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Exchange, Use and Conservation of Animal Genetic Resources

Policy and regulatory options

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S.J. Hiemstra, A.G. Drucker, M.W. Tvedt, N. Louwaars, J.K. Oldenbroek, K. Awgichew, S. Abegaz Kebede, P.N. Bhat & A. da Silva Mariante

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Centre for Genetic Resources, the Netherlands (CGN)

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The views expressed in this report are to a large extent derived from a study by an interdisciplinary team, including literature surveys and stakeholder consultations, supported by four future scenarios. The views expressed in this report are the sole responsibility of the authors.

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Table of contents

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On behalf of the authors,

Sipke Joost Hiemstra
Project co-ordinator

List of acronyms

ABS	Access and Benefit Sharing
AnGR	Animal Genetic Resources
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
COP	Conference of the Parties (CBD)
CGRFA	Commission on Genetic Resources for Food and Agriculture
DAD-IS	Domestic Animal Diversity Information System (FAO)
FAO	Food and Agriculture Organisation of the United Nations
FTA	Free Trade Agreements
IGC	Intergovernmental Committee on intellectual property, genetic resources, traditional knowledge and folklore, of the World Intellectual Property Organisation (WIPO)
IP	Intellectual Property
IPRs	Intellectual Property Rights
ITC	Intergovernmental Technical Conference on AnGR
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
MAT	Mutually Agreed Terms
MTA	Material Transfer Agreement
NGO	Non Governmental Organisation
OECD	Organisation for Economic Co-operation and Development
OIE	Office International des Epizooties
PGR	Plant Genetic Resources
PIC	Prior Informed Consent
SPS	Agreement on the Application of Sanitary and Phytosanitary Measures
SoW-AnGR	State of the World's Animal Genetic Resources
TRIPS	Agreement on Trade Related Aspects of Intellectual Property Rights of the World Trade Organisation
UPOV	The International Union for the Protection of New Varieties of Plants
WIPO	World Intellectual Property Organisation
WTO	World Trade Organisation

Executive Summary

The FAO Commission on Genetic Resources for Food and Agriculture (The Commission) has recognized the importance of conservation and sustainable use of animal genetic resources for food and agriculture (AnGR)[1]. The Commission approved the finalisation of the first Report on the State of the World's Animal Genetic Resources which will be presented at the First International Technical Conference on Animal Genetic Resources (September, 2007). The Commission views the Conference as important, both in terms of providing an excellent opportunity to reach agreement on how to best address priorities for the sustainable use and conservation of AnGR, and to raise awareness and appreciation of the various roles and values of these essential resources.

Within the framework of these developments, and following a recommendation of the Intergovernmental Technical Working Group on Animal Genetic Resources2, FAO commissioned this study to assess how exchange practices regarding AnGR affect the various stakeholders in the livestock sector and to identify policies and regulatory options that guide the global exchange, use and conservation of AnGR. The aim of this report is to support informed and evidence-based decision-making by exploring a range of policy and regulatory options related to exchange, use and conservation of AnGR.

Characteristics, status and trends of AnGR and the livestock sector

Domestic animals supply 30% of total human requirements for food and agriculture and 70% of the world's rural poor depend on livestock as a component of their livelihoods. The global livestock sector consists of a variety of production systems and farm animals are used for a variety of functions.

Centuries of selective breeding and exchange of farm animals or germplasm among users within and across countries have resulted in the development of the current diversity of breeds and within-breed genetic diversity. The exchange of AnGR has played and will continue to play an important role in breed and livestock sector development. Although detailed quantitative data about gene flow between countries and continents is not available, different AnGR flow directions can be characterized to a large extent.

There is a tremendous exchange of genetic material between developed countries (North to North) and – driven by globalization – high performing breeding stock is exported from North to South. South to South exchange has also been extensive and has been very important for livestock development. However, such exchange has been much less well documented than North-North exchange. Movements of livestock germplasm from South to North have been rare in the past century, and in most cases the economic benefits to both North and South have been relatively small. This is in contrast to plant genetic resources, where South to North flows are prominent, mainly driven by the search for new disease resistances and adaptive traits to be incorporated in new plant varieties.

There is consensus that global AnGR diversity is under pressure. The existence of threats to AnGR is generally accepted, even though debate remains about the severity of genetic erosion. The loss of breeds is only one indicator for the loss of farm animal genetic diversity, as a major part of genetic diversity is found within breeds and there is also significant genetic overlap between breeds. By focussing largely on direct output functions (e.g. for food and fertilizer), AnGR conservation is likely to be consistently undervalued. Other significant economic and cultural roles (e.g. livestock as a form of finance and insurance) are also relevant and long term conservation should also take into account indirect use and non-use values (e.g. option values related to currently unknown future uses. See Box 2.1 for a detailed typology of values and examples).

International, regional and national law, as well as customary law at community levels, are all relevant for AnGR. Although not designed primarily for AnGR, international agreements with a general scope (CBD, WTO/TRIPS and

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1 Throughout the study, the term AnGR refers to animal genetic resources used in or potentially useful for food and agriculture

2 CGRFA/WG-AnGR-3/04/REPORT, paragraph 24

WIPO Treaties) also apply to AnGR. Currently, the exchange of AnGR is mainly regulated by the transfer of private ownership (by private law contracts and customary law) and is also influenced by zoo-sanitary regulations. As the implementation of the above international treaties with a general scope advances further, they may have an increasingly significant impact on AnGR exchange, use and conservation. While the special nature of agricultural biodiversity is recognized, the FAO Global Strategy and the FAO State of the World's AnGR play a key role in facilitating and informing the debate on specific AnGR needs and challenges.

Analysis of the current state of affairs is not enough. There are emerging issues which will definitely have impact on future exchange, breeding and developments in the livestock sector. Four such emerging challenges (globalization, biotechnology, climate change, emerging diseases and disasters) were identified in this study and future scenarios were used to discuss the need for a change in the regulatory framework for AnGR.

Core elements of the International Treaty on plant genetic resources for food and agriculture (ITPGRFA) are the inclusion of farmers' rights and the multilateral system of access and benefit sharing to cover the genetic resources of major food and fodder crops that are under the control of the Contracting Party Governments and the international gene banks. Debates and developments related to international agreements in the crop sector have tended to frame the debate for AnGR as well. In order to assess the need for any specific AnGR policies and regulations, key differences between plant genetic resources for food and agriculture (PGR) and AnGR were identified. These include important biological, historical, socio-economic and institutional differences. These differences need to be understood and to be brought into the policy, regulatory and legal discussions about AnGR.

Identified policy and regulatory issues and challenges

The study identified a number of main issues and challenges for AnGR and the livestock sector that may determine whether there is a need for an international policy/regulatory framework for AnGR. Policy and regulatory options were assessed in the context of their appropriateness, their relative advantages and disadvantages, as well as in terms of potential *content*, *form* and *scale.*

The CBD has not extensively dealt with particular challenges for AnGR. A global initiative that puts AnGR in the political limelight and that either creates specific rules at the international level or that creates a stronger emphasis for AnGR at the national and local levels would be extremely useful. Significant differences between PGR and AnGR suggest a need to differentiate and to tailor regulatory regimes accordingly. Rather than developing a new or adapted internationally legally binding framework, the intergovernmental process under FAO may instead wish to focus, in the first instance, on the development of voluntary instruments to strengthen national policies and implementation of action at national levels. This could be carried out in parallel with an analysis of how other international regimes may influence AnGR.

A number of the policy and regulatory issues and challenges described below could be addressed through a process to develop an international voluntary instrument or set of instruments for the responsible exchange of animal genetic resources. This process may facilitate reaching international consensus on the conservation and sustainable use and movement of animal genetic resources to maximize the sharing of benefits derived from their use, for present and future generations. It may enable the establishment of principles, in accordance with the relevant rules of international law, for their responsible use and exchange, taking into account all relevant biological, technological, economic, social, environmental and commercial aspects. Principles and criteria could be established for the elaboration and implementation of national policies for the responsible conservation, management and development of animal genetic resources, serving as an instrument of reference to assist States in the establishment or improvement of the legal and institutional framework required for the exercise of responsible animal genetic resources management, as well as in the formulation and implementation of appropriate measures. It may also provide standards of conduct for all persons involved in the sector.

Conservation and sustainable use

It is generally accepted that farm animal genetic diversity is under threat and that action is needed to halt further losses. In situations where AnGR currently have a low direct use value, they may nonetheless be particularly valuable for future use, which will require the public sector to play an important role in their conservation and management. However, there is limited awareness about the importance of the conservation and sustainable use of AnGR among policy makers and major stakeholders in the livestock sector.

Genetic erosion may be minimised through *complementary ex situ (in vitro) and in situ conservation approaches organised at national, regional and/or global levels*. Such approaches should take into account different views of the 'unit of conservation'. A variety of different strategies is available to stimulate *in situ* conservation, including strengthening of breeding capacity and programmes for local breeds. *Ex situ* conservation requires appropriate infrastructure and organisation, technical capacity, legal arrangements and sustained funding.

There is an urgent need to place due emphasis on conservation and sustainable use of AnGR. The major responsibility for conservation and sustainable use of AnGR lies at the national level (according to the CBD). However, international commitment in terms of supporting national policies is also likely to be important. The international process covering potential AnGR policy and regulatory frameworks will not only raise *awareness* of global political and policy levels, but may also result in coordination and collaboration arrangements at regional and/or global levels.

Exchange

Exchange of genetic material among countries and regions has been a very valuable mechanism for breed and livestock development. Based on the characterization made above and especially when taking into account the potential for biotechnology development or climate change it might be expected that gene flow directions and/or volumes will change, thereby influencing discussions on the regulation of exchange of AnGR.

Many stakeholders in the livestock sector feel that there are currently few major limitations related to the exchange of AnGR (other than zoo-sanitary regulations) and that exchange should not be unduly frustrated by needless administrative barriers. At the same time, potential negative impacts of exchange should be avoided. While there are many positive examples of the introduction of genotypes, they are not always well adapted to the environment or the production system. Consequently there are examples of the damaging effects of taking exotic material from North to South in order to improve local breeds.

It is a general belief that the current exchange of AnGR has generated benefits for both seller and buyer under the present circumstances where private law agreements have been in use. However, there are some cases where stakeholders consider that benefit sharing has not been sufficiently catered for. These are cases where the value in further breeding turned out to significantly outweigh the purchase value of the exported breeding animal or germplasm.

In cases where negotiating capacities or market positions are significantly unequal, an *export regulation* could provide a useful supplementary tool for private law agreements. Such a regulation could set rules or a minimum standard for the content of a private law agreement. Countries may also empower their national institutions by giving them a more prominent role in securing *Prior Informed Consent* (PIC) and negotiating *Mutual Agreed Terms* (MAT). For example, two countries who commonly trade AnGR could also decide to develop *bilateral framework agreements*, aiming at facilitating exchange of AnGR.

The development of *(genetic) impact assessment* methods or instruments may be worth considering as a basis for putting in place strategies to support the mitigation of the potential negative side effects of particular exchange practices. Application of impact assessments could start with the development of (soft) *guidelines* or a *code of good practice.* A more binding approach might involve the approval of an impact assessment by a relevant authority as a prerequisite for exchange.

In order to facilitate or at least not to frustrate the exchange of AnGR, it may be advisable to continue to emphasize further *harmonisation* of zoo-sanitary laws or to establish regulations at the regional and global levels. Furthermore veterinary laws could – where possible - be brought further in line with conservation objectives.

Under the ITPGRFA a multilateral system for facilitated access and benefit sharing was negotiated for a number of plant species. While it may make little sense to simply replicate such aspects of the ITPGRFA for AnGR, it may be useful to develop a *model Material Transfer Agreement* (model MTA) for AnGR at the international level. This would support the responsible exchange of AnGR and could be largely based on current exchange practices, as well as covering all important negotiation issues relevant to AnGR exchange. Development of such a model MTA may become particularly important if patterns of gene flow were to change substantially in the future.

Exclusive Rights and Use Rights

It is argued that relationships between stakeholders are becoming increasingly unbalanced. In particular globalization and changes in business organisation (e.g. global sourcing, standardisation, vertical integration and lengthening supply chains) are generating an increased concern about *equity* and the position and rights of livestock keepers and smallholders. A number of options are discussed in this report that could be used to ensure a better balance of the rights of different stakeholders in the livestock sector.

AnGR are mainly under private control and ownership, and cannot generally be considered to be in the public domain. Commercial breeders generally protect their investments through 'staying ahead' of competitors and by physically controlling the use of their most valuable breeding animals. Exchange of AnGR between private parties occurs to a large extent under private law agreements. The use of IPR in animal breeding has to date mainly been focussed on trademarks. In communal systems, sharing breeding animals is regulated by communal rules (e.g. communities themselves regulate in detail the ownership of animals, the rotation of males among herds and neighbouring communities, etc).

An increasing tension is apparent between *physical ownership* of AnGR and developments in the patent system. Physical ownership could also be challenged by *sovereign rights* exercised by a particular country. New breeding techniques have created possibilities to more directly take advantage of farm animal genetic diversity and investments could be protected through the use of patents. Concerns have been raised that a high number and a wide scope of claims may lead to a significant body of *exclusive rights* on knowledge and breeding technology with substantial impact on the use of AnGR.

