The state of the art in the management of animal genetic resources

- Characterization of breeds and production environments needs to be improved to enhance policy decisions in animal genetic resources management.
- Decision support tools for situations where information is deficient need to be developed.
- Changing market demands and the need to maintain within-breed diversity give rise to new breeding goals and require new approaches in breeding programmes.
- Stakeholder involvement and recording systems are key elements of successful genetic improvement programmes.
- Breeding programmes adapted to low external input systems need to be further developed.
- The use of locally adapted breeds to provide environmental services, support for niche market production and subsidies for keeping threatened breeds are potential elements of *in vivo* breed conservation programmes.
- Conservation measures in low external input systems need to take account of the livelihood-support functions of livestock.
- Community-based approaches to conservation and breeding need to be further developed.
- *In vitro* conservation has the potential to be an important complement to *in vivo* methods, and reliable techniques for all livestock species need to be developed.

The management of animal genetic resources is not a clearly defined scientific discipline. It comprises the full range of actions undertaken to understand, use, develop and maintain these resources. It involves assessing the characteristics of the available animal genetic resources in the context of prevailing production conditions and societal demands. Spatial and temporal diversity and projected future trends also have to be taken into account. Decisions then have to be taken as to which of the available approaches and methods for use, development and conservation should be applied to which populations. The following sections outline the state of the art in methods for characterization, genetic improvement, economic analysis and conservation.

Methods for characterization of animal genetic resources

Characterization involves the identification, description and documentation of breed populations and the habitats and production systems in which they were developed and to which they are adapted. One aim is to provide an assessment of how well particular breeds will perform within the various production systems found in a country or region, and thus to guide farmers and development practitioners in their decision-making. Another objective is to provide the information that is needed for planning conservation programmes. The latter requires information on the risk status of the breeds under consideration. Risk status is established primarily on the basis of population size and structure. Data on the extent of cross-breeding may also be important to assess the threat of genetic dilution, as may information on the breeds' geographical distribution, and the extent of inbreeding within the population.

Breeds that are identified as being at risk are candidates for inclusion in conservation programmes. However, funds are normally restricted and priority setting is needed. Decisions may be based on the genetic distinctiveness, adaptive traits, relative value for food and agriculture, or historical and cultural values of the breeds in question. Figure 12 shows the key information requirements at various stages of planning a national animal genetic resources management programme.

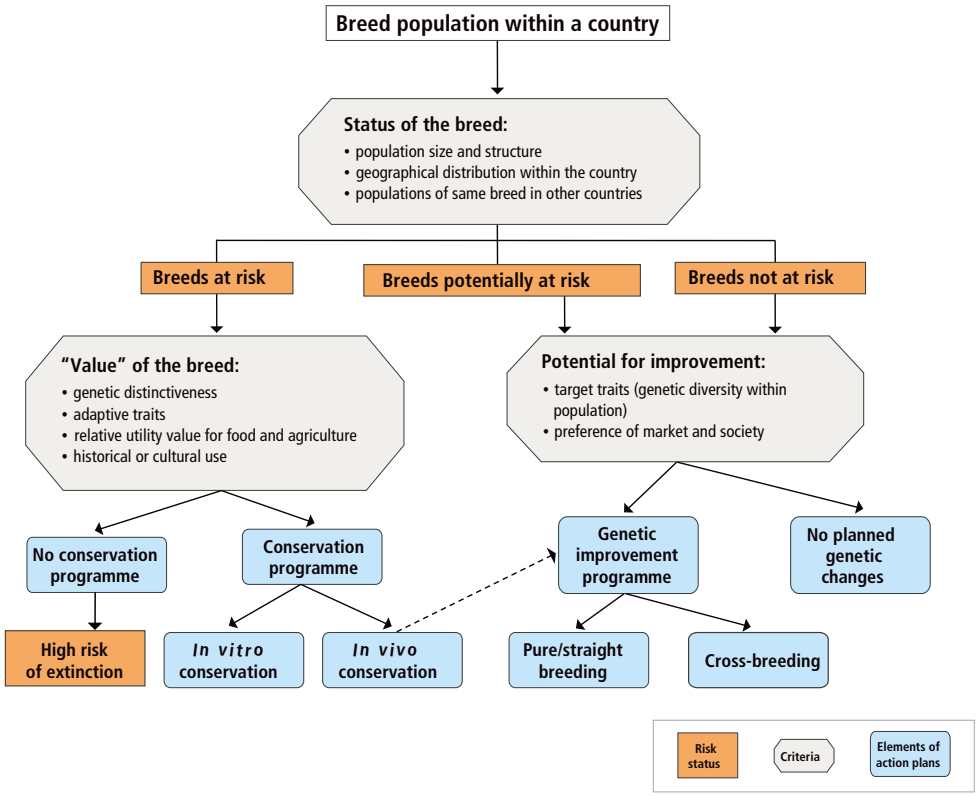
Information on the breed's specific attributes and adaptations, its genetic relationship to other breeds, its normal production environment and management practices, and any associated indigenous knowledge are all of great help in the design and implementation of conservation or breed development programmes. Characterization at the molecular genetic level offers the opportunity to explore genetic diversity within and between livestock populations, and to determine genetic relationships among populations.

