Part 5

NEEDS AND CHALLENGES

Introduction

The major global challenge for the twenty-first century is to sustainably feed a growing population that is expected to reach 9 billion by 2050: the so-called "2050 challenge to our global food system".[1] Further increase in production is needed. At the same time, the ecological footprint of food production needs to be reduced and the quantity and quality of natural resources, including biodiversity, need to be sustained. There is a need to reduce waste, increase efficiency in the use of water, feed and energy and reduce greenhouse gas emissions and the pollution of land, air and water. Ecological and economic challenges are increasingly interconnected and global. Collaboration and cooperation across national boundaries have never been more important.

Since 2007, when the first report on *The State of the World's Animal Genetic Resources for Food and Agriculture* (FAO, 2007a)[2] was published and the international community adopted the Global Plan of Action for Animal Genetic Resources (FAO, 2007b),[3] the importance of genetic resources for food and agriculture, including animal genetic resources (AnGR), has been highlighted in several major international initiatives and agreements. In 2010, the Conference of the Parties to the Convention on Biological Diversity (CBD) agreed on the Strategic Plan for Biodiversity 2011–2020, including the Aichi Biodiversity Targets.[4] The following two targets are particularly relevant to AnGR management:

> *"Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity."*
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> *"Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity."*

In 2012, the Rio+20 International Environmental Summit of Nations agreed to set new multiyear global objectives to succeed the Millennium Development Goals (2000–2015). Biodiversity featured prominently in the outcome document, *The future we want:*

> *"111. We reaffirm the necessity to promote, enhance and support more sustainable agriculture, including crops, livestock, forestry, fisheries and aquaculture, that improves food security, eradicates hunger, and is economically viable, while conserving land, water, plant and animal genetic resources, biodiversity and ecosystems, and enhancing resilience to climate change and natural disasters ...*
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> *112. We stress the need to enhance sustainable livestock production systems, including through improving pasture land and irrigation schemes in line with*

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[1] http://www.iatp.org/documents/the-2050-challenge-to-our-global-food-system

[2] FAO. 2007a. *The State of the World's Animal Genetic Resources for Food and Agriculture*, edited by B. Rischkowsky & D. Pilling. Rome (available at www.fao.org/3/a-a1250e.pdf).

[3] FAO. 2007b. *The Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration*. Rome (available at http://www.fao.org/docrep/010/a1404e/a1404e00.htm).

[4] http://www.cbd.int/sp/default.shtml

national policies, legislation, rules and regulations, enhanced sustainable water management systems, and efforts to eradicate and prevent the spread of animal diseases, recognizing that the livelihoods of farmers including pastoralists and the health of livestock are intertwined."[5]

and subsequently in the post-2015 Sustainable Development Goals:

"Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture"

"2.5 By 2020 maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at national, regional and international levels, and ensure access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge as internationally agreed"

"2.a Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks in order to enhance agricultural productive capacity in developing countries, in particular in least developed countries"

"Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss"

"15.6 Ensure fair and equitable sharing of the benefits arising from the utilization of genetic resources, and promote appropriate access to such resources"

"15.9 By 2020, integrate ecosystems and biodiversity values into national and local planning, development processes and poverty reduction strategies, and accounts"

"15.a Mobilize and significantly increase financial resources from all sources to conserve and sustainably use biodiversity and ecosystems"[6]

The Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization[7] entered into force in October 2014. It provides a legal framework for the implementation of one of the three objectives of the CBD: the fair and equitable sharing of benefits arising out of the utilization of genetic resources.

In order to monitor progress in the implementation of the Global Plan of Action for Animal Genetic Resources, the Commission on Genetic Resources for Food and Agriculture has adopted indicators for measuring both the state of implementation of the various elements of the plan itself (so-called process indicators) and outcomes in terms of AnGR diversity (so-called resource indicators).[8] The process indicators were calculated in 2012[9] and 2014,[10] based on country reporting, and the resource indicators are calculated biennially,[11] based on data entered by countries into the Domestic Animal Diversity Information System (DAD-IS)[12].