Several options were put forward as a strategy to counterbalance the effects of excessive patenting. First of all, *preventive publishing* is often put forward as a strategy to ensure that common knowledge will be considered *prior art*. Secondly, AnGR novelty/inventiveness *guidelines* for Patent Offices were proposed. Thirdly, countries may wish to introduce specific *exemptions* in national patent law, such as a *farmers' privilege* or a *breeder's exemption*. Finally, a systematic legal analysis was suggested to assess how general patent law rules might apply to AnGR and breeding. Furthermore, it may well be worth considering the degree to which patent protection is needed in practice at all in order to promote breeding, research and development in the livestock sector.

The fact that the concepts of plant variety and animal breed are quite different implies that the present system for plant breeder's rights (for example the UPOV *sui generis system*) is unlikely to be applicable to the livestock sector. A *sui generis* protection system for AnGR could nonetheless be useful, particularly where based on the *establishment of breed associations* (possibly associated with trademarks), *geographical indications*, or the protection of *traditional knowledge* and *livestock keepers' rights*. For a *sui generis* system to be adequate for the animal sector, the particular needs for legal protection must be analysed carefully.

A call for *livestock keepers' rights* aims to permit the undisturbed continuation of livestock keepers' traditional ways of life. Legal and political aspects of *livestock keepers' rights* would need to be further explored but might contain similar provisions as those on *farmers' rights* in the ITPGRFA. Recognition of the rights of livestock keepers in the framework of an intergovernmental political process could be used to support implementation of the concept of *livestock keepers' rights* at the national level.

1. Introduction

The importance of animal production for food security and rural livelihoods is well recognized. AnGR (defined by FAO, 2000 - Box 1.1) supply over 30% of total human requirements for food and agriculture (FAO, 1999) and contribute to the livelihood of 70% of the world's rural poor (LID, 1999). However, the purposes of raising livestock go beyond their direct output functions and include other significant economic and cultural roles. These include savings, insurance, cyclical buffering, accumulation and diversification, as well as various cultural roles related to status and the obligations of their owners (Anderson, 2003).

Centuries of selective breeding and exchange of farm animals or germplasm among owners within and across countries have resulted in the development of the current diversity of breeds and within-breed genetic diversity (AnGR). This diversity contributes to the multiple benefits that they provide, and to their role in risk management at the local and global levels. Throughout the study, the term AnGR refers to animal genetic resources used in or potentially useful for food and agriculture.

Box 1.1 Definition of AnGR

The Convention on Biological Diversity (CBD) defines *genetic resources* as "genetic material of actual or potential value." Whereas, *Genetic material* is defined as "any material of plant, animal, microbial or other origin containing functional units of heredity" (CBD, 1992, Article 2, Section 10 read in conjunction with Section 9). In short, this definition seeks to target or cover the uses of living organisms (biological material) when they seek to capture the value of the genes in a direct manner (Tvedt, 2006; Tvedt & Young, 2006). Thus, genetic resources as defined in the CBD refers both to the (micro) physical, tangible genetic material and to the genetic information and knowledge.

AnGR includes the genetic resources of those animal species that are used, or may be used, for the production of food and agriculture, and the populations within each of them. These populations within each species can be classified as wild and feral populations, landraces and primary populations, standardized breeds, selected lines, and any conserved genetic material (FAO, 2000).

Throughout the report of Gibson *et al.* (2006) AnGR (farm animal genetic resources) is understood to encompass animal genetic resources that are or have been maintained to contribute to food and agricultural production and productivity. This includes livestock kept by pastoralists. Fish and other aquaculture, and fisheries species and wild relatives of livestock are not included. This study takes the same approach.

Livestock production systems and agricultural practices have changed in ways that have had a major impact on the use, exchange and conservation of farm animal genetic diversity. The loss of genetic diversity is closely associated with a transition of small-scale, often largely subsistence modes of agriculture to larger-scale industrialized or semi-industrialized forms.

The exchange of animal genetic resources has also raised questions about access to AnGR by livestock keepers and breeders, and the fair and equitable sharing of benefits arising out of the use of these resources. There is a latent conflict between unconstrained access to genetic resources with, on one hand, benefit sharing and, on the other hand, the protection of investments in research (Rosendal *et al.*, 2005; Tvedt 2005a: 311-344).

The Convention on Biological Diversity (CBD, 1992) underlines the importance of conservation and sustainable use of genetic resources, and imposes obligations regarding access and benefit sharing (ABS) arising from the utilisation of genetic resources. The CBD is general in scope and thus in principle covers AnGR. The FAO Commission on

Genetic Resources for Food and Agriculture (the Commission) has recognized the need to create a strong foundation to underpin decision-making regarding AnGR. To accomplish this, the Commission, during its Eighth Regular Session in 1999, agreed that FAO should coordinate the development of a country-driven first *Report on the State of the World's Animal Genetic Resources*. During its 10th Regular Session in 2004, the Commission approved the completion of the process of the development of the *Report* at a first international technical conference (ITC) on AnGR, which could provide a framework for advancing the conservation and sustainable use of animal genetic resources for food and agriculture.

In this context and following a recommendation of the Intergovernmental Technical Working Group on Animal Genetic Resources[3], the Animal Production and Health Division of FAO commissioned this study to assess how exchange practices regarding AnGR affect the various stakeholders in the livestock sector, and to support informed decision-making on development of policy and regulatory options related to the exchange, sustainable use and conservation of farm animal genetic resources (AnGR). This study was funded by the Government of the United Kingdom of Great Britain and Northern Ireland, and executed by the Centre for Genetic Resources, the Netherlands (CGN) in cooperation with the International Livestock Research Institute (ILRI), Charles Darwin University, Australia, the Fridtjof Nansen Institute (FNI), Norway and the Animal Sciences Group of Wageningen UR, the Netherlands, to explore these options.

An interdisciplinary team embarked on a study including literature surveys and stakeholder consultations, supported by four future scenarios. Options were explored through an analysis of the current situation regarding exchange, use and conservation of AnGR, followed by the elaboration of a range of future scenarios (summarized in Annex I) and by a global assessment of the experiences, interests, objectives and views of a wide range of stakeholders (results summarized in Annex II).

Chapter 2 of this document describes the characteristics, status and trends of AnGR and the livestock sector. Chapter 3 presents the main issues and challenges for AnGR and identifies relevant policy issues and regulatory options. General conclusions and recommendations are presented in chapter 4.

3 CGRFA/WG-AnGR-3/04/REPORT, paragraph 24

2. Characteristics, status and trends of AnGR and the livestock sector

2.1 Trends in breeding and exchange

The global livestock sectors consist of a variety of production systems. In extensive systems in developing countries, animals are often used for a variety of functions, while in intensive systems the focus is primarily on food production.

Livestock has been undergoing constant genetic change, which is the normal state for AnGR. Breed development is a dynamic process of genetic change driven by environmental conditions and selection by humans. Natural and artificial selection, crossing between stocks and replacement of one stock with another stock are inherent features of livestock production systems.

Global exchange of AnGR has been vital for breed and livestock sector development at all continents. Gibson & Pullin (2005) describe several phases of livestock breeding in industrialised countries. In the 19th century, urbanisation and the development of more intensive agriculture led to the stabilisation of many breeds as distinct genetic entities through the establishment of breed societies that defined breed characteristics and purity. Breeds very often originated from a regional population that contained diverse genetic origins. Breeds better adapted to modern production systems became more widespread, while other breeds consequently declined and even became extinct in a considerable number of cases. In the middle to late 20th century, modern within-breed genetic improvement programs became widely established. This was coupled with specialization in the livestock sector, extensive use of cross-breeding and the rise of breeding cooperatives and companies.

Introduction of exotic genetic material continues to be seen as a solution to low productivity of local breeds even in areas where the exotic genotypes are ill-adapted. Economic globalization and government or donor subsidies make it relatively easy for farmers to acquire exotic germplasm. Change of species or breeds may offer more flexibility and quicker adaptation to change than making use of within breed variation only. In the short term, cross-breeding with improved breeds can show quicker impact than the time consuming and expensive selective breeding of a local breed. However, improved management and the recognition of non-market benefits in the productivity assessment show that local/indigenous breeds can outperform crossbreds under certain circumstances (for example, see Ayalew *et al*, 2003). There are a number of well documented examples of unsustainable livestock development projects based on importations of exotic genetic material in developing countries (e.g. Sainath, 1996).

Different strategies for breed development and breed improvement can be identified. Selection of preferred animals (male and female) for further multiplication is the basic method applied by livestock keepers and breeders. In modern breeding programmes this is complemented by estimation of breeding values and dissemination of superior genetic material. The more detailed the knowledge about the genetic background of desired traits, the more targeted this process can be. For livestock keepers in developing countries 'community-based management' of AnGR is relevant, in which case within breed selection is practised where phenotypically selected male animals are rotated or exchanged between herds.

Research leading to sustainable utilisation of livestock germplasm is relatively expensive and requires long-term investment and commitment. The cost of such research remains beyond the reach of most Southern countries and national capacity in those countries requires considerable strengthening.

Reproductive technologies have revolutionized the animal breeding sector and facilitated exchange of genetic material between countries and regions of the world. Breeders realize that these technologies have led to reduced genetic variation, mainly through the widespread use of a small number of superior animals. Molecular biology is

also having an increasing impact on the animal breeding sector, as well as playing a role in the introduction of the patenting of processes and products used in animal breeding.

Two recent studies (Valle Zárate *et al.*, 2006; Mathias & Mundy, 2005) analyzed historical and current AnGR exchange and aimed to quantify and assess trends in the transfer of AnGR. Although these studies provide interesting examples of gene flow, the global flow of AnGR remains poorly understood in quantitative terms. There are several reasons why there is little baseline quantitative data on AnGR exchange. First of all, import and export figures of live animals, originating from veterinary or economic records, do not usually distinguish breeding animals from slaughter animals/animal products, and the origin of import and destination of export is often unclear. Secondly, multinational companies provide no data on the intra-company exchanges of genetic material between countries. Thirdly, in many parts of the world unrecorded livestock movements take place, e.g. due to transhumance.

The current flow of AnGR can be characterized using a rather simple distinction between North (industrialised countries with predominantly intensive production systems) and South (developing countries with a wide diversity of production systems). It is understood that there are pockets of intensive production in most developing countries. It should also be noted that developed countries in tropical environments such as Australia were grouped together with Northern countries and some countries in the Northern hemisphere (e.g. India) were grouped together with Southern countries.

North to North

There have been very extensive North to North flows, driven by advances in reproductive technology, which have largely taken place in a relatively free market managed by livestock breeding companies, cooperatives and individual breeders. Such flows have driven the rapid expansion of highly improved livestock adapted to the more intensively managed systems.

South to South

Historically, South to South movements of livestock germplasm have been extensive and have had major positive impacts on productivity (Gibson & Pullin, 2005). One relevant example is the introduction of Indian cattle breeds (Kankrej, Gir etc.) into Latin America which were further developed there leading to a significant increase in their productivity; or the spread of the improved Awassi sheep from the Middle East (Galal *et al.*, 2006).

North to South

There are striking examples where such movements of germplasm, supported by business interests and development agencies, proved insufficiently adapted to local conditions. Some of these movements have been successful, especially where they were based on intensification of production systems. An example is the successful cross breeding of pigs in Vietnam. The North to South flow, particularly of cattle, pigs and poultry is mainly driven by commercial breeding companies. 'Exotics' are often promoted by intermediate organizations that aim at poverty reduction and food security.

South to North

Movements of livestock germplasm from South to North have been rare in the past century, and in most cases the economic benefits to both North and South have been relatively small. Return on investments in animal breeding is relatively low and the potential for the breeding industry to make a profit by selling improved germplasm in the South is currently limited. The potential for profit in the North is higher, but there is little or no demand in the North for the traits of indigenous livestock that make them so valuable in the South due to the big differences between Northern and Southern production circumstances. The net result is generally that Northern businesses currently show little interest in Southern livestock genetic resources. An example of a South to North exchange is the Tuli, a Sanga cattle breed in Southern Africa, which was introduced to and commercialized in Australia and the USA.

Gibson & Pullin (2005) argue that movements of germplasm, cross-breeding and within-breed selection in the developing world are all likely to accelerate in the future. The availability of a wide range of genetic diversity and proper regulatory frameworks will be critical to ensure that the developing world has the ability to develop livestock best suited to its physical and social environments and production and marketing requirements, just as it has been in the developed world.

2.2 Status and trends in conservation of AnGR

2.2.1 Loss of farm animal genetic diversity

There are more than 40 species of animals that have been domesticated (or semi-domesticated) during the past 10 to 12 thousand years that contribute directly or indirectly to agricultural production (FAO, 2000). Livestock have been undergoing constant genetic change since first domesticated. In contrast to many plant species, there is only a very limited genetic resource-base in wild populations of animal species that is of interest for farm animal breeding.

