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A STRATEGIC APPROACH FOR CONSERVATION AND CONTINUED USE OF ANIMAL GENETIC RESOURCES

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A STRATEGIC APPROACH FOR CONSERVATION AND CONTINUED USE OF ANIMAL GENETIC RESOURCES

I. INTRODUCTION

1. The Commission on Genetic Resources for Food and Agriculture (Commission), in its Tenth Regular Session, considered the document *Conservation Strategies for Animal Genetic Resources*[1]. The Commission then requested FAO to elaborate a conceptual approach to the conservation of animal genetic resources, considering complementary *in situ* and *ex situ* measures, taking into account recent advances in relevant technologies and methodologies[2].

2. The draft *State of the World's Animal Genetic Resources for Food and Agriculture* will be reviewed by the Intergovernmental Techncial Working Group on Animal Genetic Resources in December 2006.[3] This Report incorporates reports from 169 countries and international organizations, and represents the most comprehensive assessment of global farm animal genetic diversity ever attempted. It notes that ecosystems are dynamic and complex and that human preferences change, facts which result in the evolution of breeds and, until recently, a net increase in diversity over time. From the *State of the World's Animal Genetic Resources* it is evident that as production systems and livelihood strategies change, some breeds that were used in the past will not be able to further contribute to food and agriculture and will be abandoned by farmers. If a breed or population becomes extinct, this means the loss of its unique adaptive attributes, which are often under the control of many interacting genes, and are the results of complex interactions between the genotype and the environment. The situation is particularly critical in the developing countries where the pace of change in agricultural practices is most rapid.

3. In contrast, the process of "breed consolidation" has already occurred to a great extent in Europe and the Caucasus. In this region, the *State of the World's Animal Genetic Resources* documents 481 mammalian breeds (9 percent of all breeds listed) and 39 avian breeds (2 percent of all breeds listed) that have become extinct and another 624 mammalian and 481 avian breeds are at risk. While these extinctions may have occurred in less enlightened times with regard to the importance of breed conservation, they also happened in an era of much less rapid economic and cultural change than that currently observed in much of the developing world. Moreover, developed countries have now reacted to the situation through the establishment of conservation alternatives for endangered breeds, but this is not the case for most developing countries. Fifty-two percent of Country Reports indicate the presence of *in vivo* conservation measures, while only 37 percent indicate the presence of *in vitro* conservation, and most Country Reports do not indicate whether this conservation is effective.

4. The *State of the World's Animal Genetic Resources* process was designed to permit identification of strategic needs at country level, and the development of *Strategic Priorities for Action* at global level to address these priorities. A conceptual basis for a strategic approach to secure global farm animal genetic diversity and provide for its better management is required, for use both by the international community and individual governments.

5. This document outlines elements of such an approach, considering the needs and aspirations of the various stakeholders whose livelihoods and well-being depend, directly or indirectly, on animal production. It was informed by the outcome of the international conference on "Options and Strategies

[1] Background Study Paper Number 22

[2] CGRFA-10/04/REP para 50

[3] CGRFA/WG-AnGR-4/06/3

for the Conservation of Farm Animal Genetic Resources," which was held in Montpellier, France in November 2005.[4] The document will likewise serve as a basis for discussion and further development of policies, programmes, and strategies for implementation of the *Strategic Priorities for Action*.[5] Thus, the main focus here is on the global level.

II OBJECTIVES

6. A strategic approach must make provision for how the global community is to respond to situations involving rapid endangerment of potentially large numbers of breeds, mainly in the developing world. There is a need to identify clear priorities for action at the global level, specific achievable activities to address these priorities, and to mobilize resources to support these activities.

III GUIDING PRINCIPLES FOR CONSERVATION

7. A coherent strategic approach to conservation of animal genetic resoures for food and agriculture (AnGR) must acknowledge both the critical needs of the world's poor, as addressed in the U.N. Millennium Development Goals (MDG), and the responsibilities of both countries and the global community to conserve biodiversity, including biodiversity for food and agriculture. The Convention on Biological Diversity (CBD) has recognized "the special nature of agricultural biodiversity, its distinctive features, and problems needing distinctive solutions" (decisions II/15 and V/5), and has welcomed the development of *The State of the World's Animal Genetic Resources* (decisions VI/5 and VIII/23).

8. The MDGs explicitly recognize that economic development is the engine that is expected to provide for alleviation of poverty and hunger, expand access to health care and education, and maintain ecosystem integrity in developing countries. However, economic development is accompanied by powerful ancillary forces – globalization, urbanization, and the movement of workers from the agricultural sector to the manufacturing and service sectors - leading to important changes in systems of food production, processing, and marketing, invariably associated with the narrowing of animal genetic diversity used. It is essential that a conceptual approach to the conservation of farm AnGR be formulated in ways that contribute to achievement of the MDG, taking into account the driving forces shaping the world's economy. The conceptual approach must likewise acknowledge and address the very substantial differences in economic development among countries and, therefore, in priorities for AnGR use and conservation. A schema for the design of AnGR management and conservation strategie and the information required is provided in *Appendix 1* of this document.

