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Conference paper

THE STATE OF GLOBAL ANIMAL GENETIC RESOURCES, AND A NEW FAO PROGRAMME OF MANAGEMENT (1 st part)

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Introduction

A small number of species are extremely important in helping provide for our existance. Globally, they account for something more than 30% of the total value of food and agriculture. A wide variety of food products and product qualities is involved, in addition to many further contributions to agriculture by these species. Commonly, communities utilize an animal species to meet several needs, rather than for one product as we often assume. A great variety of production environments is used by food and agriculture, even within each continent of the world. Mixes of animal species, and of these with plants species will commonly increase production and productivity of sustainable agriculture in most production environments.

Expansion of and marked changes in food and agriculture production are inevitable consequences of human urges to expand and change our habitation of the planet. New combinations of plant and animal species and of lines, and changes to management and local ecosystems will be involved. New and acceptable ecosystem equilibria must be achieved to also provide for our replacement generations. Genetic diversity is the foundation for developing these equilibria, and it is in understanding the relationships and achieving the equilibrium for each production environment that is the concern of sustainable agriculture.

Hence, animal genetic diversity is critical to achieving food security for the world's rapidly growing population, and to help economies respond to structural change. Genetic diversity is essential to:

1. Increase food production.
2. Maximize productivity of agricultural lands and other inputs.
3. Achieve sustainable agriculture for the benefit of present and future generations.
4. Consistently meet the variety of known and yet-to-be-determined needs of human society.

The magnitude of the challenge is underscored by the estimate that at the current rate of growth, the world's population will consume in the second decade of the next century a quantity of food equivalent to the total agricultural production of the past 10,000 years.

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The genetic diversity at the species level of course is provided by the total gene pool for the species. In evolutionary timeframes this pool is dynamic, with alleles continually being lost and new alleles created. During the 10,000 years of domestication much of this within-species variation has been redistributed to now be unique to the subspecies breed level. Human communities spread to previously unpopulated areas of the globe taking animal species samples with them to the new environments. They remained reletively isolated for centuries and sampled consecutive generations to maintain their herds and flocks, possibly even applying some directional selection over time.

An essential question in establishing gest courses for action is: How much of the within-species diversity is unique to the breed level? If this portion is small, the maintenance and development of breeds to suit particular production environments and requirements is not important; while if it is large then by not conserving unique breeds we are jeopardizing short and longer term opportunities and returns, and possibly even substantially reducing the amount of land which can sustain animal agriculture.

Animal production is primarily concerned with the complex quantitative genetic traits, associated with adaptation to stresses and the reproduction, production and product quality traits, with each of these being determined by a good number of genes interacting with the total production environment. Hence, our existing animal genetic resources, developed over long periods of time, for all intents and purposes can be assumed to be irreplaceable. Although a very small number of man-made mutations have proved useful to date for improving plant production, animals are more complex and costly organisms. The technology to artificially achieve the vast array of changes in genetic make-up which could be supplied by currently existing and readily available animal genetic resources, does not exist and may well not exist a century from now. The management costs required to maintain our existing unique resources, to cover the range of current and possible future uses, are negligeable compared to the massive costs which would be involved to quickly custom make a breed artificially to satisfy a specific change or combination of changes in environment and to do this efficiently and in a way which is sustainable, even if it were technically feasible.

During times of major social and economic change it has often been the practice for countries and international support agencies to defer attention to the commonty accompanying dramatic changes in the genetic structure of domestic livestock sectors, presumably assuming that this local restructuring of the species gene pools will properly solve itself and lead to best and sustainable animal agriculture. This is unlikely. In addition, sectoral changes as fundamental as and with the built-in continuity of gene pool restructuring will be difficult to alter dramatically again once stability in the economy is achieved.