The status of AnGR or livestock breeds, particularly in the developing world, is poorly understood. Loss of genetic diversity through the disappearance of local livestock breeds is widely reported but difficult to quantify. Hall & Ruane (1993) estimated that some 16% of the uniquely adapted breeds are extinct. FAO estimated (FAO, 2000) that about one third of all domesticated animal breeds were threatened with extinction. These figures have been criticised because they are based on national endangerment estimates, regardless of the total population size of the breed in question across countries and the genetic relationship between breeds across countries. After recent updates of the global Domestic Animal Diversity Information System (DAD-IS), the number of recognized domesticated animal breeds totals 7,600, consisting of 'transboundary breeds' (regional and international) and 'local/national breeds' (Scherf *et al.*, 2006).

The term 'breed' does not have a universally accepted biological or legal definition. In developed countries breeds are characterised by clear definitions, physical characteristics and strict definitions of purity of pedigree, typically regulated by a breed society which is backed by law. In developing countries a breed is commonly defined by local tradition, identifying physical characteristics, a geographical location or ethnic group by which it was developed. We use the term as follows: a population of animals that share certain defined physical characteristics and which are not routinely bred with other populations (Gibson & Pullin, 2005).

Rege & Gibson (2003) and Hoffmann & Scherf (2005) summarized the factors that threaten diversity of AnGR. These include, i) cross-breeding with and/or replacement by imported breeds in programmes designed to improve animal productivity, ii) neglect arising from shifts in social settings, production systems and/or market demand of certain animal products, iii) urbanisation and its impact on traditional animal agriculture, iv) drought, v) civil strife/conflicts and vi) famines.

The loss of breeds is only one indicator for the loss of genetic diversity in farm animal species, as Hammond & Leitch (1996) observe that the genetic variance between breeds accounts for approximately 30-50% of the total variance. This diversity is large within breeds and overlapping with others. Hence, indiscriminate cross-breeding can be considered to be a threat to the survival of a breed but may not always reduce genetic diversity within the species. Very little is known about the distribution of specific genes and the genetic uniqueness of breeds, although a range of rather unique adaptation traits have been documented for local/indigenous breeds.

2.2.2 The value of farm animal genetic diversity

The value of AnGR can be analysed at different levels (livestock keeper, community, national, global) and should take into account a wide range of functions of livestock (Box 2.1). For an overview of economics of AnGR, see Drucker *et al.* (2005) and Zambrano *et al.* (2005).

It is apparent from the typology of values that current economic decisions are largely based on only the direct use values, although the other categories of value may often be of equal or greater importance. For example, it has been estimated that approximately 80% of the value of livestock in low-input developing country systems can be attributed to non-market values, while only 20% is attributable to direct production outputs. By contrast, over 90% of the value of livestock in high-input developed country production systems is attributable to the latter (Gibson & Pullin, 2005). By focussing largely on direct use values, AnGR conservation is likely to be consistently undervalued.

Note also that not all types of conservation strategy (discussed below) are capable of safeguarding all of the above values. For example, *ex situ in vitro* conservation cannot generate direct use values, while *in situ* conservation may be poor at ensuring option values in the face of drought.

Box 2.1 Types of values of AnGR

The different types of values constitute components of "Total Economic Value" (TEV), which is equal to the sum of the following:

- *Direct Use Values (DUV)* refers to the benefits resulting from, *inter alia*, actual uses, such as for food, fertilizer and hides, as well as cultural/ritual uses.
- *Indirect Use Values (IUV)* are the benefits deriving from ecosystem functions, such as the maintenance of genetic stock and other important interactions between these breeds and the ecosystem.
- *Option and Quasi-Option Values (OV)* are derived from the value given to safeguarding an asset for the option of using it at a future date. It is a kind of insurance value against threats to livelihoods, the occurrence of, for example, unforeseen changes in the ecosystem, in future market demands, in supplies of external inputs, by emerging disease challenges or by a combination of these factors. Quasi-option values relate to the extra value attached to future information made available through the preservation of a resource.
- *Bequest Values (BV)* measure the benefit accruing to any individual from the knowledge that others might benefit from a resource in the future.
- *Existence Values (XV)* are derived simply from the satisfaction of knowing that a particular asset exists.

Source: Adapted from: Anderson, 2003; Pearce & Moran, 1994; Arrow & Fisher, 1974; Roosen et al., 2005.

2.2.3 Conservation strategies and programmes

Awareness among nations and stakeholders about the (potential) loss of animal genetic diversity has already resulted in many initiatives aiming at conservation of breeds or conservation of within-breed diversity.

In general, there is consensus that conservation should ideally be *in situ* or *on-farm*, supported by *ex situ* conservation (CBD, 1992). According to Gibson & Pullin (2005), such conservation is sustainable only to the extent that the AnGR being conserved also provide an appropriate livelihood strategy to the livestock keepers in the present and the future. Given the constant evolution of agricultural production and marketing, *in situ* or *on-farm* management of genetic resources should include the genetic improvement of the AnGR so as to ensure its competitiveness as a future livelihood option. Given the uncertainties about *in situ* and *on-farm* conservation, it is prudent to give serious consideration to other options of conservation (*ex situ in vivo* or *in vitro)* as complementary approaches.

Ex situ conservation programmes can either have a short term perspective (e.g. to support breeding and *in situ* programmes) or a long term perspective (e.g. insurance). Sometimes emergency actions are needed to safeguard a breed or breeding population. One serious drawback of *ex situ* conservation (*in vitro*) for AnGR is that germplasm cryo-preservation requires sufficient resources in the form of trained manpower, equipment and supplies. Furthermore, *ex situ* conservation may not be viewed as a priority by either governments or farmers in developing countries. Ideally, the activity domains of characterisation, conservation and utilisation of AnGR form an integrated

continuum and it is important to develop an integrated strategy or a combination of strategies. Complementary use of different approaches has great potential to support conservation of farm animal genetic diversity.

Box 2.2 Complementary approaches to conservation

- *In situ or on-farm conservation* requires continued use of a breed by livestock keepers in the agro-ecosystem in which the breed evolved or is now normally found. This includes both actual farms and pastoral production systems. Continued management of breeding animals maximizes opportunities for utilisation and the study of breeds, as well as supporting the maintenance of community identity and stability.
- *Ex situ – In vitro conservation* involves the maintenance of endangered AnGR outside their traditional environment. It includes cryo-conservation of gametes, embryos or somatic cells that have the potential to reconstitute live animals.
- *Ex situ – In vivo conservation* involves the maintenance of living animals outside of the area where they evolved or are now normally found, e.g. research stations or zoos. The difference between *in situ* conservation and *ex situ in vivo conservation* is not always clear in practical situations.

Source: Adapted from Gibson et al., 2006

A substantial increase in national AnGR conservation activities occurred in the 1990s (Blackburn, 2004). However, Gibson & Pullin (2005) observe that there was no international coordination when several industrialised countries initiated substantial multi-species collections of cryo-preserved germplasm.

Analysis of country reports on AnGR in the context of the FAO State of the World's Animal Genetic Resources shows that about 50% of all country reports provide information on *in vivo* conservation, illustrating that there is a wide variety of conservation initiatives involving different stakeholders from hobbyists to breeding industry. Less than 40% provide information on *in vitro* conservation and the number of 'well established' gene banks, specifically developed for conservation purposes, is small. It should be emphasized that in several AnGR-rich (sub)regions, no substantial conservation activities have been undertaken until today.

2.3 Current policy and regulatory framework for AnGR

International, regional, and national law as well as customary law at national and community levels are all relevant for AnGR. It is important to realise that most rules that affect AnGR have not been developed for animal breeding, but for more generic issues (for example the conservation of biological diversity in general or industrial inventions) and they may have negative implications for AnGR.

2.3.1 Ownership issues in national and customary law

The main principle is that the owner of the individual animal has the *right* to use the genetic resources in further breeding. Delimitation of the *right* needs to be based either on the consent by the owner (e.g. by contract) or by specific legislation altering this general point of departure, which is in many cases based on customary law.

Traditional animal breeding occurs, especially by pastoralists, within the traditional laws governing the community. Ownership of animals, rotation of males among herds and neighbouring communities are often regulated in detail by the communities themselves. Where modern animal breeding occurs within the territory of a country the point of departure for breeders, farmers and livestock keepers in this sector is the national legislation. Private or communal ownership of animals and AnGR is the rule and public domain the exception.

In the absence or in the context of other regulations, access to AnGR often takes place under a contract or informal agreement between the provider and the user of the genetic resources (the breeding animal or breeding material). It is the contract (or informal agreement) which determines the scope of what is transferred and which *rights* still belong to the seller. As a contract is individually agreed, the seller may keep certain *rights* to the offspring of the animals. If such a clause is not included in the terms of sale, the assumption is that the buyer of the animal also receives the *right* to take advantage of the genetic resources, as it is an integral part of the individual animal (see also intellectual property rights below).

2.3.2 National laws that affect the way of life and rights of livestock keepers

Several types of law affect the way of life and *rights* of livestock keepers, and influence directly or indirectly the diversity of animal breeds they keep. Livestock keepers are sometimes restricted by rules on land tenure, grazing rights, production and waste quotas, through environmental protection laws and, increasingly, biosecurity considerations. Private ownership of (agricultural) land, the establishment of nature reserves and limitations on crossing national borders in remote areas can also greatly affect the capability of livestock keepers to maintain their farming system or way of life and the AnGR that are associated with them. Parallel to this, very few countries recognise specific traditional resource rights and rights on indigenous/traditional knowledge that could balance the above limitations to some extent. In the World Intellectual Property Organisation (WIPO) the Intergovernmental Committee on genetic resources, traditional knowledge and folklore (IGC) is working on legal aspects of intellectual property rights protection of genetic resources and traditional knowledge in general, but has not until now addressed the particular challenges related to AnGR or related knowledge.

2.3.3 International trade of AnGR

Most countries and regions have developed veterinary rules that specifically target the animal production sector (FAO, 2005). Veterinary regulations are guided by the standards set by the Office International des Epizooties (OIE) based in Paris. Member States of the Sanitary and Phytosanitary measures (SPS) of the World Trade Organisation (WTO) have to establish national SPS measures consistent with internationally 'harmonised' standards, guidelines and recommendations. The SPS Agreement aims at restricting the use of unjustified sanitary and phytosanitary measures for the purpose of promoting trade. Though not designed to regulate the exchange of AnGR *per se*, these rules, however, greatly impact the international exchange of genetic resources. Especially countries with limited infrastructure to guarantee freedom from animal diseases face significant problems exporting their animals or animal products.

2.3.4 International developments in intellectual property rights

To date, Intellectual Property Rights (IPR) have not been a major issue in the livestock sector. Four types of intellectual property rights are relevant in the field of AnGR: *geographical indications, trademarks, trade secrets and patents* (FAO, 2005: 28). A *trademark* is a 'sign, or any combination of signs, capable of distinguishing the goods or services that may add value to a product by distinguishing the product from other similar products in the market. Genetic material *per se* cannot be protected or covered by a *trademark*, but a breed or the product developed from that breed may be connected to a *trademark*. Similarly, a *geographical indication* cannot protect AnGR *per se*, but it may add commercial value to animals or animal products of a particular breed, produced in a particular region (e.g. Bresse chicken, see Box 2.3). *Trade secrets* refer to the 'Protection of Undisclosed Information'. This is relevant in commercial animal breeding, where the breeders want to keep their nucleus stock and associated information secret for their competitors.

Box 2.3 Example of Protected Designation of Origin

The French production of chicken meat is differentiated as standard broiler (SB), label chicken (LB), certified chicken (CF), organic chicken and Protected Designation of Origin (PDO). At the moment the latter category is reserved for the Bresse breed only (protected in 1957). These chickens, 1.4 million raised per year, are produced in the Bresse geographical area only, as defined by law. The production is characterized by natural conditions and a production system unique for that area. The breed has unique phenotypic characteristics. After an initial starting period of 5 weeks a fixed set of specific growing conditions (diet, housing) must be applied for at least 9 weeks. Specific regulations also apply to slaughtering conditions and processing of carcasses. The price for the chicken is 50-60% higher than for standard or label chicken. Starting as a threatened breed kept by fancy breeders, the Bresse breed became locally a very popular breed yielding high profits.

Verrier et al., 2005

Patents may be granted on products or processes (e.g. a breeding method) that are novel, involve an inventive step and that have an industrial application. The concept of *prior art* defines what the *patent system* regards as previously known and thereby not open to be included under patent protection. Two developments have caused patent law to potentially become a major issue in the use and possibly also the conservation of AnGR. The first is breakthrough court decisions in the USA and later in other OECD countries that allow the patenting of living organisms and their genetic components, which have been recently applied to the processes and products of animal breeding. The second is the expansion of IPR systems geographically, initially through the Agreement on Trade Related Aspects of intellectual Property Rights of the World Trade Organisation (TRIPS) which provides for minimum standards of IPRs, followed by a range of free trade agreements (FTAs) between (groups of) countries that commonly include requirements for the developing country partners that go beyond the minimum requirements of TRIPS. Thirdly, there are a number of examples of regional cooperation and harmonisation of patent law by regional search and granting authorities for patents. Finally there are international processes that intend to harmonise national IPRs in more detail through the Substantive Patent Law Treaty, negotiated in the WIPO.