9. Developing countries possess an substantial share of the word's farm AnGR. In developing a conceptual model for conservation and use of farm AnGR, the continued use of breeds in livelihood-based production systems, tailored to the specific needs of developing countries, is the favoured strategy for long-term breed conservation. This approach is one of the guiding principles for the Global Strategy for the Management of Animal Genetic Resources (Global Strategy) and is in line with the principles of the CBD. Thus, the highest priority in AnGR conservation remains synchronization of livestock genetic resources to specific production conditions, physical environments and markets, and the appropriate further development of local breeds, in order to contribute to the achievement of MDG 1, *Eradicate extreme poverty and hunger*, and MDG 7, *Ensure environmental sustainability*.

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[4] Organization of the conference described in the CGRFA/WG-AnGR-4/06/2; reports are available at "Backgound Documents" http://www-data.fao.org/ag/againfo/programmes/en/genetics/angrvent2006.html

[5] CGRFA/WG-AnGR-4/06/4

IV PATTERNS OF CHANGE IN ANGR USE AND THEIR IMPACT ON CONSERVATION OF LOCAL ANGR

10. The forces of globalization, urbanization, and economic development are having a profound impact on patterns of AnGR use. Global access to livestock breeds of high production potential, coupled with reproduction biotechnology, permits rapid change in the genetic composition of livestock populations. Robust global supplies of feed grains and rapid economic development in some regions have allowed establishment of intensive livestock production systems utilizing high input-dependent breeds. However, a global view of patterns of change in AnGR use reveals both the continuing need for highly adapted local breeds in more slowly evolving production systems and in marginal ecological conditions, and increasing recognition of the importance of conserving local breeds.

11. For the least-developed countries, including many African countries and a number of small landlocked and mountainous countries of Asia and Latin America, subsistence livelihoods remain dominant, and increasing urbanization has not been accompanied by rates of economic development sufficient to lift a high proportion of the population out of poverty. In these countries, critical poverty-related problems therefore demand that conservation of farm AnGR be approached in ways that also reduce hunger and contribute to economic development.

12. Continued increases in animal production and productivity will be necessary to enhance food security and provide critical products and services to hundreds of millions of resource-poor families. The introduction of high-input, high-output exotic breeds without corresponding changes in management and improved access to national and international markets has generally not been successful. The sustainable intensification of animal production must be approached in holistic and sustainable ways that avoid high levels of external inputs. Under developing country conditions, animals must retain the capacity to cope with a diverse array of stressors, including climatic factors, endemic diseases, and inconsistent and highly variable access to nutrients. Strategies involving incremental improvements in the production potential and productivity of traditional breeds and corresponding gradual improvements in management and access to veterinary services, supplemental feeds, and markets appear most promising. Continued use of traditional breeds is likely to remain the most effective strategy for resource-poor farmers in many of the least developed countries. However, opportunities may exist both to improve local breeds and for carefully managed and limited introductions of exotic breeds in areas of greatest production potential. These opportunities must be seized when genuinely available.

13. In the more rapidly developing countries, speedy intensification of animal production to meet growing demands is already occurring, fuelled largely by the willingness of increasingly urbanized and newly affluent consumers to spend discretionary income on animal-based foods and other products. This rapid intensification of animal production requires access to AnGR with high production potential in order to cover the costs of external inputs such as housing, feed, and veterinary services. At the same time, demographic shifts involving movement of workers out of the agricultural sector, and associated rapid growth of urban and coastal regions have facilitated the replacement of typical village markets with urban supermarkets. These larger and more organized food outlets require greater uniformity of product and consistency of supply, and have, therefore, accentuated the trend toward larger and more intensive periurban production units, and to longer supply chains. In rapidly developing countries, the rate of intensification of animal production exceeds the capacity of many local breeds to adapt, and the use of exotic breeds in intensive production units or cross-breeding with local breeds is an appropriate development strategy.

14. It is not correct, however, to assume that intensive livestock production will quickly come to dominate throughout the world, or that intensive systems alone can optimize the use of the available resources, for food production. Even in the most rapidly developing Asian economies, the contribution of intensive production systems to total production remains modest. China's Country Report (2003) indicates that 50 percent of chicken meat is produced in flocks of more than 10 000 birds, but only 30 percent of eggs are produced in flocks of more than 2 000 birds and only 20 percent of pork is

produced in units containing more than 50 pigs. India's Country Report (2004) states that only 60 percent of poultry meat and 50 percent of eggs are produced in intensive production systems, and India has become the world's largest producer of milk and milk products by using an approach that combines limited strategic intensification of production with the mobilization of large numbers of small, resource-poor families. The contributions of medium-input, small-to-medium sized livestock production units thus will remain important, both to serve growing urban markets and for local consumption. Even in the most rapidly developing countries, inequities in access to the benefits of economic development remain striking, and many families continue to keep a few animals of traditional breeds, often with very low use of inputs, to provide a wide variety of products and service for household consumption and for sale in local markets. The development of opportunities for these families to intensify production and participate in national markets or to find more lucrative non-agricultural employment is not likely to occur in the near future. In the meantime, continued access to well-adapted local breeds will remain important.