Further, the need to conserve and sustainably use global biodiversity has now been formalized with the introduction in December 1993 of the Convention on Biological Diversity (hereafter termed The Convention) as an international treaty. Yhe convention also specifically treats agriculture and its sustainable use of diversity. In addition, in 1991 the Member Governments of FAO resolved to arrange a consultation of experts to examine the management of global animal genetic resources. This was held (FAO, 1992) and the recommendations were accepted in 1993 by the FAO governing bodies.

This mandate to FAO, together with the Organization's obligations under The Convention has led to the programme for conservation of domestic animal diversity, and the desing and early implementation of this programme is now underway, managed by FAO.

The impact of these events on the future application of genetics to animal production will occur for example via various policy initiatives by national governments, commening particularly with those nations that have already ratified.

The Convention; via opportunities for and activities of non-governmental organisations (NGOs), such as breed and breeding associations; in likely changes associated with the international movement of germplasm; and with binational and multinational assistance to developing countries. The scientific community will also play a key role through involvement with the many technical facets, locally, nationally and internationally, and through research, teaching and consulting activities.

Some working definitions

Clear terminology is necessary in the conservation effort, to advance understanding, facilitate education and training, communicate successfully with the wider public and realise a common purpose in application. Terms must accommodate all practical situations - in our case all genetic resources and diversity associated with each species, both resources currently in use and those not in use, the common and the rare, the long developed and the new, the commercial lines and the research stocks. The conservation literature includes a number of terms that are not well understood in the domestic animal context; and the following simple working definitions are proposed.

Animal Genetic Resources

The genetically unique breed populations formed throughout all domestication processes within each animal species used for the production of food and agriculture, together with their immediate wild relatives (here "breed"" is accepted as a cultural rather than a technical term, and also includes strains and research lines).

Domestic Animal Diversity

The genetic variation or genetic diversity existing among the species, breeds and individuals, for all animal species which have been domesticated and their immediate wild relatives.

Conservation (of domestic animal diversity)

The sum total of all operations involved in the management of animal genetic resources, such that these resources are best used and developed to meet immediate and short term requirements for food and agriculture and the diversity they harbour remains available to meet possible longer term needs.

Conservation (in general)

The management of human use of the biosphere so that it may yield the gratest 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 (IUCN-UNEP-WWF and FAO-UNESCO, 1980).

In-situ Conservation

Primarily the active breeding of animal populations for food production and agriculture, such that diversity is both best utilized in the short term and maintained for the longer term. Operations pertaining to in-situ conservation include performance recording schemes, and development (breding) programmes. In-situ conservation also includes ecosystem management and use for the sustainable production of food and agriculture. For wild relatives in-situ conservation - generally called in-situ preservation - is the maintenance of live populations of animals in their adaptive environment or as close to it as practically possible.

Ex-situ Conservation

In the context of conservation of dommestic animal diversity, ex- situ conservation means storage. It involves the preservation as animals of a sample of a breed in a situation removed from its normal production environment or habitat, and/or the collection and cryopreservation of resources in the form of living semen, ova, embryos or tissues, which can be used to regenerate animals.

While other methods of genetic manipulation, such as the use of various recombinant DNA techniques, may represent useful means of studying or improving breeds, these methods do not constitute ex- situ conservation, and may not serve conservation objectives. At present the technical capacity to regenerate whole organisms from isolated DNA does not exist.

The need for concern and action?

Nations have decided, intergovernmentally, to take action to conserve biodiversity, including that used for the production of food and agriculture. The following points further justify the need for action. Most of these should be further challenged, to help improve our understanding of how best to provide and maintain food security throughout the world, and of how to develop and maintain the most effective programme for conserving domestic animal diversity.

1. Increasing demand - Human needs for food will about double over the next 2 generations with the demand for animal products increasing more rapidly than that for plants. This, together with lifting of trade barriers, should create opportunities for Central and Eastern Europe. In addition, in developed countries consumer emphasis on product quality is increasing, markets are becoming more segmented, and efficiency of input resource use is being increasingly emphasized throughout the world. As a result, genetic development of animals for production, productivity and product quality will intensify.

