding and Milk Production) for their tireless efforts and to the dedicated scientists coming from different countries, regions and organizations to participate in this meeting. It is indeed heartening to see such a distinguished group of experts in animal genetic resources assembled to discuss, exchange information and advise on experiences, achievements and methodologies for efficient management and conservation of the world's animal genetic resources for future needs. To all these we are most grateful.

Since the very beginning of human life on earth, man and animal have been tied together in intimate association and while domestication of plants provided humans with the main source of food and fibre, that of animals was the main source of protein, hide and fur. Over 56 million tons of edible protein and over 1 billion mega calories of energy annually come from livestock. The highly valuable protein for human consumption is over 50 percent of that produced by plant crops and in terms of fertilizer value animal waste is said to contain valuable plant nutrients which has been estimated annually to be worth over 1 billion.

With the current situation of about two thirds of the world's population already suffering from inadequate intake of protein and with the estimate that within the next 30 years the population will double, the potential deficit of

livestock products by the year 2000 staggers our imagination. It is therefore essential that man must have at his disposal both the plant and animal genetic resources that would be deployed to meet his needs.

The impact of developments in animal breeding on animal populations combined with vast technological advances in this field is likely to swing the balance in favour of the economically superior breeds to meet the requirements of the growing world populations. A natural consequence of this process is a gradual decline in genetic variability within domestic animal populations particularly in developing areas with dense populations and dwindling resources.

Just like crop plants, the presently available broad diversity of breeds (varieties, strains, races, populations, etc.) of domesticated animals is the product of thousands of years of environmental adaptations, even more consciously guided by man. Quite often the progenitors and wild relatives of presently domesticated species are extinct and hence further genetic diversification will have to rely on existing breeds. Commercial pressures for the use of exotics in developing countries has also often been excessive and the indiscriminate crossing of local breeds from outside the local environment has probably already caused serious loss of valuable local adaptations and characteristics. The tendency among decision-makers - because of the pressing needs - to put an emphasis on developmental aspects and immediate livestock improvement through imported genet material may have reduced future options for improvement of livestock production through the use of indigenous well adapted genetic material. The technical ease with which artificial insemination could be applied and the recent developments in preservation and transportation of germplasm made the loss much more rapid and drastic in recent years. As a result indigenous breeds are disappearing and small farmers and villagers cannot afford the high input breeds that are being introduced.

The loss of genetic variability is a matter of concern to both FAO and UNEP, to many other organizations and to the scientific community when viewed against present and future trends in livestock production. There are examples that can be given of breeds which were thought to have little value under a prevailing economic condition at a certain time but proved important when the requirements for breeding and production systems have changed. We must not be concerned only with domesticated animals, we should be also concerned with wild feral populations as human intervention in domestication of animals is not yet complete. Some of the species existing in the wild today may be domesticated in the future.

The UNEP concern is fully expressed in the 1980 overview on genetic resources and in the various Governing Council decisions since 1973. We are not interested in conservation for conservation nor is FAO or other active organizations. Our goal is that the broadest genetic diversity within each of those species which have significant, or potentially significant, socio-economic value among domesticated or semi-domesticated farm and pastoral animals (including their wild relatives) should be preserved and to help make such genetic material and information thereon freely accessible for utilization in environmentally sound bioproductive systems so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of the future generations.

The emerging awareness of the need for urgent positive action to conserve and develop the world's animal genetic resources as man's chief insurance against their destruction has resulted in a number of limited uncoordinated efforts. UNEP and FAO have a history of cooperation since 1974. They supported a number of joint activities in this important field. The early joint activities 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 consultation on animal genetic resources in Latin America and on dairy cattle breeding in the humid tropics, an inventory of special conservation herds and a high level FAO/UNEP technical consultation in 1980 to identify the world's problems facing the world's animal genetic resources and to draw a plan of action for international cooperation which was lacking. The

creation of the FAO/UNEP Panel of Experts on Animal Genetic Resources Conservation and Management and its first meeting in 1983 was a realistic step towards the establishment of an international programme in this important field and both FAO and UNEP were instrumental in the implementation of the proposals recommended by the expert consultation and the Panel where many of you have participated and contributed. Pilot trials for the establishment of data banks in Africa, Asia and Latin America, pilot inter-country conservation schemes for selected breeds which are often scattered in several countries, training of animal scientists from developing countries, publication of the Newsletter "Animal Genetic Resources Information", creation of inventories about the livestock resources of the USSR and China and plans to establish regional gene banks for cryogenic conservation of animal genetic resources in developing countries and to restore the Przewalski horse to its natural habitat are all in progress since the previous meeting of this distinguished Panel.