15. Across developing countries, growth in intensive pig and poultry production has dominated livestock sector development. Intensification of pasture-based production of meat cattle and small ruminants has been limited, and pastoral communities often have only limited direct access to emerging national and international markets. In part, this situation reflects inadequate attention to the development of rural infrastructure (roads, railways, etc.), or at least the deferral of investment in rural infrastructure in favour of investments in manufacturing capacity and associated urban and coastal centres. Also, the environmental degradation that has occurred in many pastoral areas as a result of overgrazing and inappropriate management practices and land-tenure policies has, in some cases, resulted in significantly reduced productive capacity. In such circumstances, greater emphasis on rural community development and appropriate ecosystem management can yield significant long-term dividends by more efficiently mobilizing land resources for food production, providing development options for rural communities, reducing environmental concerns associated with periurban livestock production, and providing both motivation and resources for better management of pastoral ecosystems. Unpredictable long-term changes in global supplies and prices of feed grains, and concerns regarding sustainability of current rates of economic development argue for the implementation of broadly based strategies to develop national agricultural capacities.

16. In the most developed countries, the intensification of animal production and the movement of workers out of agriculture-based livelihoods have already occurred. For example, the countries of the European Union (EU) rely on highly developed transboundary breeds of poultry, pigs, and dairy cattle for most of their production. However, they have also developed strong public and private commitments to the maintenance of traditional breeds within agricultural landscapes, through a comprehensive regulatory and support framework. Characteristics of the European model include:

- a public commitment, generally supported by the population as a whole, to retention of traditional agricultural livelihoods and landscapes, with use of subsidies, when necessary, to achieve that goal;
- relatively affluent consumers that retain considerable interest in, and willingness to pay for, high-value animal products;
- high levels of technical capacity and a willingness to apply that capacity to in situ maintenance and ex situ conservation of AnGR; and,
- perhaps most importantly, levels of food production, economic development, and government stability that minimize concerns about hunger and extreme poverty.

17. Other models of breed conservation have emerged in other highly developed countries, though with different mixtures of public and private support. Thus, in North America, Australia, and New Zealand, conservation of rare breeds is achieved almost exclusively by non-governmental organisations operating in the private sector.

V CURRENT CONSERVATION STRATEGIES

Conservation by continued use

18. In developing countries, local breeds are central to animal production. Even in the most rapidly developing nations, local breeds remain important to communities and households that continue to practice typical subsistence agriculture. At the same time, however, the pressing need to increase animal production and productivity dictates that planners remain alert to opportunities to improve productivity and support rural development by establishing genetic improvement programmes for local breeds, or by the careful and normally gradual introduction of exotic breeds, when those activities have potential to provide genuine economic benefits to rural communities and farming families.

19. Greater use of exotic genetic resources – often a much narrower overall range of genetic resources – will inevitably occur in intensive production systems, but there will also be opportunities to combine local and exotic breeds to develop new and more productive livestock types. At all levels of livestock production, development projects that are carefully implemented after a thorough evaluation of the life-cycle productivity of the alternative genetic types, active consultation with farmers, and establishment of management protocols that allow the appropriate and sustainable use of both local and exotic breeds, have the potential to both increase animal productivity and maintain genetic diversity.

20. In the developed world, conservation of AnGR through continued use involves use of local breeds in both traditional roles (e.g.. to produce high-value typical national or regional products for sale in various niche markets) and innovative uses (e.g., landscape management, weed control, heritage value). Thus, Iberian pigs are used in oak-forest production environments in Spain to produce high-value cured pork products, while in the United Kingdom, the role of grazing livestock has been recognized as critical in the maintenance of wildlife and native plants biodiversity in many high nature value ecosystems. In the rapidly developing countries of South and Southeast Asia, local chicken breeds have long been preferred, because of their distinctive flavour, but their limited suitability for intensive production led to their rapid replacement with industrial lines. More recently, however, premium markets favouring local birds and their crosses have appeared, reflecting increases in consumers' disposable income and providing motivation for continued use. Markets such as this can appear only after an initial period of economic development, and the future value for local breeds in such markets provides justification for their conservation.

21. Conservation could take a variety of forms, including:

- use of traditional breeds to produce high-value specialty foods and other animal products, maintain traditional landscapes, and support tourism;
- maintenance of conservation herds on government farms or via farmer subsidies;
- maintenance of traditional breeds by hobbyists or private rare breed conservation organizations; or
- cryopreservation of gametes and embryos in national gene banks.

22. A willingness to invest national resources in conservation of farm AnGR exists today in many developed countries, suggesting that as the countries of the developing world become more affluent, they will also accept greater responsibility for AnGR conservation. Willingness to support conservation when discretionary funds are available has been demonstrated by the establishment of active national programmes in rapidly developing countries such as Brazil, China, and India.

23. The challenge will be for local breeds in developing countries to survive the dramatic social changes that commonly accompany economic development, avoid genetic dilution through indiscriminate use of exotic breeds in uncontrolled or improperly designed cross-breeding, programmes, and retain adequate levels of genetic diversity to ensure their continued maintenance and capacity to contribute to future needs. There is also need to encourage recognition and understanding

of the diverse relationships that link animals to cultural and community identity. These challenges are the areas where assistance from developed countries and the international community is most required.