Periodic monitoring of population size and structure is important, so that management strategies can be adapted if necessary. There may be opportunities to increase the cost-effectiveness of monitoring by taking advantage of existing related activities. National livestock census processes offer good opportunities for this. The next World Programme for the Census of Agriculture, which is produced by FAO every ten years to guide countries in the conduct of their agricultural census, encourages the collection of livestock data at breed level.

Another important aspect of the characterization process is to make relevant data available to a wide range of stakeholders, including policy-makers, development practitioners, livestock keepers and researchers. Existing public domain information systems need to be further developed to expand their content and allow users easier access to the data they require. Linking breed data to environment and production system maps would be an important aid to decision-making.

Ideally, tools and methods for decision-making, as well as early warning mechanisms to identify at-risk breeds, would be based on comprehensive information of the kind described above. However, given that immediate action is required to conserve and improve the management of animal genetic resources, there is a need for tools and methods that make effective use of incomplete information.

FIGURE 12
Information required to design strategies for managing animal genetic resources



Methods for genetic improvement

Genetic improvement is a vital element of efforts to meet the increasing demand for livestock products. Great progress has been made in genetics and reproductive biotechnology, which has enabled rapid advances in highly controlled production systems. However, recent years have seen a growing realization that selecting solely for product output per animal leads to a deterioration of animal health, increased metabolic stress and reduced longevity. Functional traits, such as disease resistance, fertility, calving ease, longevity and behavioural characteristics, are receiving more attention. Breeding goals also need to adapt to new demands on the part of consumers, who may be concerned about animal welfare or environmental impacts, or acquire tastes for speciality food products. Ensuring that within-breed genetic diversity is not compromised is another increasingly important consideration. Genetic improvement in small populations included in conservation programmes is a field requiring specific management strategies.

New techniques are needed to ensure that breeders are able to meet these emerging challenges. Priority areas for research include breeding for disease resistance (including the practical application of selection based on molecular markers associated with resistance); selection for welfare traits (e.g. reduction of foot and leg problems in dairy cattle); and selection for increased efficiency of feed utilization.

There is urgent need to design and implement programmes that are appropriate for low external input production conditions. For many local breeds, genetic improvement is likely to be essential if their utilization is to remain economically viable. Methods for the establishment of stable cross-breeding programmes that involve the maintenance of pure-bred herds or flocks of local breeds need to be investigated.

Successful genetic improvement programmes require the involvement of all stakeholders, particularly of livestock keepers and their organizations. The establishment of breeders' associations should be encouraged. Wide consultation is essential, but within a breeding programme there should be clear definition of roles. Recording systems are vital to genetic improvement programmes, and efforts should be made to establish such systems. In the context of smallholder production systems, it is vital that sufficient consideration be given to the objectives of the livestock keepers, impacts on the environment and the wider community, the adaptation of all the animals

involved to local production conditions, and the availability of infrastructure, technical resources and trained personnel.