One major event in this area has taken place since the previous meeting. Recognizing the fact that conservation is an integral part of sustained management and utilization of genetic resources, the African Ministers' Conference on the Environment, called by UNEP and held last December decided to establish an African Regional Network for the Conservation and Management of Genetic Resources (as one of eight regional networks that will be established). Another decision which also bears relevance to animal genetic resources is the implementation of 150 village pilot projects and 30 pilot semi-arid stock-raising zones aiming at self-sufficiency in food and energy.

We shall ask you to address an appraisal on the work which was achieved or is now in progress and to advise on how to proceed. We shall be looking to you for assistance in the establishment of the African network on genetic resources. The task will undoubtedly remain the responsibility of national authorities and the scientific and learned societies. But a certain minimum guidance and coordination will be needed and the Panel meetings give a good example of the provision of scientific, technical and logistical guidance. With the collective experiences and wisdom of such a distinguished group of experts, I have no doubt that we shall all come out with concrete recommendations. We thank you for coming and we look forward with great interest to continued cooperation.

Thank you.

## **APPENDIX 2**

### **FAO/UNEP JOINT EXPERT PANEL ON ANIMAL GENETIC RESOURCES**

### **CONSERVATION AND MANAGEMENT**

#### Terms of Reference

#### I. 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 caused 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 to 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 resulted in the 1970s 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 animal 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 was considered desirable to establish an FAO/UNEP Panel of Experts on Animal Genetic Resources Conservation and Management. This is 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.

## 2. OBJECTIVES AND FIELDS OF ACTIVITY

The objectives of the Panel are to:

- Review periodically ongoing work on animal genetic resources conservation and management in 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 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 ex situ conservation methodology of 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.

### 3. MEMBERSHIP

The Panel is a standing and authoritative body of experts, the total number not exceeding 40. The number of participants at specific meetings depends on the topics dealt with, as well as on the budgetary allocations available.

Half of the members are nominated by the Director-General of FAO and half by the Executive Director of UNEP. The nominations are 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 rests 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 genetic resources, it is envisaged that other international agencies concerned, such as UNDP and the World Bank, will be encouraged to support the Panel.

### 4. 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 of 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 is an extension, taking into account experiences gained during the initial period.

#### 5. PERIODICITY OF SESSIONS

It is planned 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 3 MEMBERS OF THE JOINT FAO/UNEP PANEL OF EXPERTS ON ANIMAL GENETIC RESOURCES AND MANAGEMENT**

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**APPENDIX 4**  
**SECOND MEETING OF THE JOINT FAO/UNEP EXPERT PANEL ON**  
**ANIMAL GENETIC RESOURCES**

Warsaw, 13-18 June 1986

## AGENDA

Friday 13 June

- 08.30 1. Introduction
- 09.00 2. Welcome Address on behalf of FAO/UNEP (Dr. H.A. Jasiorowski)
3. Welcome Address try Representative of Host Government of Solano.
4. Adoption of the Agenda
5. Election of Chairman and Vice-chairman  
(Dr. H. Newton-Turner and Dr. Jorge de Alba were unanimously elected)
6. Review of Business of the Meeting (Dr. John Hodges)
- 10.00 Break
- SECTION A - PRINCIPLES FOR INDIGENOUS ANIMALS IMPROVEMENT IN TROPICS Cattle  
(Rapporteur: Dr. Jorge de Alba)
- 10.30 7. Professor E.P. Cunningham (Kenana in Sudan)
- 10.50 8. Dr. F.E. Madalena (Crossbreeding in Latin America)
- 11.10 9. Dr. Jorge de Alba (Criollo in Latin America)
- 11.30 10. Dr. John Hodges (Sahiwal in Kenya and Pakistan)
- 11.50 11. Discussion
- 12.00 Lunch
- Buffalo (Rapporteur: Dr. F.E. Madalena)
- 14.00 12. Dr. S. Sivarajasingam (General Asian experiences)
- 14.30 13. Dr. John Hodges (FAO/UNDP/Philippine Government Project)
- 15.00 Break
- Sheep and Goats (Rapporteur: Professor C. Novoa)
- 15.30 14. Professor A. Lahlou-Kassi (North African/Mediterranean experiences)
- 15.50 15. Dr. Pushkar Nath Bhat (Asian experiences)
- 16.10 16. Dr. L.L. Ngere (African experiences)

16.30 17. Discussion

Saturday 14 June

SECTION A (CONTINUED) - PRINCIPLES FOR INDIGENOUS ANIMALS  
IMPROVEMENT IN TROPICS

(Rapporteur: Professor L.L. Ngere)

Camelidae (Rapporteur: Professor A. Lahlou-Kassi)

09.00 18. Professor C. Novoa (Latin America)

10.00 Break

Pigs (Rapporteur: Dr. Pushkar Nath Bhat)