Overall these law-making bodies develop patent law in general without discrimination between sectors. This implies an overall challenge for AnGR and patents, as patent law is not particularly adapted to the particular needs of securing innovation in the livestock sector. Furthermore, the degree to which such protection should extend to plants and animals is contentious among countries and there are potential areas of overlap with the objectives of the CBD.

2.3.5 Convention on Biological Diversity (CBD)

Of all the international environmental agreements, the CBD is the only one specifically designed to promote conservation and sustainable use of biological diversity, and the fair and equitable sharing of benefits arising out of their use. The USA is the only country with a significant animal breeding/livestock sector that is not a contracting party to this Convention.

Under the CBD, genetic resources are recognised as being under the *sovereign rights* of countries. *Sovereign rights* signify that countries may regulate a number of aspects of genetic resources including property right issues and access to the resources at the national level. The CBD prescribes that access should be subject to *prior informed consent* from the providing country and that the terms of access should be on *mutually agreed terms*. Parties should also stimulate conservation, sustainable use and fair and equitable sharing of benefits arising from the utilisation of genetic resources. Nevertheless, there is a lack of clear definition about which types of utilisation of genetic resources should be included/covered and how the benefits from these activities should be shared (Tvedt & Young, 2006). In 2002, the Conference of the Parties (COP) to the CBD adopted the Bonn Guidelines (CBD, 2002), a voluntary set of guidelines to assist governments and regional bodies to develop policies, legislation and administrative practices to ensure access and benefit sharing (ABS).

A growing number of countries are designing and implementing national legislation that is in accordance with the CBD. This legislation commonly makes no distinction between wild biodiversity, PGR, AnGR and micro-organisms, and between industrial and agricultural uses of the genetic resources. Few countries would claim that they have effective access legislation in place which is expediently implemented. It is in this context that COP Decision VII/19d led to the establishment of the *Ad hoc* Open-ended Working Group on ABS. The mandate of the Working Group is to elaborate and negotiate an international regime on ABS within the framework of the CBD.

In its decision V/5, the CBD recognized 'the special nature of agricultural biodiversity, its distinctive features, and problems needing distinctive solutions'. However, this recognition has not yet been translated into specific rules or actions under the CBD and, compared to wild biodiversity and PGR, the particular challenges for AnGR have not been extensively dealt with.

2.3.6 International initiatives on AnGR under the FAO

It should be noted that the CBD does not specifically target genetic resources for food and agriculture, and made no special provisions for them that took into account their unique nature (Esquinas, 2005). The TRIPS Agreement makes special provisions and exemptions in article 27 on the protection of plants and animals.

Genetic resources for agriculture are categorically different from wild genetic resources, for a number of reasons (Stannard *et al,* 2004):

- They are essentially *man-made*, that is, they have been consciously developed and selected by farmers since the origins of agriculture, over 10,000 years ago. Much of the genetic diversity of farm animals can only survive through continued human management and care. Scientific animal breeders have built upon this rich inheritance for little more than a century.
- They are not randomly distributed throughout the world. Although not as well defined as for crop species, major species originate from different continents.
- Because of the diffusion of agriculture and livestock keeping throughout the world, and because of the association of major farm animal species with the spread of civilizations, many farm animal genes, genotypes and populations have spread, and continued their development in livestock production systems all over the planet. Most genetic resources have a composite background. Many persons, communities and countries having contributed to this. Continued agricultural progress implies the need for continued access to the global stock of genetic resources for food and agriculture.

Currently, the FAO Global Strategy and the FAO State of the World's AnGR (SoW-AnGR) are the most important policy and technical development processes related to AnGR. Under the SoW-AnGR process national reports and national policy priorities for AnGR were developed. FAO's Domestic Animal Diversity Information System (DAD-IS) is the key communication and information tool for implementing the Global Strategy, providing countries with a clearing-house for both information and data.

The Commission on Genetic Resources for Food and Agriculture (CGRFA) is the permanent forum of FAO where governments discuss and negotiate matters relevant to genetic resources for food and agriculture. The main objectives of the CGRFA are to ensure the conservation and sustainable utilization of genetic resources for food and agriculture, as well the fair and equitable sharing of benefits derived from their use, for present and future generations. The Commission aims to reach international consensus on areas of global interest, through negotiations. Although current debates regarding agricultural genetic resources have largely had a crop/plant focus, these discussions and the international instruments or agreements that are emerging have tended to frame the debate for AnGR as well. There is an international treaty that regulates plant genetic resources for food and agriculture (ITPGRFA). It may be useful to analyse the ITPGRFA and see whether the animal sector can draw lessons from the ITPGRFA, while keeping in mind the differences between PGR and AnGR.

Box 2.4 The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)

- Recognition of international interdependence on agricultural resources; understanding of the unique nature and features of PGR and the distinctive problems and challenges of the sector;
- Integration of the objectives of conservation and sustainable use of PGR to the overall development objectives of food security and sustainable agriculture in harmony with the CBD (Article 1);
- Options for the conservation of PGRFA and their sustainable use, national responsibilities and technical assistance (part II);
- Introducing the concept of *farmers' rights* (Part III), based on a recognition of the role of farmers in the conservation and development of PGR;
- Introduction of a multilateral system of access and benefit sharing (Part IV), a system which avoids complex procedures and high transaction costs;
- Linking existing initiatives to the Treaty as supporting components, such as the Global Plan of Action, the system of *ex situ* collections held by international institutes, the international PGR networks and Information System (Part V);
- Financial and institutional provisions (part VI and VII).

2.4 Emerging issues and challenges

The conditions for animal breeding and conservation of AnGR diversity are changing for a number of reasons. Development of a policy or regulatory framework for AnGR should therefore anticipate future developments. For this reason, four emerging challenges or (potential) future scenarios have been discussed in the context of this study. Scenarios are presented in Annex I.

Globalization

Between 1993 and 2020, population growth, urbanisation and increased incomes are expected to more than double meat and milk consumption in developing countries between 1993 and 2020 ('Livestock Revolution'). This 'revolution' will show a major increase in the share of developing countries in total livestock production and consumption, putting greater stress on grazing resources and triggering more land-intensive production closer to cities. It is also associated with rapid technological changes and livestock production shifting from a multipurpose activity with mostly non-tradable outputs, to one focused on food and feed production in the context of globally integrated markets.
Globalization trends may be expected to result in a wider use of a limited number of breeds, standardization of consumer products and a move towards large scale production. Retailers and supermarkets will be leading actors in the globalization process. Vertical integration is expected to become the primary business model on a global scale. Furthermore, globalisation may adversely affect smallholder competitiveness and threaten the sustainable use of local breeds.
(references include: Delgado *et al.*, 1999; FAO, 1997; Delgado *et al.*, 2001; Dirven, 2001; Hobbs & Kerr, 1998; Tisdell, 2003; Sere *et al.*, 1996; Popkin & Duy, 2003)

Biotechnology

A series of developments in biotechnology are expected to speed up on-going developments in the livestock sector with major (potential) impact on exchange, use and conservation of AnGR:

- Continued progress in reproductive and cryopreservation technologies for all livestock species;
- Development of a new generation of quantitative genetic tools, linking genomics and quantitative genetics;
- Improved efficiency and safety of transgenic and cloning technologies;
- Better control of animal diseases and increased availability of (marker) vaccines.

Under a biotechnology development scenario, superior genotypes can be distributed and used across the globe even more easily than today, which may negatively affect conservation of global farm animal genetic diversity. Furthermore, rapid developments in biotechnology are providing new opportunities to explore and possibly exploit

genetic resources in ways that were not possible before. Exchange patterns may change and AnGR from developing countries may increasingly contribute to commercial breeding. Molecular biology is already having an increasing impact on the animal breeding sector, as well as playing a role in the introduction of patenting of processes and products used in animal breeding.
(references include: AEBC, 2002; EC, 2003; Gibson & Pullin, 2005; Hiemstra *et al.*, 2005; Meuwissen, 2005; Rothschild *et al.*, 2003; Hoffman & Scherf, 2005; Andersson & Georges, 2004)

Climate change

There are five main climate change related drivers. These are temperature, precipitation, sea level rise, the incidence of extreme weather events, and atmospheric carbon dioxide and other greenhouse gas content. Climate change can be expected to affect livestock productivity directly by influencing the balance between heat dissipation and heat production, and indirectly through its effect on the availability of feed, fodder and water, as well as changes in disease challenge. Among other possible effects, climate change may significantly move livestock production away from current marginal rangelands, and may thus contribute to the shift in favour of intensive production systems.
(references include: IPCC, 2001; CCAA, 2002; MAFF, 2000; Anderson, 2004; Robertshaw & Finch, 1976; Hulme, 1996; IMAGE 2.0—Alcamo, 1994; FAO, 2004; AGO, 2004; Kenny, 2001)

Diseases and disasters

International trade and human travel has already led to the rapid spread and ultimately the globalization of diseases, resulting in a deterioration of the global animal health situation during 1980-2000. This situation is expected to worsen. Diseases, natural disasters, civil war and other threats can have a serious impact on local AnGR and thus on conservation of global farm animal genetic diversity.
(references include: Kouba, 2003; FAO, 2004; McDermott *et al*, 2001; Otte *et al*, 2004, FAO/OIE, 2005; Kadomura, 1994; Scoones *et al*, 1996; Charron, 2002)

2.5 Stakeholders in the livestock sector

The stakeholders in the AnGR debate include all groups involved in the livestock production chains. Stakeholders include livestock keepers and their communities, specialised breeders, consumers, scientists, policy makers and groups that aim to influence policies relevant to AnGR with backgrounds in environment, development, commerce and culture.

Having obtained views through stakeholder consultations and an e-conference, in this section we summarise the general *views* or *positions* of different stakeholder groups, while noting that the summary below may not represent the views of all stakeholder groups nor every individual belonging to a specific stakeholder group.

One general observation is that a majority of people in the livestock sector are not aware of the current policy debate that may significantly influence the exchange, conservation and use of AnGR. So far, government representatives, non-governmental or civil society organizations and a number of scientists have dominated the debate. There is a gap between the perceptions of policy makers and those who actually work with AnGR in practice, such as farmers, breeding organizations and pastoralists.

Livestock keepers have very different characteristics across the globe. This group includes pastoralists, smallholder farmers, local and indigenous communities, and hobby farmers, They have different objectives, appreciate very different values of AnGR and play important but different roles in AnGR conservation and use. The different interests of livestock keepers or their communities relate to the different values they assign to AnGR, for example *direct use* values versus *indirect use* and *non-use* values.

Gradual modernisation of livestock production in many countries (North and South) is driving smallholders out of business or is creating pressures to increase output, often through the use of different breeds or cross-bred animals. Livestock keepers' views on conservation of AnGR primarily have a socio-economic perspective. They are mainly interested in generating income, in continuing their livestock keeping activities and in sustaining their livelihoods. In many industrialized countries, hobby farming and small scale farmers have become increasingly important for conservation of AnGR.

End users of breeding material, such as commercial farmers in industrialized countries largely tend to consider their animals or AnGR as a source from which to generate income. Especially in the poultry and pig sector in industrialized countries, farmers receive breeding material from specialized breeding industries. Large scale commercial farmers or animal production enterprises sometimes are not only recipients of genetic material, they are often part of a vertically integrated food chain.

Specialised breeders and multipliers have a very significant impact on maintenance of breed diversity and within breed genetic diversity. Their main activity is to produce nucleus stock, superior males and/or parent lines for hybrids, and to sell breeding material for production purposes. Breeders take strategic decisions about the maintenance of breeding populations and breeding decisions affect genetic diversity within breeding populations. In industrialized livestock sectors specialized multipliers are commonly closely related with the breeders and their influence on breeding and maintenance of genetic diversity is limited.

Even though most private breeders claim that they have sufficient diversity within their breeding stocks, there is a long-term interest in conservation and access without unnecessary restrictions. Benefit sharing arrangements in this sector do not go beyond purchasing contracts on individual animals or semen/embryos.

Business organisation in the livestock sector has changed rapidly and resulted in concentration and increasing vertical and horizontal integration. A small number of global players produce an increasing percentage of global livestock products, starting from a small number of breeding populations.

Breeders in (the public sector) in developing countries are interested in having access to exotic high-productive breeding material. Regarding their own indigenous breeds, awareness of potential benefit sharing is also growing in some countries.

Consumers are mainly interested in food safety, prices, and quality. Special requirements linked to the use of AnGR (e.g. specific taste or appearance, recognised origin, animal welfare, biodiversity, etc.) are generally not rated very highly among consumers, but there are important (niche) markets, related to specific characteristics of animal products.

Traders, processors and retailers may look for either standardised qualities or specialty products. Market opportunities for these different qualities are important for the animal genetic diversity that is used to supply these chains. These stakeholders have usually no special interest in AnGR.

Scientists develop knowledge, methodologies and products that can be used in animal breeding (quantitative and molecular genetics, biotechnology, etc). Some scientists play a prominent role in the international debate on conservation, sustainable use, intellectual property rights or access and benefit sharing. Others are hardly aware of the policy issues.