Methods for economic valuation of animal genetic resources

The large number of breeds that are at risk and the limited financial resources available for conservation and breed development imply that economic analysis of the value of the genetic resources at stake and of potential management interventions is necessary to guide decision-making. Important tasks include:

- determining the economic contribution that particular animal genetic resources make to various sectors of society;
- the identification of cost-effective conservation measures; and
- designing economic incentives and policy/institutional arrangements for the promotion of conservation by individual farmers or communities.

Methods to address these issues have been slow to emerge. Reasons include the limited availability of the data required. Effective economic analysis in the field of animal genetic resources requires paying attention to the non-market values of livestock. Obtaining these data frequently requires the modification of economic techniques for use in conjunction with participatory and rapid rural appraisal methods. Despite the problems, a growing number of economic studies in this field are being undertaken based on the use of techniques adapted from other areas of economics. Important points emerging from such studies include:

- Adaptive traits and non-income functions are important components of the total value of indigenous breed animals.
- Conventional criteria used to evaluate livestock productivity are inadequate to evaluate subsistence production systems, and have tended to overestimate the benefits of replacing local breeds with exotic ones.
- The costs of implementing an *in situ* breed conservation programme may be relatively small, both when compared to the size of subsidies currently being provided to the commercial livestock sector and when compared to the benefits of conservation.
- Household characteristics play an important role in determining differences in farmers' breed preferences. This information can be of use in designing cost-effective conservation programmes.
- Conservation policy needs to promote cost-efficient strategies. Decision-support tools to support this objective have been developed, but require further refinement and evaluation.

Methods for conservation

Conservation strategies involve the identification and prioritization of targets for conservation. A critical first step is to identify the most appropriate "unit" of conservation. In the case of agricultural biodiversity, a primary objective has to be the maintenance of diversity for potential future use. Given the current state of knowledge, it is considered that the best proxy for functional diversity in livestock species is the diversity of breeds, or distinct populations that have developed in distinct environments. Moreover, cultural arguments for conservation relate to breeds rather than to genes. It is therefore reasonable that conservation decisions are usually taken at the level of the breed. However, it should be recognized that breed diversity does not represent the whole picture of genetic diversity. At the molecular level, genetic diversity is represented by the diversity of alleles (i.e. differences in DNA sequences) across the genes affecting development and performance.

Assessing the significance of a breed from the conservation perspective requires a synthesis of information from a number of sources including:

- studies of trait diversity, i.e. diversity in the recognizable combinations of phenotypic characteristics that define breed identity;
- molecular genetic studies, which provide objective measures of diversity within and between breeds, or evidence for unique genetic attributes;
- evidence of past genetic isolation; and
- evidence indicating cultural or historic importance.

Risk status is a further important consideration. Optimizing conservation strategies also requires consideration of how the available resources should be divided among the breeds under consideration, and decisions as to which is the most efficient conservation strategy from among the options available. Further work is required to develop effective tools for optimizing resource allocation in conservation strategies.

In vivo conservation encompasses a range of contexts and approaches. Landscape and vegetation management, organic farming approaches, participatory breeding, production for niche markets, and hobby farming all offer opportunities to keep breeds in use. Support to any or all of these may be important elements of a conservation strategy. In some cases, direct subsidies for keeping rare breeds may be necessary to prevent extinction. This approach is only feasible where resources are available; where there is political will to expend public funds to meet conservation objectives; where breed characterization is adequate to allow breed populations to be identified and classified according to their risk status; and where there is sufficient institutional capacity to allow eligible farmers to be identified, to monitor their activities and to administer payments. Careful attention to breed targeting is essential. Even where it is possible to deliver targeted subsidies, there will always be doubts regarding financial commitments over the long term, and such measures should be complemented by efforts to promote activities that offer scope for the breeds to become self-sustainable in the future.

PART **4**

In situ[7] conservation cannot be isolated from efforts to develop the production systems in which the breeds are kept and must not place restrictions on livelihood options, particularly of poorer livestock keepers. Unfortunately, little is known about how to improve production systems and infrastructure in such a way that the livelihoods of local people are improved and food security is enhanced while also conserving indigenous animal genetic resources. A limited number of community-based approaches involving intense cooperation with local livestock keepers and respect for their production objectives and knowledge have achieved some success.