2. *The range in production levels* - Over this same period, the large between-region differences in human needs for food and agriculture and in production capability will persist at the global level with almost three quarters of world agriculture remaining at the low- to medium-input levels where animal production environments commonly incorporate combinations of stress (feed, diseases, climatic). Genetic resources then should be custom-developed.

3. *Achieving sustainability* - Food and agriculture production systems must increasingly, utilise mixes of biological diversity, plant and animal several species, and particular combinations of lines across species, with line development applying increasingly to particular production environments, in both developig and developed countries. In this regard, genetic improvement in plants has generally been concentrated within environments to meet specific requirements; whilst animal breeding is increasingly emphasising the development of just one or two breeds per species, generally in high-input environments.

4. *Rushing to one genetic resource per species* - Animal breeding is increasingly promoting and otherwise facilitating the universal use of these very few "superior" breeds, via international sale and advertising of stock and semen, international genetic evaluation, international assistance. Verbal reports suggest that abrupt changes in breed composition are occurring in Central and Eastern Europe during its transition, with a small number of exotic breeds being rapidly introduced and expanded as straight- and cross-breds, and with concurrent dramatic reduction in population numbers for many of the indigenous breed resources.

5. *The imapct of longer-term food security* - These very few genetic lines will not achieve high levels of production, productivity and sustainability for each of the broad range of production environments and combination of needs. To rely on these few lines globally or even of continual (systematic) crossbreeding, incorporating one or more of these lines, may substantially reduce food security over time in many situations.

6. *Establishing national strategies for resource use* - The fitness traits associated with adaptation to a particular environment are generally much more difficult to measure and change than are the "production" traits. This seriously questions the common approach of introducing to low- to medium- input environments high-input/high-output exotic breeds and then relatively quickly expanding these, expecting them to rapidly adapt. Instead, a superior strategy for these low to medium environments aimed at developing the production traits in one or more indigenous breeds which are already adapted and which local farmers are still prepared to use. Remember, much of the very large amount of low - to medium - input agriculture is likely to remain for much of the next century. Some medium - to even high - input pockets of agriculture are emerging in some developing countries particularly aroung large cities and to better utilise waste products. These situations enable use of some higher demanding and producing genetic resources particularly when disease, parasite and climatic stresses are substantially and permanently reduced by other changes to the production environment. However, even in many of these countries low-input rural production

from a range of species will remain important and will require highly superior adaptation to achieve sustainable agriculture. It is also of interest that in these adapted types, under the low-input and otherwise highstress environments, the relative variability between animals for the production traits is often very high, suggesting that rapid rates of improvement in these traits under these stresses may be feasible.

7. Understanding the genetic by production environment differences - We have little understanding of the important ranking differences between environments of the genetic types developed under low-, medium- and high- input levels. Included among the low level are the combination high-stress and scavenger production environments, so relevant because of the continuing importance of this form of agriculture in much of the world. The high selection intensities which have ruled for very long periods in these environments, result in types which are more likely to differ between different low environments, and also from lines developed under more benign high-input conditions. Studies to characterise this reranking of genetic types among environments are not easy to design and conduct well. However, they are very important and likely to be rewarding relatively quickly particularly for the smaller species.

8. The relative size of the components of variation in each species - A cursory examination of those few cattle, sheep and pig breed evaluation studies which incorporated six or more breeds and reported the necessary results for several quantitative traits, suggests about 50% of the total variation at the quantitative level is between-breed, the remainder being common to all breeds. Hence, a move to one breed would eliminate half this variation in the species.