National governments are responsible for policy development in the livestock sector and have to balance biodiversity and livestock sector needs with other priority areas in the country. Most countries are signatory to the CBD and national governments are responsible for implementation of the CBD or – more specifically – of policies that relate to the conservation, sustainable use and benefit sharing in relation to AnGR. Most have limited information about AnGR and the capacity to balance AnGR policies with other policy areas (e.g. CBD/environment) is often weak.

International organizations have a mandate from national governments to coordinate or to take action in a particular area. Several international organizations are active in the area of AnGR, with specific activities dependent on their mandate. FAO has a specific mandate for genetic resources in food and agriculture.

Non governmental or civil society organizations (NGOs) may have a national or an international focus. They usually represent particular (stakeholder) groups in society. Relevant NGOs in the AnGR policy debate are, for example, NGO movements arguing in favor of livestock keepers rights or NGOs representing the breeding industry.

2.6 Differences between PGR and AnGR

Although current debates regarding agricultural genetic resources have largely had a crop/plant focus, these discussions, and the international instruments or agreements that are emerging have tend to frame the debate for AnGR as well. An understanding of the biological differences and similarities between PGR and AnGR is useful. The question is: can the AnGR sector learn from the developments in the crop/plant field and what are the biological, technical and institutional similarities and differences which may affect the need for (specific) policy or regulatory options?

At first sight plant breeding does not differ much from animal breeding. The genetics of plants and animals are based on the same principles. Plant and animal breeders both need genetic diversity in order to advance and the genetics determine adaptation to particular agro-ecological circumstances, as well as product qualities to a large extent. However, plant varieties can be protected by plant breeder's rights (UPOV), which is not the case for animal breeds/strains. Plant breeders aim at the development of new uniform varieties that are defined by certain phenotypic traits that can identify them from other varieties. Farm animal breeding is largely based on the selection of individuals within populations rather than selection between populations or strains. Farm animal breeders are interested in individual animals (within populations/breeds), while the whole population of a plant variety (clones) is the main focus of plant breeders.

Biological differences also clearly require different approaches to conservation, breeding and use. Key differences include, *inter alia*, the following:

- Although an individual animal might carry unique gene combinations or new mutations, in contrast to the situation with many plant species, exploiting the unique genetic characteristics of an individual animal is extremely difficult. This is due to long generation intervals, low reproduction rates and the high cost of evaluating the genetic characteristics of a single animal, although there are substantial differences between species (Notter, 2004).
- In plants, intensification of crop production has generally been accompanied with the emergence of a strongly institutionalized and centralized seed production sector dominated by publicly funded national and international centres and private firms. In the animal sector public breeding programmes are few and international gene banks non-existent.
- Institutional capacity for AnGR conservation is limited. Ownership of AnGR resides almost exclusively in the private sector and exchange is dominated by the exchange of material between private parties or within companies. There are few public national gene banks for AnGR, and there is no material held under the auspices of FAO as is the case for PGR. Public gene banks are established mainly for conservation of back-up collections and are not involved in large-scale exchange programmes. In plants, implementation of the ITPGRFA relied heavily on the institutions of the seed sector that were already heavily involved in the international movements of germplasm.
- The animal 'seed' stock sector is far less centralized and institutionalized than the plant seed sector, although there has been a substantial movement towards centralization in the poultry, pig and dairy cattle private sector. The breeding industry is highly concentrated and breeding programmes in developing countries are often under-developed.
- Costs to collect and subsequently reconstitute AnGR germplasm are many times greater per preserved animal embryo or semen sample, than costs to collect and utilise seeds. This is one important reason why AnGR conservation has much more heavily emphasized *in situ* conservation. However, preservation of AnGR in liquid

nitrogen may be cheaper than in PGR seed banks due to the need in the latter case to periodically rejuvenate the samples. The advantage of AnGR is that cryopreserved gametes remain viable in perpetuity.

- The centres of origin or diversity for AnGR are not as clearly defined as for plants. South-North exchange is small compared to plants, mainly because introgression of disease resistance genes in new varieties is much more advanced than in farm animals. North-South and North-North exchange are dominant, and South-South exchange may become more important.

Table 2.1 summarises these and a number of other important differences between PGR and AnGR.

Table 2.1 Biological, technical and institutional differences between plant and farm animal genetic resources.

Factor	Plant genetic resources	Farm animal genetic resources
Mendelian segregation	Yes	Yes
Self pollination	Yes	No
Asexual reproduction / clonal propagation	Yes	No, only artificial
Cross-breeding	Yes, between inbred lines	Yes, between selected lines or different breeds
Inbreeding	Yes	Not desirable
Genetic modifications	Possible and efficient	Possible but hardly accepted
Generation interval	Low < 1 year	High 1 up to 8 years
Number of offspring	High	Small number up to high number
Economic value of an individual or germplasm	Low	Moderate to high
Phenotyping costs for production traits (individual/family)	Very low to low	High to very high
Phenotyping costs for adaptation or resistance traits (individual/family)	Very low to moderate	Very high
Cost of breed/variety testing	Inexpensive	Expensive
Status of in situ genetic conservation	Promoted	Promoted but not well established
Status of in vivo ex situ conservation	Minor role	Major component of ex situ conservation
Status of gene banks	Extensive collections (important role of CGIAR*)	Semen collections in developed countries and in a small number of developing countries (no involvement of CGIAR*)
Technical feasibility of ex situ (in vitro) conservation	For majority of species	For semen of majority of species and embryos of several species
Conditions for storage	In cool conditions	Liquid nitrogen only
Ease and costs of extracting/testing accessions from gene banks	Generally easy and relatively low cost	Difficult, costly and/or time consuming (often several generations backcrossing)
Ongoing collection of indigenous/wild germplasm	Still significant	Very little activity
Costs of collection	Low	High to very high
State of global databases	Relatively advanced databases	Country controlled data in FAO database

* *Consultative Group on International Agricultural Research*
Source: Adapted from Gibson & Pullin (2005)

3. Policy and regulatory issues and challenges

3.1 Introduction

In chapter 3 we describe and discuss the major issues and challenges for AnGR and the livestock sector, as well as presenting options for further development of policies or regulatory approaches related to AnGR. Options were derived from literature surveys and stakeholder consultations, supported by four future scenarios. Scenarios and the results of stakeholder consultations are presented in Annexes I and II.

Chapter 3 is structured as follows. In Section 3.1 we discuss the current international regime, whether there is a need for an international policy/regulatory framework for AnGR, as well as the call for a separate handling of AnGR, given the special nature of genetic resources for food and agriculture and following the negotiations for the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGR). In Sections 3.2 – 3.4 we consider policy and regulatory options related to the *conservation and sustainable use, exchange* and *rights systems that apply to AnGR*. We note, however, that there is significant overlap between these issues.

Current international regime affecting AnGR

As previously discussed, international agreements/instruments with a general scope (CBD, various agreements under WIPO and WTO) and international institutional and technical processes (e.g. the FAO State of the World's AnGR and the FAO Global Strategy for AnGR) apply to AnGR. Nevertheless, it is important to appreciate that the major part of the existing policy and regulatory framework applying to AnGR is at the national level and occasionally at the regional level (FAO, 2005). The regional framework is especially relevant for harmonisation of zoo-sanitary regulations.

The need for an international policy/regulatory framework for AnGR

In general, exchange of AnGR follows commercial practices – as well as, in some cases, strict communal rules – and is limited mainly by zoo-sanitary regulations. Only a few countries implement AnGR exchange restrictions in national biodiversity laws based on the CBD. Implementation of the CBD varies between very detailed legislation (e.g. Andean Pact countries) or very open legislation (e.g. Nordic countries). The main question is whether the on-going implementation process of the CBD is likely to be appropriate.

The ITPGR illustrates that there may not necessarily be any conflict between the development of specific rules for AnGR under the auspices of FAO on the one hand and the provisions of the CBD on the other hand. A majority of stakeholders in the crop sector consider the ITPGR as a success. In this respect, the ITPGR could be used as a positive model for policy making on AnGR. On the other hand, there are also reservations, and – taking into account the large differences between PGR and AnGR – simply translating the ITPGR into a binding instrument for AnGR is unlikely to be effective.

The debate on the need for an international legal framework and other options to deal with sovereignty, benefit sharing, access, exchange and conservation of AnGR has slowly intensified. A number of international NGOs, with the increasing support of several developing countries support the 'Karen Commitment' (LPP, 2003) and have called for an international agreement on AnGR at recent international fora, including the 9th (2002) and 10th (2004) meetings of FAO's Commission on Genetic Resources for Food and Agriculture (CGRFA). Their main focus is to safeguard the *rights* of livestock keepers. Other CGRFA Members considered the suggestion of a need for a legal instrument to be premature and stated that any discussion should await the completion of the first *Report on the State of the World's Animal Genetic Resources*, due to be discussed by CGRFA-11.

Before considering whether a 'FAO Animal Treaty' is needed or alternative regulatory options might be preferable, it is necessary to first of all clarify what it is that we would like to regulate or influence positively. Sections 3.2, 3.3

and 3.4 present the main issues and challenges, as well as discussing potential policy and regulatory options to improve the management of AnGR.

Note also that in addition to questions about the possible 'content' of a future regulatory framework for AnGR, questions also arise about the ideal *form* of international agreements on AnGR. Different *forms* have distinct advantages and disadvantages in terms of their effectiveness and efficiency in reaching a given target. These include:

- *non-binding* alternatives (e.g. a policy, a declaration, a guideline, a code of conduct, a standard protocol or a comprehensive non-binding undertaking);
- *legally binding* alternatives (e.g. a treaty/convention, law, standard legislation or regulations)

Furthermore, both *non-binding* and *binding* alternatives can be developed at various *levels:*

- *national* level, including where standard legislation or policies are developed to be transferred to the national context;
- *bilateral* level, i.e. between pairs of countries (this includes a standard framework as to how two countries could structure their relationship);
- *regional* level, i.e. covering a geographically delimited group of countries.
- *global/multilateral* level, i.e. as an international common regulation for all countries;

Nevertheless, since *form* will largely be dependent on the main issues and challenges that decision-makers choose to focus on and the outcome of subsequent discussions, we restrict ourselves in the remainder of the report to discussing these substantive issues. Consequently, we do not return to the issue of in which *form* these topics should be dealt with.

3.2 Conservation and sustainable use

Main issues and challenges

Although precise data and detailed knowledge is limited and a better understanding of the global status of AnGR is needed, it is generally accepted that genetic diversity in farm animals is under threat and that action is needed to halt the loss of farm animal genetic diversity. Important threats are related to animal diseases, exchange practices, indiscriminate cross-breeding, intensification of production systems or changing consumer demands in general.

The loss of AnGR is viewed with concern as AnGR play an important socio-economic role in terms of supporting current and future livelihoods as well as profits. AnGR diversity should also be maintained because of other values or roles (e.g. cultural value) and – generally speaking - it is crucial to maintain sufficient genetic variation in farm animals in order to be able to respond to (unpredicted) future changes or circumstances.

Where AnGR have a direct use value (i.e. directly contributing to livelihoods/profits and food security), breeders, breeding companies or communities are likely to find it in their own best interests to voluntarily undertake the conservation and management of these genetic resources. By contrast, AnGR which have lower direct use values but may have important indirect use and non-use values (including option value) will require the public sector to play an important role in their conservation and management. This is because the costs of conservation are likely to fall locally (limited existence of offsetting livelihood benefits), whereas the future benefits may be national, regional or global (Drucker *et al.*, 2001).

Many policy makers have only limited awareness of the importance of the conservation and sustainable use of AnGR, and awareness of existing and potential policies affecting AnGR is generally low among major stakeholders in the livestock sector. Furthermore impact on AnGR can occur as a result of, *inter alia* i) macroeconomic interventions (e.g. exchange and interest rates), ii) regulatory and pricing policy (e.g. taxation, price controls, market and trade regulations), iii) investment policy (e.g. infrastructure development, donor funding priorities) and iv) institutional policy

(e.g. land tenure). Animal disease protocols also have a high impact on international exchange of farm animals and genetic material.

Genetic erosion may be minimised through complementary *in situ* or *ex situ* conservation approaches organised at national, regional and/or global levels. In the field of conservation, there is a need for closer international collaboration, prioritising the (within and between breed) diversity that needs to be conserved and based on a thorough analysis of current farm animal genetic diversity that is under threat. Improved coordination with regard to priority setting can form the basis for more efficient conservation initiatives.

Coordinated conservation approaches are likely to need to take into account different views on 'the unit of conservation'. Some stakeholders are primarily interested in breed conservation, while others focus on the overall maintenance of diversity in genes or alleles. Moreover, the relation between AnGR and traditional knowledge or practices needs to be acknowledged and taken into account. It will also require increasing our knowledge in terms of the characterisation and valuation of existing breeds, as well as optimum conservation strategies under different situations, i.e. the balance between *in situ* and *ex situ* strategies.

Ex situ conservation requires appropriate infrastructure, organisation, technical capacity, agreed priorities, sustained funding and (new) legal arrangements. Legal arrangements could include clarification of ownership, access rules and if and how benefits should be shared, especially where regional or international cooperation is pursued.