Towards the *ex situ*[8] end of the spectrum of *in vivo* conservation approaches, farm parks devoted to keeping rare breeds have been established as successful tourist attractions in many (mostly developed) countries. These sites have an important role in terms of educating the public about animal genetic resources. In the developing world, the most commonly observed *ex situ in vivo* conservation activities are in herds or flocks maintained by state-owned institutions. These establishments are normally linked to ongoing use on farms, and their potential contribution in situations where breeds are no longer in use needs to be further assessed.

In vitro methods provide an important back-up strategy when *in vivo* conservation cannot be established or cannot conserve the necessary population size. It may also be the only option in the case of emergencies, such as disease epidemics or military conflicts. Further efforts are required to make reliable cryoconservation techniques available for all species.

[7] *In situ* conservation refers to conservation of livestock through continued use by livestock keepers in the production system in which the livestock evolved or are now normally found and bred.

[8] *Ex situ in vivo* conservation refers to conservation through maintenance of live animal populations not kept under normal management conditions (e.g. zoological parks and in some cases governmental farms) and/or outside of the area in which they evolved or are now normally found.

Needs and challenges in animal genetic resources management

The livestock sector has to balance a range of policy objectives. Among the most urgent are: supporting rural development and the alleviation of hunger and poverty; meeting the increasing demand for livestock products and responding to changing consumer requirements; ensuring food safety and minimizing the threat posed by animal diseases; and maintaining biodiversity and environmental integrity. Meeting these challenges will involve mixing species, breeds and individual animals with the qualities needed to meet the specific requirements of particular production, social and market conditions. However, there are many constraints to meeting the goal of matching genetic resources to development needs.

Inventory and characterization are fundamental to the management of animal genetic resources, but remain far from complete, particularly in developing countries. Addressing the knowledge gaps that impede decision-making should be a priority. The current rate of genetic erosion also gives cause for significant concern. Well-targeted conservation measures to address threats to particular breeds are essential. However, there is an emerging consensus that the real requirement is for sustainable approaches to use and development, both for individual breeds and for animal genetic diversity as a whole. There is a need to establish principles and elements that underpin effective management, balance current and future use, and address economic, social and environmental concerns. Community-level programmes that both support the livelihoods of the livestock keepers involved and address global concerns about biodiversity are required. Initiatives of this type must be backed up by strengthened institutional and organizational structures, and policy and legal frameworks that support sustainable development.

Accepting global responsibility

The countries and regions of the world are interdependent in the utilization of animal genetic resources. This is clear from evidence of historic gene flows and current patterns of livestock distribution. In the future, genetic resources from any part of the world may prove vital to breeders and livestock keepers elsewhere. There is a need for the international community to accept responsibility for the management of these shared resources. Support for developing countries and countries with economies in transition to characterize, conserve and utilize their livestock breeds is necessary. Wide access to animal genetic resources, for farmers, herders, breeders and researchers, is essential to sustainable use and development. Equitable frameworks for access, and for sharing the benefits derived from animal genetic resources, need to be put in place at both national and international levels. It is important that the distinct characteristics of agricultural biodiversity – created largely through human intervention and requiring continuous active human management – be taken into account in the development of such frameworks. International cooperation at all levels, from research to institutional and legal arrangements, and better integration of animal genetic resources management into all aspects of livestock development, can help to ensure that the world's wealth of livestock biodiversity is suitably used and developed, and remains available for future generations.

Sustainable management of the world's livestock genetic diversity is of vital importance to agriculture, food production, rural development and the environment. *The State of the World's Animal Genetic Resources for Food and Agriculture* draws on 169 Country Reports, contributions from a number of international organizations, 12 specially commissioned thematic studies and wider expert knowledge to provide the first global assessment of these resources and their management. This "in brief" version, intended for use by decision-makers and the wider public, presents a summary of the key findings of the main report.

As well as providing a technical reference document, the country-based preparation of *The State of the World* has led to a process of policy development and a *Global Plan of Action for Animal Genetic Resources*, which once adopted, will provide an agenda for action by the international community.

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