10.30 19. Professor J.W.B. King (General)

11.15 20. Discussion on Section A (led and summarized by Professor E.P.  
Cunningham)

12.00 Lunch

SECTION B - EDUCATION AND TRAINING FOR ANIMAL GENETIC RESOURCES IN THE TROPICS

(Rapporteur: Professor J.W.B. King)

14.00 21. Professor A. Lahlou-Kassi (Africa)

14.15 22. Dr. S. Sivarajasingam (Asia)

14.30 23. Professor C. Novoa (Latin America)

14.45 24. Professor E. P. Cunningham (Developed country view)

15.00 25. Discussion

15.15 Break

SECTION C - PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN  
TROPICS

(Rapporteur: Dr. Pushkar Nath Bhat)

15.45 26. A. Teixeira Primo (Brazil National Plan)

16.05 27. Professor C. Novoa (Camelidae)

- 16.25 28. Dr. H. Newton-Turner (Sheep and goats)
- 16.45 29. Professor Imre Bodó (Principles in use of live animals)
- 17.05 30. Dr. Stefan Wierzbowski (Principles in use of cryogenic storage)

Sunday 15 June

Field Visits

Monday 16 June

\* SECTION D - PRINCIPLES AND PRACTICES OF USE OF RARE BREEDS OF CATTLE, HORSES, SHEEP AND GOATS IN EUROPE

NOTE: Section D was held jointly with the EAAP/PSAP Symposium

- 09.00 31. Opening Session
- 10.00 32. Roles of animal genetic resources in production, natural environment, conservation, human enjoyment and recreation (Rapporteur: Professor J.W.B. King)
- 11.00 Break
- 11.20 33. Cattle (Rapporteur: Dr. Jorge de Alba)
- 13.00 Lunch
- 15.00 34. Horses (Rapporteur: Professor Imre Bodó)
- 16.20 Break
- 16.40 35. Sheep and Goats (Rapporteur: Professor C. Novoa)

Tuesday 17 June

(Rapporteurs: Dr. A. Teixeira Primo and Dr Y. Madkour)

- 09.00 36. Short papers on Section D
- 15.00 Horse riding show

Wednesday 18 June

SECTION E - REGIONAL GROUPS DISCUSS PRIORITY TARGETS AND DESIGN PROJECTS FOR ACTION NATIONALLY AND REGIONALLY

- 09.00 37. African Region -  
(Rapporteur: Cunningham) Professor E.P. Cunningham  
Professor A. Lahlou-Kassi  
Dr. Y. Madkour  
Dr. K.O. Adeniji  
Dr. L.L. Ngere
38. Asian Region -  
(Rapporteur: King) Dr. Pushkar Nath Bhat  
Professor Imre Bodó  
Dr. S. Sivarajasingam  
Professor J.W.B. King
39. Latin American Region -  
(Rapporteur: Newton-Turner) Dr. Helen Newton-Turner  
Dr. Jorge de Alba  
Dr. F.E. Madalena  
Professor C. Novoa  
Dr. A. Teixeira Primo  
Dr. Stefan Wierzbowski

SECTION F - RECOMMENDATIONS PRESENTED, DISCUSSED AND ADOPTED

- 14.00 Presentation of recommendations by  
rapporteurs

Section A - PRINCIPLES FOR INDIGENOUS ANIMAL IMPROVEMENT IN TROPICS

40. Cattle (Dr. Jorge de Alba)
41. Buffalo (Dr. F.E. Madalena)
42. Sheep and goats (Professor C. Novoa)
43. Camels (Dr. L.L. Ngere)
44. Camelidae (Professor A. Lahlou-Kassi)
45. Pigs (Dr. Pushkar Nath Bhat)
46. Section B - EDUCATION FRAMEWORK (Professor J.W.B. King)
- Section C - PRINCIPLES FOR PRESERVATION OF ENDANGERED SPECIES AND BREEDS IN TROPICS
47. General (Dr. Pushkar Nath Bhat)
48. Cattle (Dr. Jorge de Alba)

49. Horses (Professor Imre Bodó)

50. Sheep and Goats (Professor C. Novoa)

Section D - REGIONAL PRIORITIES AND PROJECTS

51. African (Professor E.P. Cunningham)

52. Asia (Professor J.W.B. King)

53. Latin American (Dr. H. Newton-Turner)

18.30 Conclude

**APPENDIX 5**  
**JOINT FAO/UNEP EXPERT PANEL ON ANIMAL GENETIC**  
**RESOURCES**

Warsaw, Poland, 13-18 June 1986

PARTICIPANTS AT MEETING

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## **APPENDIX 6 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 Strategy, 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 description of:

- i. the genetic attributes of an animal species or breed which has a unique genetic identity; and
- ii. the environments to which 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.

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