In terms of sustainable use of AnGR, there is a lack of human resources and institutional capacities in animal breeding in many countries. Lack of effective breeding programmes for local breeds may be one of the reasons that such breeds lose their competitive advantage, especially in situations where production systems or external conditions are subject to change. Individual countries may lack the technical and institutional capacity or funding to set up *ex situ* or *in situ* programmes.

Policy and regulatory options

National and regional approaches

Conservation and sustainable use of AnGR is primarily a national responsibility, as specified by the CBD. National policies could include measures to promote *in situ* conservation and sustainable use of local AnGR, such as *subsidies*, *breed improvement programmes*, *technical assistance*, *marketing support or re-stocking of local breeds* (after disasters). Moreover, they could also include *policies on cross-breeding* with exotics, and the stimulation and introduction of *breed associations* and herd books, or other forms of registration of animals and their pedigrees. Breed improvement activities contribute to the maintenance of local breeds and range from national breeding programmes (run by institutions) to community-based, participatory methods. Where the conservation of local breeds could be supported by mechanisms to add value to such breeds and their products, the use of existing IPRs, such as *geographic indications* and *trademarks*, could be stimulated.

It is important to realise that stimulating AnGR exchange, use and conservation is linked to a range of important policies in other areas, notably livestock development (including sanitary aspects), rural development, agricultural production and poverty reduction. Although this increases complexity, it also provides opportunities for conservation. For example, increased consumption of animal products, especially in the South, may increase the potential profitability of livestock production there, and may also create or enhance opportunities for *in situ* conservation. In the particular case of breeds that are found across two or more national boundaries, conservation measures could benefit from cooperation between countries.

The implementation of national policies for AnGR conservation is likely to require *funding mechanisms*, *technical guidance* and/or *legal frameworks* (laws, regulations). *Ex situ* conservation in particular requires long-term financial support. This also applies to *in situ* conservation when market or direct use value is low. On the one hand, *regional and global cooperation* may be needed to set conservation priorities, to share tasks, and to use existing knowledge

and technical capacity efficiently. On the other hand, measures at a regional or global level may be more complex than at a purely national level, possibly resulting in higher (transaction) costs.

In many countries animal breeding laws have either only recently been developed or are currently in the process of being upgraded (FAO, 2005). Regional cooperation and possibly even global *harmonisation* of breeding laws may reduce the risks of these institutions developing into trade barriers.

International level approaches

Conservation and sustainable use of AnGR happens both at a local and national level, but is also a global issue. Contracting Parties of the CBD have an obligation to conserve AnGR and promote their sustainable use. However, a large number of countries are unlikely to be able to do that, either because they are currently concentrating on other policy priorities or types of biological diversity, or because they have insufficient capacity or access to funds to do so. Therefore, opportunities to stimulate conservation are likely to need to be actively pursued.

The CBD identified the special nature of agricultural genetic resources but may lack the specific capacity and focus to sufficiently support countries to meet their obligations with regard to AnGR. Under such circumstances, FAO and the Commission on Genetic Resources for Food and Agriculture need to play a facilitating and guiding role. The Commission has already taken on a responsibility by developing the State of the World's AnGR process, which needs to have substantial follow-up action. Whether the establishment of, for example, internationally coordinated *ex situ* conservation initiatives would be part of such follow-up mechanism will depend on specific countries' needs and their assessment of the potential effectiveness of regional or global initiatives.

Similarly, generic arrangements are needed to help developing countries to build appropriate capacities to fulfil their tasks in terms of conservation and sustainable use. After more than a decade of the CBD being in force, implementation is still lagging behind. Given the countries' obligations under the CBD and the priority that should be put on conservation approaches, the need to build such capacities at the national level is imperative from an AnGR perspective.

Funding restrictions are identified as a major bottleneck. These may be solved by bilateral aid initiatives, for example, aiming at *capacity building* and improvement of infrastructure. However, given the long term commitment needed to effectively manage AnGR, a global solution may need to be discussed, possibly in line with the objectives and mechanisms of the Global Crop Diversity Trust. The Global Environmental Facility may also have a significant role to play in this context and has in fact already begun to finance a small number of AnGR-related projects under their agrobiodiversity programme.

An international commitment to conservation and sustainable use of AnGR can only be generated when awareness of the importance of this component of biodiversity is high. The incorporation of AnGR conservation and use issues into international processes in different forums ('*mainstreaming*') would have the benefit of increasing *awareness* among different stakeholders.

In summary

The box below contains a list of the major potential initiatives relevant to the conservation and sustainable use of AnGR.

Promote *in situ* conservation of local breeds
- Strengthen national policies
- Organise breed improvement programmes
- Establish breed associations
- Develop or strengthen breeding laws
- Add value to breeds and their products
- Use of trademarks and geographical indications in marketing
- Generate financial support (including but not limited to subsidies) to maintain local breeds
- Technical assistance for breeding and conservation
- Re-stocking after diseases or disasters
- Better linkage of AnGR to other policy areas
- Trans-boundary breed conservation collaboration
- Regional policy development and harmonization of laws

Raise awareness
- International policy forums
- Stakeholder involvement

Develop and implement *ex situ* conservation strategies
- National priorities
- Technical guidance
- Legal aspects
- Funding mechanism
- Regional or global facilitating mechanism

3.3 Exchange

Main issues and challenges

As previously discussed, there is a high level of interdependence between countries and regions with regard to the flow of AnGR. The types of flow associated with the international exchange of AnGR have already been described (see Section 2.1) and, generally speaking, no major limitations associated with current AnGR exchange practices have been reported other than veterinary rules and restrictions.

Benefit sharing issues and the impact of the introduction of exotic genotypes are also issues that have been highlighted previously. Private ownership of AnGR and associated (contractual) exchange arrangements are dominant in the livestock sector and AnGR is generally not considered to be in the public domain. This consequently provides a different point of departure for the development of policies and regulations for AnGR exchange compared to PGR. When developing policy and regulatory options one should, however, keep in mind that biotechnology or climate change may substantially change future exchange patterns, needs and practices.

Policy and regulatory approaches

National and regional approaches

The value for further breeding is commonly included in the sale of animals between private parties. This system works to the benefit of both parties, assuming that market positions and negotiation capacities are broadly equal. Where that is not the case, an *export regulation* could provide a useful supplementary tool for private law agreements. Such a regulation could set rules or a minimum standard for the content of a private law agreement to be considered legal or valid, thereby regulating the sale of AnGR/breeding material to another country/private entity.

Where uncontrolled export bypasses national sovereignty and could result in missed opportunities in benefit sharing or business opportunities, countries may also wish to consider arrangements for a more prominent role of national

institutions in securing *Prior Informed Consent* (PIC) and negotiating *Mutual Agreed Terms* (MAT). Such national institutions could either provide PIC and negotiate MAT themselves or facilitate such a process.

Countries could also develop *bilateral framework agreements* with countries they commonly trade AnGR with, aiming at facilitated exchange of AnGR and providing the (private) traders with enhanced transparency, based on a pre-negotiated set of rules. The Bonn Guidelines (CBD, 2002) may prove a useful tool when deciding which elements therein would be applicable to AnGR.

Countries may however also need to consider avoiding the importation of animals or germplasm that may negatively affect the survival of domestic breeds and local genetic diversity. One useful regulatory approach could be the implementation of a requirement to carry out (genetic) impact assessments where AnGR are being exchanged internationally. This would call for defined responsibilities of both buyer and seller, with the aim of avoiding any significant potential negative side effects of the exchange. Impact assessments could begin with the development of 'soft' guidelines or a code of good practice. Guidelines could underline the importance of the need to assess the likely impacts on, inter alia, production, markets, environment, introgression into breeds or breed replacement, community livelihoods, genetic resources use, animal health and food safety. A more legally binding approach might involve approval of the impact assessment by a relevant authority or institution and embedding such a tool in national policies or legislation (supported by the international community). However, it would be important to ensure that such approaches do not create substantial barriers to desirable exchange. One should also note that - to the authors' knowledge - no actual methodological development of model (genetic) impact assessment protocols has yet been undertaken.

Role of the international level

The CBD is currently negotiating an international regime on access and benefit sharing (ABS). CBD discussions so far have not really touched upon specific AnGR issues in detail. Based on the current and expected exchange patterns for AnGR and the biological differences between animals and plants it could be argued that the ABS debate on AnGR should be different from the pharmaceutical and crops sector.

High transaction costs (i.e. the costs of negotiating the terms of a contract and ensuring its subsequent enforcement) and a lack of prompt responses to applications for access have been major reasons for the negotiation of the facilitated access regime for a number of crops under the ITPGRFA. It seems unlikely that this model of the Multilateral System of the ITPGRFA could be directly applied to AnGR, as the situation for AnGR is different. Given the different characteristics of AnGR exchange, the transaction costs argument is considered to be less relevant for AnGR.

Negotiating bilateral agreements about the exchange of AnGR may remain cumbersome, time consuming and costly. Where countries choose not to develop a multilateral approach to exchange using a standard *Material Transfer Agreement* (standard MTA), they may instead choose to facilitate exchange by agreeing multilaterally on a single or limited number of *model MTAs*. Such models may include aspects related to i) the characteristics of the AnGR; ii) transfer prices and conditions; iii) use restrictions and iv) supplementary benefit sharing. Such model contracts may also lead to a reduction in the inequality of negotiations due to differential levels of knowledge and experience in such matters. The development of such *model MTAs* might be particularly important given the expectation that the number of exchanges and their characteristics may change in the future.

High sanitary standards are important from a human and animal health perspective, and further *harmonisation of SPS regulations at regional and global levels* is needed to deal with the global control of communicable diseases. However, existing exchange practice favours the North–South flow of AnGR because northern suppliers of semen, embryos and animals can comply with the necessary procedures and meet the sanitary standards, whereas southern suppliers often cannot. Sanitary barriers can block exchange and may indirectly create a bias between commercial breeds and local breeds, which may negatively affect the conservation of local breeds. It may therefore be worth considering specific areas where sanitary regulations could be adapted in such a way to better take into account conservation objectives.

In summary

The box below contains a list of major potential initiatives relevant to the exchange of AnGR.

Regulation of import and/or export
- Development of a global model MTA (or a set of MTAs)
- Implementation of (genetic) impact assessment methodology
- Provide guidelines for 'responsible exchange'
- Development of 'codes of good practice'
- Development of national access laws
- Obligation to include PIC and MAT in (bilateral) exchange agreement

SPS regulations
- Harmonization of laws on regional and global scales
- Integration of conservation objectives in sanitary law

3.4 Exclusive rights and use rights

3.4.1 Property rights and animal keeper's rights

Main issues and challenges

Classical ownership of AnGR is clearly defined. The owner of the animal or germplasm normally decides about use for production and/or breeding. Conventional breeders operate within this system of classical ownership and commercialise the fruit of their labour through the sale of animals or germplasm. Breeders generally 'protect' their investments through 'staying ahead of the competition' and by controlling the use/sale of their most valuable breeding animals. In communal livestock systems, the decisions of individual owners of AnGR may also be regulated by communal rules on the sharing of breeding animals.

Physical ownership and the associated *right to use* AnGR is challenged by both *intellectual property rights* (see 3.4.2) and *sovereign rights* over biological diversity. Individual owners of animals may be restricted in their *right* to determine whether to sell them at a privately negotiated price, particularly if the transaction crosses national borders. Awareness of limitations posed by national sovereignty is low among commercial traders of animals and germplasm. Most industrialised countries do not put major restrictions on the exportation of germplasm, but some developing countries implement strict access regimes.

There is a call for *livestock keepers' rights* that recognize the current and historic role of livestock keepers as custodians of AnGR and traditional knowledge. These aims to allow the undisturbed continuation of livestock keepers' way of life through the protection of traditional rules, including those on natural resource use. Classical ownership and the inherent *rights* of livestock keepers to use and develop their own breeding stock and breeding practices may come under strong pressure where *intellectual property rights* related to AnGR are increasingly exploited by industry.

The call for such *livestock keepers' rights* also relates to the process of globalization and changing business organisation. There are increasing concerns that global sourcing, vertical integration and lengthening supply chains in the livestock sector may adversely affect smallholder competitiveness and threaten the sustainable use of local breeds. The issue of how to maintain smallholder competitiveness in a globalizing economy is likely to need to be addressed.

Policy and regulatory approaches

Since traditional rights systems may differ among communities, *livestock keepers' rights* may be perceived differently among different groups and may have to be recognised in different ways in different countries. Finding a common ground at the international level may stimulate debate as to the potential scope and content of *livestock keepers' rights.* These may be perceived as *rights* arising from the past, current and future role of livestock keepers as custodians of AnGR and associated traditional knowledge in the development and maintenance of AnGR. *Livestock keepers' rights* are currently unexplored legal or political concepts although some NGOs have started to develop such concepts e.g. the 'Karen Commitment' (LPP, 2003). The concept of *livestock keepers' rights* could include, *inter alia:* grazing rights; the right to keep, to breed and to sell animals; and the right to be consulted in policy making. There are a number of issues that need to be clarified in this relation, *inter alia* how these rights shall be implemented and enforced.