[5] http://tinyurl.com/czenz9g
[6] http://sustainabledevelopment.un.org/focussdgs.html
[7] https://www.cbd.int/abs/
[8] http://www.fao.org/Ag/AGAInfo/programmes/en/genetics/Targets_and_indicators.html
[9] http://www.fao.org/docrep/meeting/027/mg044e.pdf
[10] http://www.fao.org/3/a-at136e.pdf
[11] http://www.fao.org/3/a-at135e.pdf
[12] http://fao.org/dad-is

Section A

Challenges posed by livestock sector trends

Economic, social and environmental trends in the livestock sector continue to pose many challenges to the sustainable management of AnGR. Rapid growth in demand for animal products has been a major driver of change in the livestock sector in recent decades, particularly in some developing regions, and the associated changes in livestock production systems have had a major effect on AnGR management and often posed a threat to diversity. Traditional production systems that harbour diverse genetic resources have been marginalized and a narrow range of international transboundary breeds have become more widely used. In some circumstances, these breeds have been indiscriminately crossed with locally adapted breeds, a development that is regarded as a major threat to AnGR diversity in many countries. Growth in global demand for animal-source foods is expected to continue over the coming decades, although at a slower pace overall. Africa and South Asia are predicted to be major centres of growth in demand. Both are resource-constrained regions where smallholder and pastoral production is still widely practised and where smallholder milk production has historically been strong. Both are also home to a wealth of locally adapted AnGR.

Economic and market-related factors are frequently highlighted by stakeholders as threats to AnGR. Shifts in market demand or increasing competition may mean that particular breeds can no longer be raised profitably. Shifts of this kind are part of social and economic change, and there are always likely to be some breeds that are at risk of falling out of use and declining towards extinction. However, there may be measures that can be taken to reduce economic threats, either by "valorizing" individual at-risk breeds via marketing initiatives, genetic improvement or the identification of new roles, or by more general policy measures such as eliminating support measures that create favourable economic conditions for breed replacement.

Climate change is placing increasing pressure on the livestock sector, especially on production systems that depend heavily on the state of the local ecosystems. Livestock are recognized as contributors to climate change, but also as an entry point for climate change mitigation. Grazing systems in arid and semi-arid areas are likely to be particularly severely affected, but mixed farming systems will also need to adapt. Grazing and small-scale mixed farming systems harbour many locally adapted livestock breeds that possess characteristics that enable them to thrive in harsh conditions. These breeds, and other AnGR, increase the options available for adapting production systems to the effects of climate change. However, climate change also poses threats to AnGR diversity: for example, because of the increased risk of breed loss as a result of natural disasters. It remains difficult to predict how climate change will affect the future of livestock production and what the consequences will be for AnGR diversity. The uncertainty of climatic projections is a major constraint, but there is also frequently a lack of data on breeds' characteristics, distributions and production environments. Information on the level of threat posed to AnGR by extreme climatic events and other disasters and emergencies remains limited.

Given the major roles of small-scale livestock keepers and pastoralists in maintaining AnGR

diversity, factors that undermine the sustainability of smallholder and pastoralist production systems constitute significant threats to AnGR. These threats may include both market-related factors (e.g. competition from large-scale producers or exclusion from markets because of difficulties in meeting the specific requirements of retailers and consumers) and problems related to the degradation of (or lack of access to) natural resources. The importance of livestock-keeping to the livelihoods of many of the world's poorest people and the major significance of livestock-keeping areas (e.g. grasslands) in the provision of ecosystem services (carbon sequestration, water cycling, provision of wildlife habitats, etc.) imply that the sustainable use and development of livestock populations in pastoralist and smallholder production systems is a challenge that extends well beyond the immediate field of AnGR management. Balancing different objectives is unlikely to be easy. However, there may be scope for synergies in efforts to promote AnGR-management, livelihood and environmental objectives.

One trend affecting the livestock sector in many parts of the world is a movement of people out of livestock keeping and into alternative employment. In most countries, small-scale livestock keeping is unlikely to disappear in the short or medium term. However, where trends of this type are strong, AnGR associated with particular traditional types of livestock keeping or particular communities may be threatened.