Maintenance of breeding herds outside the production environment: *ex situ in vivo* conservation

24. Emphasis on maintenance of live animals as the preferred method for conservation of AnGR has led to renewed interest in how to efficiently maintain endangered breeds under ex situ conditions (i.e., outside the production environment where they are normally used). Ex situ in vivo conservation strategies take a variety of forms, ranging from maintenance of breeding animals in public research institutions or by hobbyists, where production conditions may be similar to those found in traditional production systems, to the establishment of herds in farm parks and zoos where display, rather than economic utility, is the primary objective. The long-term viability of such programmes is questionable unless they are closely linked to the maintenance of animals in traditional livelihood-based production systems, or other reasons that encourage people to conserve them exist. For example, ex situ in vivo conservation may also be appropriate for breeds that are valued for aesthetic, cultural, or historical reasons. In the United States of America, Hog Island sheep survived in an unmanaged state for over 200 years on an isolated island in the Atlantic and appear to have found a secure site for ex situ conservation at Gunston Hall Plantation, in Fairfax County, Virginia, where they are displayed as a part of an exhibition of eighteenth century plantation life. Nonetheless, the breed is still designated as critically endangered by The American Livestock Breeds Conservancy. Efforts are being made to expand ownership of the breed via a network of rare breed enthusiasts and hobby breeders. This exemplifies the challenges involved in ex situ in vivo conservation

25. The primary advantage of ex situ in vivo programmes to conserve breeds that are no longer used in situ is that the animals remain accessible for study and potential future use. Given the relative difficulties: high cost and the number of years /generations required for restoring a livestock breed from material stored in gene banks (discussed below), the decision not to maintain live animals of an endangered breed is likely to limit the future restoration of the breed to conditions of extreme need, and preclude most speculative and entrepreneurial uses.

Cryoconservation of endangered AnGR

26. From a technical viewpoint, technologies exist to secure genetic variation present in endangered breeds by cryopreservation of gametes and, for many species, embryos. These approaches are widely used in the developed countries to complement in situ and ex situ in vivo programmes. In most cases, cryopreserved material is considered to provide both a “last-resort” conservation alternative for breeds that may otherwise become extinct, and a backup store of diversity which can be used to assist in the maintenance of living populations.

27. In the implementation of the Global Strategy, the establishment of national capacity for cryoconservation of genetic material has been accorded a high priority. However, Country Reports show that only about one third of the countries have cryoconservation facilities. In addition, these reports indicate that this capacity remains very limited in developing countries. Among the 107 countries of Africa, Asia, the Near and Middle East, Latin America and the Caribbean, and the Southwest Pacific, only 28 (26 percent) report in vitro conservation programmes. If the 25 Asian countries are also excluded, the proportion of countries having in vitro programmes further decreases to only 16 of 82 (20 percent).6 Equally significant is the lack of evidence of collaboration between countries to share the substantial facility costs associated with in vitro storage. Only the Nordic Gene Bank appears to represent a genuinely regional effort.

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[6] CGRFA/WG-AnGR-4/06/3

28. The development of national capacity to employ cryoconservation for the management of AnGR has, thus, proceeded in an uneven manner, mirroring the uneven pace of economic development across the world. The hope that national programmes and goals would meet global objectives has generally not been realized, with many developing countries unable to devote adequate resources to conservation of their livestock breeds. At this point, the issue is not generally a failure of will; rather it is an inability to shift resources from areas perceived to be of higher priority, as well as, in some cases, a desire to focus cryoconservation programmes on the dissemination of improved or exotic genetic material rather than conservation of local breeds.

VI PROPOSED ELEMENTS OF A GLOBAL PROGRAMME

29. Global coordination of activities involving AnGR and monitoring of status and trends in AnGR use are essential to the conservation and better management of these resources. The FAO Global Strategy for the Management of Farm Animal Genetic Resources and the associated Domestic Animal Diversity Information System (DAD-IS) is currently the only truly global network providing these services. During the last decade, the Global Strategy and the *State of the World* process have achieved a considerable increase in awareness of the importance of AnGR. DAD-IS and activities undertaken within the framework of the Global Strategy at national level play a key role in supporting the implementation of the programme of work on agricultural biodiversity on the Convention on Biological Diversity. Other critical components of the Global Strategy include:

- production and distribution of a variety of technical guidelines for AnGR conservation and use;
- coordination of conservation activities through communication networks such as DAD-Net and a system of National Focal Points;
- continuation of the Global Databank for Animal Genetic Resources for Food and Agriculture for maintenance of breed inventories and monitoring of the status of global AnGR;
- maintenance of global linkages among emerging regional databases such as the European Farm Animal Biodiversity Information System (EFABIS) and the African Domestic Animal Genetic Resource Information System (DAGRIS).
- facilitation and organization of expert consultations, regional workshops, and other fora for discussion and exchange of information; and
- mobilizing donor support for AnGR management activities and for building regional and national capacity.