There is a connection with the call for *farmers' rights*, even though the origin is different. The debate on *farmers' rights* originated as a response to the spread of strengthened *breeders' rights* in the plant sector. The concept of *livestock keepers' rights* originates from a broad range of potential threats to fundamental rights to livestock keepers. *Livestock keepers' rights* may contain similar provisions as those on *farmers' rights*, such as: the right to the protection of traditional knowledge; the right to benefit sharing; the right to participate in decision-making on matters related to AnGR; the right to exemptions in IPR and breeding laws where these are necessary to sustain their own management of AnGR; and free choice and access to breeding material.

In summary

The box below contains a list of major potential initiatives related to the rights to use AnGR.

Livestock keepers' rights
- Grazing rights
- Right to keep, breed and sell animals
- Right to be consulted in policy making

3.4.2 Intellectual property rights

Main issues and challenges

New breeding techniques have created possibilities to more directly take advantage of farm animal genetic diversity. When research and breeding investments are insufficiently protected through physical ownership (and secrecy), protection may also be effected through the use of *intellectual property rights* (IPRs), notably patents. Although, to date, the use of IPR in animal breeding has mainly been focussed on trademarks, patents have recently started to encroach on the AnGR sector and there are concerns about the far-reaching scope of this kind of protection and its possible impact on the exchange and use of AnGR.

Patent law aims to create incentives for innovation, research and development. The concern for AnGR is that a high number and wide scope of claims may lead to the establishment of a significant body of exclusive rights with substantial impact on the use of AnGR by researchers, breeders and farmers. As a result, the rights and obligations of different stakeholder groups may become increasingly unbalanced. Regulatory frameworks could thus be developed in such a way as to *provide a balance between different property right elements*, in order to support the sustainable use, exchange and conservation of AnGR.

Key areas in the patent system that may raise particular issues are:

- *Prior art* – where current practices or best techniques are not published in a sufficiently formal manner, there is a risk that common knowledge (e.g. traditional knowledge or common breeding methods) could become patent protected.
- *Novelty and inventiveness* – closely linked to the prior art criterion, it should be noted that the novelty and inventiveness of an invention are considered by comparing the *prior art* with the invention described in the patent claims. If extensive publication is not the norm in the livestock (breeding) sector, the livestock sector might be exposed to patent protection of relatively common principles and methodologies.
- *Scope of the granted right* - the extended scope of patent claims on life organisms is a major source of criticism of the patent system applied to biological material. In particular, there is concern that the scope and coverage of products by process patents could be applied to animal breeding.
- *Exemptions to the patent protection* – the TRIPS agreement specifies that countries have discretion to implement exemptions in the right conferred by the patent at a general level in the patent act (Article 30). Exemptions that apply to AnGR may be useful to render the patent system more appropriate to the specific requirements of the livestock sector. However, such exemptions have not yet not widely explored.

The protection of *breeds* or *breeding populations* could benefit from an effective *sui generis system,* as is the case with the protection of plant varieties (*plant breeder's rights*) under the different versions of the UPOV Convention. Such a principle can however not be easily replicated for AnGR, since *plant breeder's rights* rely on the concept of a genetically homogeneous variety, while animal breeds are much more heterogeneous and animal breeding is a more continuous process.

Policies and regulatory options

With regard to the patent system, *preventive publishing* is often put forward as a strategy to ensure that common knowledge will be considered *prior art*. However, it should be appreciated that such publishing only prevents patents from being granted in relation to that particular form of published information, and does not protect against small adaptations to what was originally published ('patenting around the prior art').

To cope with both the inventiveness requirement and excessively broad patenting, the development of specific AnGR-relevant novelty/inventiveness assessment *guidelines for Patent Offices* may be useful. Such specific guidelines would of course have to comply with the requirement in the TRIPS Agreement which states that patent protection is granted without discrimination among the various technological fields.

Exemptions to patent protection have been introduced in various national patent laws with regard to plants, such as the introduction of a *farmers' privilege* and a *breeder's exemption* in the patent laws in the EU-countries by Directive EC/98/44. With regard to the issue of whether to include exemptions in patent law for AnGR, there is a need for a thorough, systematic legal analysis related to assessing how general patent law rules might apply to AnGR and breeding.

Finally, it is also worth considering the degree to which patent protection is needed at all in order to promote breeding, research and development in this sector. The patent application process and subsequent enforcement can be time consuming and expensive. It would therefore be useful to *assess what the potential benefits of patent protection might be* in the context of the promotion of breeding, research and development in this sector, and to balance these against any potential costs e.g. increased costs of breeding material and reduced exchange and use of AnGR.

The '*sui generis*' option for the protection of plant varieties (*plant breeder's rights*), as an alternative to providing patent protection, is unlikely to be useful to AnGR. A *sui generis* system to protect breeds or breeding populations would require a clear definition of the *subject matter* to be protected. Rather than the farm animal breed or breeding population, the *individual breeding animal or its germplasm* would be the most relevant entity to protect.

A *sui generis* system for AnGR might instead involve the regulation of recognition of *breed associations* and *herd book registration* (possibly associated with trademarks), *geographical indications* (i.e. appellations controlées) or

livestock keepers rights (see 3.4.1). Furthermore, *sui generis* systems for *traditional knowledge* have been on the agenda in WIPO for some years, although agreement on such an international system may still be far off.

In summary

The box below contains a list of major potential initiatives related to exclusive rights to AnGR.

Use flexibility of the patent system
- Preventive publishing to ensure common knowledge is considered *prior art*
- Guidelines for patent offices on criteria for novelty and inventiveness in livestock sector
- Exemptions to patent protection for *farmers* and/or *breeders*

Sui generis system
- Recognition of breed associations
- Explore options for *sui generis* protection in animal breeding
- Protection of traditional knowledge
- Identify legal possibilities to protect breeds, breeding populations or breeding animals

4. Conclusions

General

There is an urgent need to increase efforts related to the conservation of AnGR, and the stimulation of their sustainable use. This includes issues related to access, benefit sharing and the demarcation of private, communal and national rights. Three important issues need to be discussed in international policy forums dealing with AnGR:

- How can we halt the further erosion of farm animal genetic diversity and promote their sustainable use?
- Is there a need to (further) regulate the international exchange of AnGR?
- How to better balance different rights system and to improve equity between stakeholder groups?

A range of policies have impact on AnGR, including general biodiversity policies, but also notably policies on economic development, public and animal health, rural development, agriculture, environment and poverty reduction. Although many such policies do not specifically target AnGR, they nonetheless have a significant impact on the sector. Hence, in addition to specific policies and regulations for AnGR, policy changes in other areas may play an equal or even more important role.

Awareness among policy makers and the general public regarding the threats to AnGR and their impact on sustainable agricultural production, as well as cultural identity and social development, is low. Awareness is also low among stakeholders in the animal breeding and livestock production sectors with regard to existing genetic resource policies. The low awareness and importance given to AnGR in general may thus be one of the reasons why there is so little attention given to the potential impact of many other policies on AnGR.

Existing international law places major responsibilities at the national level. The CBD makes signatory parties responsible for conservation and sustainable use, and the fair and equitable sharing of the benefits arising out of the utilization of biological diversity, including AnGR. Although the CBD recognized 'the special nature of agricultural biodiversity, its distinctive features and problems needing distinctive solutions', particular challenges for AnGR have not been extensively dealt with. An initiative that places AnGR in the political limelight and that either develops rules at the international level or that creates a stronger emphasis on AnGR at the national and local levels would be extremely useful.

Significant differences between PGR and AnGR suggest a need to differentiate and to tailor regulatory regimes accordingly. Simple extension of the content and form of the ITPGRFA would be unlikely to be appropriate. Rather than beginning by developing a new or adapted internationally legally binding framework, the intergovernmental process under FAO may instead wish, in the first instance, to focus on the development of voluntary instruments to strengthen national policies and implementation of action at national levels. This may facilitate reaching international consensus on the conservation and sustainable use of animal genetic resources, as well as the fair and equitable sharing of benefits derived from their use, for present and future generations.

Discussions regarding a *voluntary* instrument or set of instruments could provide a process within which to develop a framework to tackle the different policy issues and challenges identified. Such a process may facilitate establishing principles, in accordance with the relevant rules of international law, for the responsible use and exchange of animal genetic resources, taking into account all relevant biological, technological, economic, social, environmental and commercial aspects. It could also help in establishing principles and criteria for the elaboration and implementation of national policies for their responsible conservation, management and development, serving as an instrument of reference to assist States with the establishment or improvement of the legal and institutional framework required for the exercise of responsible animal genetic resources management, as well as in the formulation and implementation of appropriate measures. This framework may also provide standards of conduct for all persons involved in the sector. The process could be carried out in parallel with the identification and analysis of how other international regimes may influence AnGR.

Conservation and sustainable use

It is generally accepted that global farm animal diversity is facing a number of major challenges. There is an urgent need to place due emphasis on the conservation and sustainable use of AnGR. Strengthening national initiatives and improving coordinated efforts to conserve AnGR are key elements. A global process or an international agreement on AnGR is likely to need to target, *inter alia:* i) more effective exchange of information and best practices on approaches to *in situ* and *ex situ* conservation; ii) the development of increased capacities (human and institutional) to support these initiatives; and iii) novel funding and facilitating mechanisms for the conservation of AnGR.

While the costs of conservation are likely to be incurred locally, the future benefits may be national, regional or global. A similar differentiation arises from the fact that the costs of conservation are likely to fall on the public sector, whereas the economic benefits arising from AnGR often accrue to the private sector through, for example, the use of intellectual property rights. This suggests the need for public investment or innovative funding mechanisms. Capacity building is also key to stimulating sustainable use, notably capacities to further develop local breeds and to develop markets for biodiversity based products.

Exchange

Farm animal genetic resources are generally privately owned and not considered to be in the public domain. This situation is significantly different from the crop sector where public institutions have substantial gene bank collections. Exchange of farm animal genetic resources usually follows commercial practices and in some cases strict communal rules. Other than zoo-sanitary restrictions, only a few countries implement exchange restrictions for AnGR in biodiversity laws based on the CBD.

Given the importance of exchange of AnGR for livestock sector and breed development and the historical interdependence between countries and regions, there is less urgency for the further regulation of exchange of AnGR other than harmonisation of zoo-sanitary regulations. In general, commercial sales of breeding animals or germplasm can be adequately handled within the current regime.

There are several reasons to propose the development of *soft* instruments which could contribute to conservation, sustainable use, access and fair and equitable benefit sharing. Globally accepted 'codes of conduct' for handling AnGR exchange, using a single or limited number of model MTAs could be further explored, including by adapting standard MTAs used for crops to account for the biology and breeding conditions of AnGR. Such instruments may greatly facilitate future negotiations. The development of methods to assess (genetic) impact could also be used to minimize the impact of inappropriately controlled exchange.

If levels, directions or characteristics of AnGR exchange change dramatically in the future – which may happen as a result of climate change, globalization and/or biotechnology – there may be a need for a comprehensive global regime on ABS. If parties decide on a multilateral approach to access and benefit sharing of AnGR, such a multilateral system would likely have to be different from the multi-lateral system for crops, mainly because there is hardly any animal breeding material in the public domain. Furthermore, any ABS regime would need to ensure that the substantial levels of existing benefit sharing (both monetary and non-monetary) under the current situation are either maintained or enhanced under any new regime.

It is also notable that problems, perceptions and a sense of urgency differ between stakeholder groups, regions or species. Hence, there may be a need to consider differentiating policy and regulatory options depending on particular flows.

The need to develop a special international regulatory regime rather than giving consideration to the development of *softer* instruments or tools first, within the existing international regulatory framework, needs to be carefully considered. While 'harder' legal approaches such as one based on the model of the ITPGRFA may be required in the future, the AnGR community may instead first wish to focus on the major issues and, where necessary, begin developing appropriate *binding* or *non-binding* instruments.

Exclusive rights and use rights

'Classical ownership' of AnGR includes physical ownership and communal 'law of the land' affecting livestock keeping and breeding. There is an increasing tension with developments in the realms of biodiversity law and intellectual property rights protection. Demarcation of these different *rights* systems and maintaining *equity* among different stakeholders is crucial to avoiding conflict and increased transaction costs. In this context, it is important to consider the *rights* of livestock keepers vis-à-vis national level sovereign *rights*, as well as *obligations* between patent holders and breeders/livestock keepers.

There are several options to better balance the rights of different stakeholders in the livestock sector. Some examples of specific exemptions in patent law in the crops sector and also *sui generis* protection may provide a basis for studying options for AnGR. Options for development of *sui generis* approaches for AnGR include protection of breeds through the establishment of breed associations and definition of *livestock keepers' rights.* Key issues related to the patent system are up-dating the *prior art* search practice and perhaps review of the patent criteria for innovations relating to AnGR, as well as implementation of exemptions for livestock keepers and breeders.

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Annex I.
Scenarios

Future scenarios for exchange, use and conservation are used in this study to illustrate plausible future developments ('histories of the future') and aim at making better decisions in the present about issues that have long-term consequences in the future.

Four scenarios are presented in this Annex:
- Globalization & regionalization
- Biotechnology
- Climate change & environmental degradation
- Diseases & disasters

The scenarios are based on a much more detailed analysis. Full details are available from the lead author upon request.