International gene flows have continued to expand over recent years. Exchanges are still dominated by North–North and North–South exchanges, with importers taking advantage of the genetic improvements achieved in the world's most advanced breeding programmes. The share of global imports accounted for by imports into developing countries has increased in some subsectors. This represents a large increase in gene flows of high-output international transboundary breeds from the North to the South. For many developing countries, South–South gene flows are also significant.

Gene flows clearly have the potential to increase the options available to livestock keepers and breeders as they seek to improve the productivity of their animals and adapt to change. However, countries are increasingly concerned about the effects of international gene flows on the diversity of their livestock populations and recognize that the establishment of exotic breeds and the production systems needed to maintain them can be challenging in terms of the additional resources and management skills required and the vulnerability of the animals to diseases, feed shortages and climatic hazards. Effective management of gene flow and effective use of imported genetics involve all the main elements of AnGR management: characterization of breeds and production environments to ensure that they are well matched; well-planned breeding strategies; monitoring of outcomes in terms of productivity and genetic diversity; measures to promote the sustainable use and conservation of breeds that may be put at risk of extinction; and appropriate policies and legal frameworks.

Section B

Characterization and monitoring

Characterization and monitoring are the foundations of sustainable AnGR management. However, in most regions of the world, there are still major gaps in the coverage of characterization activities and hence major gaps in knowledge about the characteristics of AnGR. There are also major gaps in programmes for monitoring trends in breed populations and hence the current risk status of many breeds is unknown. These gaps in knowledge inevitably hamper the sustainable use, development and conservation of AnGR.

In many countries, the basic task of establishing a complete inventory of national breeds across the full range of mammalian and avian livestock species has not been completed. For many recognized breeds, phenotypic characteristics – morphology, performance in specific production environments, degree of adaptation to specific diseases or climatic challenges, and so on – have been inadequately studied. Gaps are particularly prominent in developing countries, which means that the characteristics of the locally adapted breeds of these countries have been poorly described and that the comparative performance of different breeds in the production conditions prevailing in these countries has been inadequately assessed. Detailed description of typical production environments has been undertaken only for a limited number of breeds, precluding even the application of basic intuitive or heuristic approaches to breed comparison. At within-breed level, advanced technologies such as those related to the prediction of breeding values for individual animals and genomic selection have huge potential, but require phenotypic data. If developing countries lack characterization and performance data, they will be unable to take advantage of new technologies of this kind.

Reporting on AnGR has improved over recent years. The number of national breed populations recorded in the Domestic Animal Diversity Information System (DAD-IS) has increased. However, breed-related information remains far from complete. For almost two-thirds of all reported breeds, risk status is unknown because of a lack of recent population data. Trends in the global state of AnGR diversity cannot therefore be monitored precisely. However, the available data indicate that genetic erosion is ongoing. Missing population data remains the biggest weakness of the current system for monitoring the global state of AnGR diversity. Another concern is the non-coverage of cross-bred and non-descript populations, which make up a large part of livestock populations worldwide. To obtain a more comprehensive picture, all livestock populations, regardless of their level of cross-breeding, need to be included in the monitoring system.

Breed effect is one of the many factors that influence the composition and quality of animal-source foods. Interest in the relationship between breed diversity and human nutrition has increased to some extent in recent years. Some comparative studies that assess the effect of breed *per se* and identify nutritional differences by controlling for other factors have been undertaken. However, high-quality studies that disentangle genetic and environmental factors are lacking, particularly for locally adapted breeds.

Section C

Sustainable use and development

While the majority of countries report that they have at least some livestock breeding programmes in place, the information provided in the country reports suggest that these programmes are often in a rudimentary state – or in some cases non-existent in the sense of organized programmes involving the establishment of breeding goals, recording of performance and subsequent selection of superior animals for mating. Efficient mechanisms for appropriately distributing improved genetic material are also often lacking.