9. Basic characterisation, and conservation - The levels of basic documentation and collation of research and other knowledge for the breeds of virtually all 40+ domestic animal species are relatively poor; and comprehensive national conservation plans even for this domestic animal segment of biodiversity generally await development. National action plans covering all segments of biodiversity are sought by The Convention. Thanks to an earlier initiative by EAAP and work at the University of Hannover, FAO's Global Databank for Animal Genetic Resources affears to list most of the breeds for seven domestic livestock species in Central and Eastern Europe, and it incorporates basic descriptive information on each, including breeding population, numbers for many of these breds. Most of this information is pre-transition, meaning that a description of the current situation with animal genetic resources in Central and Eastern Europe is not available internationally. If this data were to be produced, they would, in addition to enabling identification of the breeds now at risk of loss, provide informative comparisons with pre-transition.

10. The animal genetic resources at risk of loss - With the help of many organisations and individuals throughout the world, FAO has commenced surveying the 40+ species and is preparing the Global Databank on Animal Genetic Resources. The Databank now includes initial data on about 2,800 breeds of 7 species and population size data for about half of these breeds. Together with UNEP, FAO published the first edition of the World Watch List for Domestic Animal Diversity (FAO/UNEP, 1993) as another component of the global early warning system for domestic animals - and also called for under The Convention. The early results suggest that at least 30% and possibly as high as 40% of all animal genetic resources are currently at high risk of extinction - the simple criteria used were, in summary, < 1,000 breeding females and < 20 breednig males remain; and remember the majority of these breeds occur in high risk developing regions. Adequate records do not exist to enable us to obtain reliable estimates of either loss rates of these breed resources or of domestic animal diversity itself. Tables 1 and 2 summarize the analysis of the Global Databank, by region and by species. A global survey for all poultries species and for camels is currently underway.

Table 1. - BREEDS OF DOMESTIC ANIMALS AT RISK - BY SPECIES (PRELIMINARY DATA* - STAGE 1 GLOBAL DATABANK)

Species	On File	With Population Data	At Risk*	Projected at Risk*
Ass	78	17	11	21
Buffalo	62	28	1	17
Cattle	783	446	112	211
Goat	313	133	32	85
Horse	357	175	81	96
Pig	263	141	53	71
Sheep	863	493	101	233
Total	2 719	1 433	390	> 734

Adapted from FAO, 1993   * Global data not complete for species and regions.

Table 2. - BREEDS OF DOMESTIC ANIMALS AT RISK - BY REGION (PRELIMINARY DATA * - STAGE 1 GLOBAL DATABANK)

Region	On File*	With Population Data	At Risk*	Projected at Risk*
Africa	297	110	9	80
Asia and Pacific	746	302	51	201
Europe and former USSR	1 058	847	274	286
Latin Am. & Caribbean	165	77	23	45
Near East	284	56	3	77
North America	169	41	30	46
WORLD	2 719	1 433	390	> 734

Adapted from FAO, 1993   * Global data not complete for species and regions.

11. Which are the more important genetic resources of each species - Comprehensive genetic evaluation at the breed level to cover all breeds for both current and future production potential is not feasible nor required. However, knowledge of the total amount of variation in each species and the size of each breed's contribution to this would assist priority setting in breeding and particularly in accounting for where the needs are unpredictable and financial resources limited. FAO (1993) set out the preferred design and organization for such a global study each domestic species. The results will depend upon effective coordination of the methods and procedures; in sampling the breed population, sample treatment, assaying, and in data recording, collation and analysis.

12. Our hedge against loosing unigue resources at risk - Eith such a large number of breeds currently at risk of extinction and so little known about most, a minimal safety net would be provided by having stored an adequate sample of semen from each breed, for the species where cryopreservation is feasible. Yet current information suggests that very few such samples exist for the set of high risk breeds. The Convention calls for the use of ex-situ conservation where required, to maintain diversity. Generally, the most cost-effective means of maintaining an animal genetic resource for the longer-term will be for numbers of farmers to want to use and develop it. With well designed development operations (breeding programmes) genetic variation will be retained in these populations. Hence, careful consideration must also be given to the place of indigenous breeds in achieving food security and sustainable agriculture.

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