30. Since 2000, the activities associated with the *State of the World's* reporting process became a key area of work for the Global Focal Point. This critically important Report will be finalized at the First International Technical Conference on AnGR, in September 2007. With the achievement of this milestone, under the guidance of FAO's inter-governmental Commission on Genetic Resources for Food and Agriculture, there will be the opportunity to define specific achievable activities to address the *Strategic Priorities for Action* defined in the process, and mobilize the necessary resources. Any future global action plans should continue to support current national and regional activities, but also address carefully chosen, globally significant issues in AnGR conservation and build global institutional capacity for AnGR management. Specific achievable objectives should be justified in terms of contributions to the achievement of the MDGs, enhancement of the long-term security of global AnGR, and generation of new knowledge.

31. The brief analysis above suggests that the following priorities for action should be addressed at global level and comprise the main elements of a global programme for conservation of AnGR:

- maintanance and strengthening of global networks contributing to conservation of AnGR;
- support for optimal AnGR use by livestock keepers in sustainable production systems;

- development of private-sector capacity to manage AnGR;
- clarification of genetic relationships among transboundary livestock breeds;
- development of regional and/or national gene banks to complement *in situ* conservation programmes; and
- building institutional capacity for conservation and use of AnGR.

Maintenance and strengthening of global networks and monitoring capacity

32. Global capacity to monitor and inventory AnGR, coordinate AnGR conservation activities, and educate policy makers, scientists, farmers, and consumers regarding the better use and conservation of global AnGR is essential. The establishment and maintenance of a Global Focal Point in FAO Headquarters and the identification of an associated network of National Focal Points under the Global Strategy have been very effective in building awareness of issues in AnGR management and initiating actions at national level. This capacity should be maintained and further strengthen and enhanced, to implement the *Strategic Priorities for Action* at all levels.

33. The following areas of concern need to be addressed in order to provide better coordination of AnGR conservation activities:

- Greater capacity to monitor global livestock diversity and implement an effective early warning system is desperately needed. The need for these activities has long been acknowledged and would ideally be coupled with capacity to respond rapidly to emergency situations. For example, a global outbreak of avian influenza, coupled with transmission of a highly virulent strain such as H5N1 to humans, could lead to the decimation of many local chicken breeds. There is at present essentially no capacity in many developing countries to rapidly secure genetic resources threatened by such an outbreak in order to re-establish flocks after the emergency. An effective monitoring system requires deployment of resources at national level to track changes in breed numbers and patterns of breed use, and would be facilitated by development of better tools and communication networks to assist in reporting. A Global Focal Point with capacity to evaluate information provided by countries and set priorities for international assistance is needed, and should be interfaced with an effective rapid-response capacity. In cases of rapid and unanticipated changes in breed population size or genetic make-up, assistance to collect gametes and/or embryos for cryopreservation under field conditions (discussed below) may be required and could be accomplished for most species with current technology.
- The establishment of Regional Focal Points with capacity to address regional and national issues, strengthen regional cooperation among National Focal Points, and influence regional policy, remains a high priority. Attempts to establish Regional Focal Points have been successful only for Europe, highlighting the need for commitment by governments and relevant institutions to provide stable funding in order to achieve greater regional integration.
- Updated listings of global livestock breeds obtained from the Country Reports highlight the need to better understand the genetic architecture of livestock species. The *State of the World* process has confirmed the central role of the Global Databank within DAD-IS, but also indicated that data quality, especially for population data, need to be improved. The existence of transboundary breeds represented in several countries, and the establishment of significant populations of some breeds outside their region of origin demonstrate the need to better understand and describe genetic relationships among breeds in order to facilitate better decisions on conservation and use. The collection of existing information on breed relationships, creation of a database cataloguing these relationships, and development of objective structures to describe genetic relationships and assist in conservation decisions are, thus, sorely needed.

- Leadership to address issues of access to AnGR and mechanisms for appropriate sharing of benefits from AnGR use is a critical need. Donor funding for conservation and sharing of plant genetic resources has benefited from open global access to conserved plant genetic resources. The greater complexity and cost of livestock conservation schemes will require different and more innovative agreements to provide equitable access to conserved material.
- Continued funding by FAO and the global donor community to support the core activities of the Global Focal Point, maintain its identity as a central location for monitoring and coordination of activities involving AnGR, and aid the mobilization of existing global capacity and new donor funds required for the implementation of the *Strategic Priorities for Action* is critical. The largely facilitative, normative and coordinative role of the Global Focal Point makes a unique and essential contribution to the global management of AnGR.