Recent advances in the field of genomic selection have created opportunities to increase the rate of genetic progress for some traits (particularly those that are difficult to measure in all animals at a young age). However, use of genomic selection has, for the most part, been restricted to particular circumstances that favour its application (extremely large reference populations with extensive phenotypic data, high values of individual animals and established systems for distributing improved germplasm). This has further increased the gap between the most technically advanced breeding programmes and the rest of the sector – for example, Holstein breeding programmes relative to programmes for other breeds of dairy cattle.

Policies aimed at improving the state of livestock breeding are widespread, but in many countries these policies focus mainly on the introduction of exotic breeds for use in cross-breeding, sometimes paying little attention to the establishment of breeding programmes at national level. Introducing exotic AnGR can help countries boost their output of livestock products. However, great care is needed to ensure that these resources are managed appropriately. Exotic breeds are sometimes introduced into production environments where they fail to flourish or prove to be risky investments. Moreover, indiscriminate cross-breeding – often with exotic genetic material – is one of the most widely reported threats to the survival of locally adapted genetic resources. Developing a national breeding strategy can be very challenging, particularly given that the information needed to assess the relative costs and benefits of different approaches is often unavailable. The existence of these knowledge gaps underlines the importance of strengthening efforts to characterize breeds and their production environments and the need to keep track of trends and drivers of change in the livestock sector.

While interest in expanding the use of exotic breeds is practically universal in developing countries, a number have also recognized the need to take greater advantage of the characteristics of their locally adapted breeds, particularly given the challenges associated with climate change and the ongoing need for livestock that are suitable for use by small-scale producers and in low-input production systems. In this context, breeding programmes for locally adapted breeds offer a potential means both of supporting rural livelihoods and of helping to keep a diverse range of breeds in use and hence available as resources for the future. In many countries, however, the underlying preconditions for the establishment of breeding programmes remain weak, particularly the organizational structures needed to facilitate the involvement of livestock keepers and breeders and the relatively high levels of knowledge

and technical skills needed to plan and implement programmes successfully. Experience indicates that while breeding programmes can be initiated by governments and research organizations, the involvement of breeders' associations and/or commercial companies increases the likelihood that they will be sustainable in the longer term.

One significant development in recent years has been a growing interest among developing countries in establishing animal identification schemes. These programmes are introduced primarily with the aim of improving animal health and product traceability, often driven by the incentive of gaining access to export markets that have high animal-health and product-safety standards. However, they may serve as the basis for more comprehensive programmes that include performance and pedigree recording.

Much of the potential of AnGR diversity remains untapped. For example, the inclusion of genetic elements in disease-control strategies has achieved some successes, but knowledge of the genetics of resistance and tolerance remains inadequate. The urgency of adopting more holistic alternative strategies is increasing as greater numbers of microbicides are losing their efficacy. A sign of the commercial recognition of health and other functional traits is that measures of health, robustness and other traits not directly related to performance have acquired an increasing share in selection indices used in breeding programmes in developed countries.

A range of different activities can both help to increase the ongoing benefits derived from AnGR and to maintain genetic diversity for future use. Many breeds that are not at present valued in mainstream livestock production have characteristics that make them potentially valuable in the supply of products valued by a subsection of the market (niche products) or in the provision of public goods, including cultural services. Niche marketing of products from locally adapted breeds is quite widespread in developed regions such as Europe and contributes both to sustaining diversity and to rural livelihoods. Well-managed livestock can contribute to the provision of a number of ecosystem services, including those related to landscape management and the maintenance of wildlife habitats. Because of their ability to thrive in the relevant ecosystems, locally adapted breeds are often effective providers of services of this kind. However, harnessing these roles to promote the use of locally adapted breeds is not straightforward, as the benefits provided are not valued by the market. In this context, the emergence of the concept of payments for ecosystem services is an interesting development. Approaches of this kind potentially have a role in the sustainable management of AnGR.

Section D

Conservation

Conservation activities have become more widespread over the last ten years. Few countries report that they have no conservation measures of any kind in place. However, major gaps remain, both in *in situ* and in *ex situ* conservation programmes. Many breeds remain untargeted or inadequately covered by conservation programmes.