Support for optimal AnGR use on farm in sustainable production systems

34. The importance of matching farm AnGR to specific production environments and markets has been widely acknowledged. Many of these issues have been addressed in part through existing FAO Primary Guidelines for Development of National Farm Animal Genetic Resource Management Plans[7] and various Secondary Guidelines[8] or during global workshops[9]. These guidelines might need to be revised in view of new findings. Recent and ongoing activities of the Global Focal Point in the technical programme of work of the Global Strategy is reported in document *Progress in the implementation and the further development of the Global Strategy for the Management of Farm Animal Genetic Resources. Report on activities*.[10]

35. However, a sharpened focus on the integration of livestock development and conservation activities in national programmes is needed to better integrate AnGR conservation activities into active programmes for livestock improvement and rural community development. A variety of issues require deeper understanding, more widespread discussion, additional training at national and global level, and expanded global capacity. These include:

- definition of livestock sector development objectives that cater for food security, environmental and social sustainability, and public health including food safety, and address the trade-offs;
- definition of comprehensive production objectives that address both national and local development goals and can be used to guide livestock development efforts in all produiction systems;

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[7] Primary Guidelines for Development of National Farm Animal Genetic Resources Management Plans (1998), at DAD-IS library at http://www.fao.org/dad-is/

[8] Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans: Animal Recording for Medium Input Production Environment (1998)

Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans: Management of small populations at risk (1998)

Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans: Measurement of domestic animal diversity (MoDAD): Introduction (1993); Basic experimental design (1993), New recommended microsatellite markers (2004).
All documents at DAD-IS library at http://www.fao.org/dad-is/

[9] Contributions to sustainable livelihoods and development: realizing sustainable breeding programmes in livestock production. 7th World Congress for Genetics Applied to Animal Production, Montpellier, France, 2002.

International conference on "Options and Strategies for the Conservation of Farm Animal Genetic Resources," Montpellier, France, 2005.

Expert Meeting on Sustainable Utilization of Animal Genetic Resources, Ferentillo, Italy, 2006.

All documents at DAD-IS library at http://www.fao.org/dad-is/

[10] CGRFA/WG-AnGR-4/06/7 Add. 1

- development of practical breeding objectives for local and exotic breeds that adequately consider life-cycle productivity, disease resistance, and adaptive fitness;
- strategies to implement sustainable cross-breeding systems in developing countries, especially in extensive or low-input production environments;
- practical approaches to animal identification and performance recording in medium and low-input production systems, the role of animal recording in livestock development, and the establishment of community-based and community-led animal recording and improvement programmes;
- a holistic approach to livestock development that includes components related to genetic improvement and improvement of husbandry conditions;
- identification of policies that hinder use and further development of local breeds, and;
- methods to appropriately assign costs (such as those associated with environmental degradation and waste disposal in intensive production systems) and benefits (such as those derived from ecosystem services or economic opportunities for women and minorities) associated with alternative policies for AnGR use.

36. Implementation of these activities will require refocusing of existing national, international, and donor resources to better integrate conservation and livestock development activities into broader schemes for national economic development.

Development of private-sector capacity to manage farm AnGR

37. Most livestock improvement activities in both developed and developing nations are strongly "participatory", in the sense that most animal breeding decisions are made by farmers and pastoralists rather than trained animal geneticists. In small ruminants and beef and dual-purpose cattle, breeding decisions are almost totally in the hands of farmers. Only in intensive poultry breeding (and to a lesser extent in intensive swine production), a few multinational firms dominate global markets for breeding stock, with sales of offspring to producers who have no involvement in breeding programmes. Rapid global growth in intensive poultry and swine production has been aided by the presence of these integrated multinational sources of breeding animals, but their increasing influence has in some cases hastened the disappearance of local breeds.

38. In developed countries, collaborative programmes of animal recording and genetic evaluation provide opportunities for genetic improvement of livestock at farm level; understanding of the basic principles of genetic improvement permits use of cross-breeding in structured, sustainable breeding programmes; and collaborative marketing programmes increasingly (though not universally) allow farmers to be paid more for genetically superior animals. This capacity was developed in the last century almost completely through government-supported, integrated programmes of research, education, rural community development, and institutional capacity building. Now these measures have generally been withdrawn or reduced, and services privatized as private-sector capacity developed, or as a result of reduced public budgets. The time-scale involved, from initial efforts to develop private-sector capacity to large-scale privatization was in the order of a half-century, or two human generations.

39. For most livestock species, improved use and conservation of farm AnGR requires enhancement of private-sector farm-level capacity to carry out livestock recording, and genetic resource development schemes that can capitalize on opportunities provided by emerging markets, maintain productivity in diverse production environments, and continue to sustain the millions of people who continue to practice traditional agricultural livelihoods. Establishment of farmers' organisations, breed associations, and local community-development schemes, with appropriate educational, technical, and marketing support will be necessary for further development and better use of local breeds. This is especially true for ruminant species that utilize marginal lands and crop by-products and are not well-suited to intensive production. From a national development perspective,

investments in rural community development, programmes to improve local breeds, and infrastructure to facilitate delivery of animal products to national and international markets have been viewed as less pressing than development of more centralized manufacturing and service sectors that can drive economic development in a global economy. Yet realization of the food-producing capacity and human potential of rural communities is an important and increasingly complex component of national economic development.

40. Publicly funded programmes for livestock improvement are all too often carried out in isolation and without adequate linkages to local livestock keepers, processors of livestock products, and consumers. There is need to shift focus in these programmes to the development of partnerships between the livestock keepers' families and communities that make use of the livestock and the government agencies with capacity to implement or otherwise lead practical improvement activities. Government-sponsored breeding programmes, thus, must enhance their relevance to local communities. Guidelines for integrating extensive, pastoral, and smallholder production systems into national food security strategies, studies on the long-term benefits of rural development, and a greater commitment by governments to building rural infrastructure and capacity would aid in building necessary private-sector capacity.

41. The optimal involvement of public sector in breeding might be different in developed and developing countries, and for the different animal species. The reproductive capacity of pigs and poultry allows the implementation of planned breeding programmes by a small number of breeders or breeding companies within a short period of time, and it is possible to control inbreeding in closely controlled programmes. However, this is more difficult for cattle and small ruminants. The potential to implement formal breeding programmes through private organizations which exists in Europe and the Americas is the consequence of structures that had a long process of development. Conversely, many developing countries face problems in implementing formal breeding programmes. This is particularly true for low and medium external input production systems, which tend to be associated with locally adapted breeds. It is unlikely that the private sector will contribute significantly to the cost of new national ruminant breeding programmes in developing countries given the limited potential for increased production. Such costs would, therefore, have to be borne by national institutions. The cost of breeding activities, market competition and the international availability of suitable breeding material are important considerations when taking decisions regarding the development and public funding for national breeding programmes. To date, many governments have decided to rely on international genetic material for genetic improvement, especially in poultry and pigs. Collaboration in breeding activities between countries with similar production conditions, such as already occurs in Europe, is an opportunity to share costs and make breeding programmes more sustainable.

Clarification of genetic relationships among global livestock breeds

42. Until now has been that there is a reluctance to initiate projects of a truly global scope. This situation reflects both inadequate institutional capacity (discussed below) to manage such projects, as well as reluctance to risk diverting funds from national programmes focusing on *in situ* conservation and use to larger but more centralized international programmes. Yet there is an increasing sense of global need to better understand the genetic architecture of livestock species in order to secure adequate stores of livestock genetic diversity to address both foreseeable and unforeseen future needs and opportunities.

43. Tools for molecular assessment of domestic animal diversity and the identification of genetic relationships among breeds have developed rapidly over the past decade. Yet despite increasingly comprehensive efforts in the molecular characterization of livestock, information to construct a definitive set of relationships among breeds does not yet exist for any species. Early results from these studies indicate their potential to identify the most clearly distinctive breeds and thereby to improve the efficiency of the design and execution of conservation programmes. Methods to combine information on genetic relationships across studies have proven elusive, suggesting that there is need for a single, coordinated effort to identify genetic relationships among global livestock breeds. This information would allow assessment of the extent to which global diversity is being adequately

maintained by the preferred *in situ* conservation programmes, assist in directing bilateral and multilateral assistance to areas of highest priority, and identify highly endangered and unique breeds for *in vitro* conservation. An emerging literature has demonstrated that measures of molecular genetic diversity (indicative of evolutionary relationships) can be combined with measures of phenotypic diversity (indicative of underlying functional genetic variation) and knowledge of geographic distribution and selection history, to provide objective guidelines for setting conservation priorities.[11] Such an approach would greatly facilitate the targeting of international funds to areas of greatest benefit.

44. The principles for such an effort have been defined by the existing FAO MoDAD project for molecular characterization of domestic animal diversity.[12] Updating of these principles, within the context of the *Strategic Priorities for Action*, identification of a coordinating institution and funding sources for each of the major domestic species, and the development of appropriate collaborations with developing-country institutions to incorporate elements of technology transfer and capacity building would be needed, as would capacity to provide widespread electronic access to results.

45. This project would require identification of a few highly capable institutions (perhaps one for each of the major livestock species) to provide technical leadership, mobilization of new donor funding to support the work, and a coordinating body to ensure consistency in methods and reporting among participating institutions, maintain a globally accessible database of results, identify areas requiring further research and development, and provide guidelines for use of results in the design of conservation strategies. Much of the material for this effort will come from developing countries. A significant training component should therefore be included so that scientists from developing countries could participate in the work and gain expertise in the methods that will be applied and developed. Linkages between international centres and local institutions should be developed to allow extension of these characterizations to locally and regionally important livestock species.

Development of gene banks to complement *in situ* conservation programmes

46. The international community needs to seriously consider whether effective conservation of AnGR will be possible without putting greater emphasis on regional and global programmes for cryopreservation and *in vitro* storage of semen, embryos, and, perhaps, somatic tissues. International assistance for *in situ* conservation of endangered breeds at national level is unlikely to be sustainable over time, and maintenance of national breeds must eventually be supported by national governments or the private sector. *In vitro* conservation is a key component of an integrated programme to secure endangered AnGR and may be critical when resources to institute appropriate *in situ* programmes are not available.

47. The establishment of global or regional gene banks is an old idea, first raised in the 1980s as a way to develop collections of AnGR analogous to the seed banks used for the *ex situ* conservation of plants. The idea did not become a reality for reasons that included:

- incompatible zoosanitary requirements for collection of gametes and embryos and movement of those materials across national borders;
- concerns regarding isolation during storage and health-related restrictions on future use of collected material;
- issues of ownership, access, and intellectual property rights involving stored material;

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[11] see Part 4 of the draft *State of the World's Animal Genetic Resources for Food and Agriculture,* CGRFA/WG-AnGR-4/06/3

[12] Secondary Guidelines for Development of National Farm Animal Genetic Resources Management Plans: Measurement of domestic animal diversity (MoDAD): Introduction (1993); Basic experimental design (1993), New recommended microsatellite markers (2004). For the report on activities see CGRFA/WG-AnGR-4/06/7 Add. 1

- much greater costs compared to plants to collect, access, and use cryopreserved animal gametes and embryos in breeding programmes; and
- failure to identify mechanisms to provide for initial and long-term funding.