Information on threats to AnGR diversity remains far from complete. The risk status of the majority of breeds is classified as "unknown". Even where population trends are monitored, detailed assessments of threats to specific breeds are not common. This clearly constrains the development of effective conservation programmes and the prioritization of breeds for inclusion in such programmes. Given the complexity of the drivers of change affecting the livestock sector and the potential for rapid shifts in the management of AnGR, there is a need for national early-warning and response systems that can rapidly identify threatened breeds and allow quick and well-defined action to be taken.

In situ conservation programmes can involve a diverse range of activities, including those that aim to create demand for the products and services provided by at-risk breeds, those that support and incentivize livestock keepers and breeders who raise at-risk breeds, those related to breeding programmes, and those that involve promoting participation and empowerment at community level. Careful assessment of livestock-sector trends and the characteristics of particular breeds and production systems will help countries and other stakeholders to identify appropriate *in situ* strategies for particular circumstances.

An increasing number of countries have set up AnGR gene banks. However, inadequate funding, infrastructure and technical skills often remain significant obstacles to the establishment or further development of such facilities. Establishing gene banks at subregional or regional level is a potential option. However, this would require agreements on rules for the transfer of genetic material and the identification of locations considered "safe" by all parties.

Section E

Policies, institutions and capacity-building

Without effective institutions, it is difficult to strengthen AnGR management programmes. Many countries report major gaps and weakness in their institutional frameworks for AnGR management. There have, nonetheless, been several positive developments in recent years, including the more widespread establishment of specifically AnGR-focused institutional structures and policy instruments – in particular the appointment of more National Coordinators for the Management of AnGR and the development of national strategies and action plans for AnGR. The establishment of several additional regional and subregional focal points for AnGR over recent years has strengthened cooperation and capacity to undertake AnGR management actions at supranational level.

Legal and policy frameworks relevant to AnGR management have been supplemented by a substantial number of new instruments over recent years. However, effective implementation remains a problem for many countries. In many cases, the basic prerequisites for effective implementation remain weak or absent. Physical and organizational infrastructure, stakeholder participation, and knowledge and awareness of AnGR-related issues are often inadequate. Financial shortfalls and a lack of well-trained personnel are widely reported to be serious constraints in all areas of AnGR management. Communication and coordination among stakeholders involved in AnGR management and with those in the wider agricultural, rural-development and environmental sectors often need to be improved. Smallholders and pastoralists are often neglected by the private sector, but are also poorly served by public policies and programmes and have little voice in policy development.

There is a big gap between the state of the art in the use, development and conservation of AnGR and the current level of management capacity in many countries. Better education and training of development professionals, livestock keepers and other stakeholders, in animal breeding and all aspects of AnGR management, is needed. Integrating education and research across disciplines and across national boundaries and establishing partnerships spanning academic institutions, ministries and private industry – particularly between developed and developing countries – will help to decrease the gap in capacity.

In 2007, by adopting the Global Plan of Action and the Interlaken Declaration, governments

> *"confirmed their common and individual responsibilities for the conservation, sustainable use and development of animal genetic resources for food and agriculture; for world food security; for improving human nutritional status; and for rural development."*[1]

Governments recognized the need both for "substantial and additional financial resources" and for predictable allocation of these resources. While awareness has increased and some countries have allocated additional resources, the evidence provided in the country reports indicates that sufficient funding has not yet been mobilized,

[1] FAO. 2007. *The Global Plan of Action for Animal Genetic Resources and the Interlaken Declaration*. Rome (available at http://www.fao.org/docrep/010/a1404e/a1404e00.htm).

particularly at national level. Governments must demonstrate the sustained political will needed to ensure the successful implementation of the Global Plan of Action, including through the provision of adequate financial resources. If this does not happen, genetic erosion is likely to continue and world's livestock biodiversity will remain underutilized and underdeveloped. Much of its potential to contribute to sustainably increasing food production will remain unrealized.