48. The establishment of national capacity for cryopreservation of genetic material was recognized as a high priority for all countries - often considered as complementary measure to *in situ* conservation - but development of this capacity in most developing countries has not been sufficient to meet current and anticipated conservation needs.

49. A comprehensive programme to preserve material from all known livestock breeds is not practical given current global resources and capacity. Such a programme is likewise almost certainly not required to secure the genetic diversity present in each of the livestock species. However, the establishment of capacity at regional or global level to collect and cryoconserve gametes and embryos from those breeds that are both most endangered and most significant to conservation of global diversity (as determined using the approaches to understanding genetic diversity outlined above) would be useful and may be essential to the long-term conservation of AnGR. The establishment of a global system of facilities for cryopreservation of gametes, embryos, and tissues would require a substantial investment, but regional partnerships among donor and developing countries could facilitate their development.

50. The most significant challenges to establishing international gene banks involve issues of ownership, access, and benefit sharing. Concern about loss of control over potentially valuable genetic material leads to policies that may inhibit rather than encourage sharing of AnGR. However, a large part of the sharing of the benefits of genetic resources lies in the possibility to access and use them, and agricultural genetic resources are characterized by a high degree of inter-dependence between countries. Systems of access and benefit-sharing that imply high transaction costs can be counter-productive, if they limit the overall benefits to countries of accessing and using them. The ownership of and conditions of access to material stored in international gene banks will require development of an appropriate framework and legal instruments, and this may be a challenging endeavour within the further work of the Commission. In particular, strategies must be devised to convince the international community (and particularly donor countries) that investments in these gene banks will result in better global access and benefits. A further challenge will be the difficulty of replenishing materials accessed from animal gene banks.

51. Regional partnerships seem most likely to lead to a workable system of gene banks that can address the needs and concerns of both developing and developed countries. If the concept of establishment of regional gene banks is supported by governments, within each region, the developing nations must agree to pool their cryoconserved material and (often limited) national resources. Likewise, regional donors must recognize the long-term benefits associated with secure, long-term storage of global AnGR and the need to develop mutually accepted agreements for access to cryopreserved material. Issues of location will be important, with some most stable of the developing countries or the most rapidly developing countries as likely candidates. Several “natural” partnerships can be envisioned, such as support from the current nations of the EU to build a gene bank for Eastern Europe and Central Asia; support from the United States of America, Canada, and Brazil for a Latin American gene bank; involvement of ILRI in establishment of an African facility; Saudi Arabian funding for a Middle Eastern facility; and contributions from Japan and Australia to a facility for the developing countries of southern and eastern Asia and the Pacific.

Build institutional capacity for conservation and use of AnGR

52. Institutional capacity at national, regional, and international levels is inadequate to support conservation and better use of farm AnGR. Expansion of the activities of national agricultural reserch institutes (NARS) is desirable but is unlikely to allow implementation of the global programmes. The value of an integrated system of international centres working on programmes of their own and facilitating programmes of NARS has been demonstrated in the plant sector by the centres of the Consultative Group on International Agricultural Research (CGIAR). The idea that global

development of AnGR can proceed in an adequate manner without similar institutional capacity is unrealistic. Based on 2003 figures, unrestricted funding (i.e., funds available for core programmes) for livestock in CGIAR centres was not more than one tenth of the total of 162.4 million USD. Total CGIAR research expenditures for germplasm improvement and collection in animals were even smaller proportions of total expenditures in these two areas (6 percent of 65.6 million USD and 7 percent of 43.3 million USD, respectively).

53. Differences between activities involved in plant and animal genetic resource use and conservation are profound, and a simple extension of programmes of the CGIAR plant institutions to animals is not appropriate. At this time, the International Livestock Research Institute (ILRI) is the only CGIAR centre with a primary mandate to address livestock, and others, particularly the International Center for Agricultural Research in the Dry Areas (ICARDA) and the CGIAR System-wide Genetic Resources Programme (SGRP/IPGRI) contribute less than five percent each to the overall CGIAR AnGR expenditure. However, ILRI, a single institution cannot be expected to meet global needs for AnGR research.

54. The participatory nature of most animal improvement activities dictates a strongly interactive approach to farm AnGR development. Many models are possible, and each must be carefully evaluated and justified, but establishment of greater capacity for livestock research and development activities within the CGIAR or through the establishment of new institutional collaborations is badly needed. Regional institutional capacity may well be required, but will probably have to rely more on interactive programmes involving local communities and existing national and regional institutions rather than on a single large research facility. Indeed, the plant institutions of the CGIAR seem increasingly to be adopting this model, so the creation of regional livestock production and breeding centres with highly developed expertise and adequate international funding to collaborate with, and thereby impact, national programmes in the region may be one of the possible models.

Appendix 1: Design of AnGR management strategies