A scenario is defined as a coherent, internally consistent, and plausible description of a possible future state of the world. Scenarios provide alternative views of future conditions considered likely to influence a given system or activity (IPCC, 2001). The scenarios are meant to be plausible, pertinent, alternative stories about the future, with the objective of permitting an exploration of possibilities rather than predicting the future *per se*. In this context, scenarios do not have to turn out to be absolutely correct to be useful. They are based on drivers of future change that already exist.

The development of the scenarios and discussions in the consultative process proved to be a useful tool, because the discussions of policies and regulations aimed not only to address current challenges but also to anticipate future ones.

Each scenario paragraph starts with the main driving forces or pillars on which the scenario is built.

2050 Globalization & regionalization scenario

By the end of the 20th century, the "Livestock Revolution" predicted a doubling of demand for livestock products between 1993 and 2020. This forms the basis for this scenario. By 2050 global consumption and production of livestock products changed with a major increase in the share of developing countries in total consumption and production. At the same time, there has been an on-going change in the status of livestock production from a multipurpose activity with mostly non-tradable output to food and feed production in the context of globally and/or regionally integrated markets. Among other factors, developments in consumption and production were largely driven by rapid technological change in livestock production and processing in industrialized systems.

The Scenario

Globalization of production and trade was effectively promoted by the establishment of the World Trade Organization in 1993 with a much wider mandate and stronger implementation mechanisms than GATT. The global economy triggered global sourcing by processors and retailers in the most powerful markets. This global sourcing led to standardization of products. Initially, this process started with individual chains such as McDonalds that put strict standards for its potatoes, beef, and wheat flour, which finally led to prescribed potato and wheat varieties and finally prescribed one animal breed or type of animal for their global operations. This example was followed by powerful consortia of retailers.

Parallel to the globalization-led uniformity of products, consumers in the higher segments of the market started to ask for regional products with distinct consumption values, supplied through very short chains. Apart from

consumption qualities, consumers wanted to support the production function of the landscape despite scale advantages in other parts of the world. The slow-food movement, which started in a small way at the beginning of the Millennium, gained a market percentage of 5 to 15 in the industrialized world, with the USA at the low end, central Europe and Japan at the higher end and China in between. The Fair Trade movement of the 1990s has connected its initially economic and human welfare objectives with the slow-food movement, providing northern markets with regionally identified products produced in traditional farming systems.

Globalization had some adverse consequences as i) globalisation of communicable animal diseases and ii) human health consequences as a result of the over consumption of livestock products by some population sectors, and iii) exposure to livestock waste, as a result of increased livestock product consumption and intensive livestock production, respectively.

The dual development (globalization and regionalization) has led to large multinational companies that adapt the production condition to suit the needs of the high productive breeds, lines and hybrids in tightly controlled production chains. Globalization resulted in an increased demand for breeds with productive traits appropriate for intensive farming systems and consequently a reduced demand for breeds with adaptive traits appropriate for extensive farming systems, thereby increasing the relative importance of conservation measures for the latter.

As an example of these developments, the BOVARIA cattle were developed out of a cross between a European breed with excellent growth rate and carcass characteristics and a beef breed from Latin America with excellent meat quality and resistance against heat stress. BOVARIA appears to have a wide adaptability to all major beef producing environments ranging from the Argentinean pampas to the saline water - irrigated production plains on the Arabic peninsula. Introgression of the heat stress resistance genes left the important meat characteristics unchanged. The breeding company BPAIC (Bovine, Pig and Avian Improvement Company) grew into a multinational with strategic alliances with major biotechnology conglomerates and its own gene bank providing the materials for ongoing improvements. BPAIC can be considered a monopolist in the business, but it can avoid anti-trust allegations by pointing at the multitude of local breeding companies and associations maintaining the herd books of a wide variety of breeds that supply the fair-trade and slow-food regional markets. Some of these local breeding companies and associations require support, including at the regional level, from donor institutions and/or national governments in order to survive. Such subsidies are part of the International Initiative on Farm Animal Genetic Resources (II AnGR), established in 2014.

II AnGR was established to enhance a wide range of national initiatives to support the conservation and sustainable use of farm animal genetic diversity. However, the gradual development of the market into two segments (globalised and national/regional) has not resulted in an increase of international exchange of genetic resources. BPAIC is fully self-contained in terms of genetic resources and provides the commercial sector with excellent breeding stock; national breeding programs exchange genetic material within the region but the national breed activities tend to avoid the use of exotic materials. Access to genetic resources and benefit sharing issues on a global level have thus become less relevant than expected.

2050 biotechnology scenario

Major developments and breakthroughs in biotechnology have speeded up on-going developments in the global livestock sector:

- Continued progress in reproductive and cryo-preservation technologies for all livestock species
- Development of a new generation of quantitative genetic tools, linking genomics and quantitative genetics
- Improved efficiency and safety of transgenic and cloning technologies
- Better control of animal diseases and increased availability of (marker) vaccines

The scenario is based on the impact of a combination of these major breakthroughs by 2050.

Scenario: CLONESTOCK starts producing ROBUSTA clones

All continents have recovered from a serious global recession, which surprisingly did not stop scientists continuing to develop (bio) technology. After a relatively quiet period, investors are seriously interested again in the implementation of biotechnologies in their businesses. Last week, CLONESTOCK, a world leading Biotech Company, which has carried out two major acquisitions in the livestock breeding sector, organised a press conference, which attracted a lot of attention in the international agricultural press. Stock prices of CLONESTOCK increased with 20% today.

The press release showed the final, positive results of safety studies of genetically modified clones of ROBUSTA cattle. The company managed to produce a high productive breed with specific heat- and disease-tolerance characteristics. The original breed was genetically modified, introducing a selected number of genes, after many years of studying the genetic background of heat- and disease resistance. The company patented many genes with major and/or minor effects. This selection was greatly assisted by the development of effective cloning techniques developed in the early 21st century.

The introduction of ROBUSTA cattle started already in 2025 and at that moment CLONESTOCK set up a nucleus herd with the aim of selecting the best ROBUSTA sires and dams to produce commercial offspring. CLONESTOCK started selling clones of the best combinations of sires and dams to commercial dairy farms all over the world, especially to less favoured areas or those in tropical climates. CLONESTOCK predicts that by the year 2050 twenty-five percent of dairy production in Asia, Africa and the Americas will be produced by their clones.

In the late 20th century breeding and biotech companies did not invest in transgenic and cloning technologies, because of negative consumer perceptions and ethical considerations. Scientists had also serious doubts about the safety of these technologies in farm animals and about animal health and welfare implications. However, public perception changed slowly when GMO crops proved to be safe and when on-going research in this area showed that it was possible to produce transgenics and clones on a large scale.

CLONESTOCK strategically decided to combine cloning with the production of transgenic animals. Within this context the company was better able to protect the breeding stock and property rights in a relatively small nucleus. Cloning of transgenic animals appeared to be a safe and efficient way of disseminating breeding animals or embryos for production purposes. In order to protect their investments in research and breeding, CLONESTOCK introduced a 'termination' gene into the cloned genetic material, which made it impossible for the clones to reproduce.

The introduction of cloned transgenic animals does not affect smallholders directly. Poor countries and small holders can continue to breed and keep their local breeds but the production gap between the clones and the local animals is further increasing. To some extent this will affect local markets and local communities, because prices of animal products, including animal products produced by clones, are expected to drop even further.

Although policy makers and scientists argued that plant genetic resources and plant breeding raise totally different issues from those associated with animal genetic resources and animal breeding, ex-situ conservation differences between plants and animals disappeared to a large extent as a result of rapid developments in biotechnology. After the International Technical Conference on AnGR in 2007, the international community and larger biotech and breeding companies decided to develop global and private gene bank initiatives. Private companies invested in cryo-preservation of germplasm and somatic cells for strategic reasons. The international community decided to start an emergency cryo-preservation programme and develop a Trust Fund after another outbreak of Foot and Mouth Disease in Asia in 2007. Access to the global gene bank is possible under strict Material Transfer Agreement which includes a provision that benefits arising from the use of gene bank material have to flow back to the Trust Fund. Because of this strict rule, breeding and biotech companies decided to set up an insurance cryo-preservation collection themselves and to put more emphasis on maintenance of within breed/line/company diversity.

2050 Climate change & environmental degradation scenario

There are five main climate change drivers. These are temperature, precipitation, sea level rise, the incidence of extreme weather events, and atmospheric carbon dioxide and other greenhouse gas content. Climate change can be expected to affect livestock productivity directly by influencing the balance between heat dissipation and heat production and indirectly through its effect on the availability of feed, fodder and water, as well as changes in disease challenge.

The Scenario

By 2050 Earth's now more affluent human population has increased from the current 6.5 billion to 9 billion, over 65% of whom live in cities. Global mean surface temperatures have risen by 2°C compared to 1990 and mean sea levels have raised by 25 cm. Global mean precipitation is 2% higher than in 1990. However, these global numbers hide complex spatial patterns of changes. In some regions, temperature increases are three times the global mean, while in others temperatures have declined.

The specific direction of change can only be predicted by considering specific localities. Broadly speaking at the higher latitudes (beyond 50°N and 50°S), warmer temperatures have lengthened and increased the intensity of the growing season. Crop and feed yields have increased in those regions where there have been no major changes in rainfall. By contrast, in tropical and equatorial regions warmer temperatures have since 2005 further exacerbated what had already been quite frequent water and heat stress on plants due to higher rates of evaporation. In addition, changes in extreme weather and climatic events have occurred, increasing livestock losses, decreasing yield stability, damaging production infrastructure and disrupting access to markets. Environmental degradation has accompanied these processes, which caused a drop in crop and livestock. The unequal distribution of losses and gains has had a major effect on production, trade and relative prices.

The fact that the speed of climate change has been and will continue to be faster than the speed of livestock and forage evolutionary adaptation means that many of the breeds used in extensive systems have moved or replaced. Large-scale movement of livestock breeds occurred in search of more appropriate climatic zones (e.g. lowland sheep can now be found in the highlands) and less degraded pastures. By contrast hardy wildlife species, such as the Oryx, have increasingly been domesticated for use in areas of high climatic challenge.

Although the direct impact of climate change on livestock systems has only been moderate in global terms, it is expected to get much more severe and consequently all nations are strongly behind the 2027 "Son of Kyoto" protocol and its greenhouse gasses (GHGs) trading mechanisms, which include methane emitted from livestock.

The growing volume of livestock trade has resulted in AnGR research becoming more important. Increased germplasm flows within and between countries creates new opportunities for cross-breeding and introduction of exotics, together with a need to ensure that such flows are beneficial and do not threaten remaining livestock diversity. Genetic impact assessments and controlled breeding programmes play a key role in this context. Research related to the economic benefits of livestock germplasm flows have also been important, ensuring that such germplasm flows continue to facilitate monetary and non-monetary benefit sharing. Internationally funded AnGR research is now comparable to that of crops and plants, compared to being less than 10% in 2005.

2050 disease & disaster scenario

The Ripah-virus disease which affects pigs has now arrived in southern Africa. Starting in eastern Asia in April 2042, it was able to conquer almost half the globe in less than 5 years. This paramyxovirus used to be a harmless virus that lives in the hindgut and was originally excreted and decomposed in manure. However, the feeding of manure to animals had become a necessity in the 2030s in order to keep up with the increasing meat demand of the world population which has become more affluent than ever projected. Despite the many safety regulations for heat treatment of the manure the ecology of the hindgut changed, with the virus developing heat resistance and increasing virulence.

Already after the outbreak of a fast-spreading poultry disease named Avian Influenza in the early 2000s, researchers and international organizations had warned that the high density of various domestic animals species and humans in the emerging intensive production systems, particularly in Asia, may lead to increased disease risks in farm animals and human.

Today, in hot summer weather, the Ripah-virus experiences optimal conditions and spreads fast. Veterinary and medical services all over the world are collaborating in their efforts to fight the disease which has already seen 10 million pigs killed from severe diarrhoea and respiratory problems. Stamping the virus out through mass pig culling is the preferred control strategy, but breeders of local breeds are scared about the potential loss of their breeding stock. Culling is likely to particularly affect those breeds that are not registered in herd books, as registration in a herd book is required to receive the exemption permit given by the Global Animal Breed Conservation Trust. Breed registration also offers an entry point for semen or somatic cell storage in the Trust's (*ex situ / in vitro*) gene bank. However, there are many breeds for which breeds associations or herd books do not exist. These were bred either by local communities or commercial companies who had various reasons for not registering their breeds. For example, some communities had instead chosen to include their breeds in local/indigenous breed registers; whereas companies had chosen to register the products of their breeds as trademarks.

An international gene bank had become necessary after the value of breeds was internationally recognized as our global heritage and a back-up system for future restocking was considered necessary. As many countries recognized that they did not have the capacity to have their own secure gene bank, they decided to establish an international gene bank, with the necessary regulatory framework to enable the exchange of material to and from this gene bank. The international gene bank developed standard forms for Prior Informed Consent, Material Acquisition Agreements and Material Transfer Agreements for receiving and passing-on material, in agreement with the owners.

Material from the gene bank had already been used for restocking after the disastrous earthquake in Indonesia which caused the loss of most animals. Since its establishment in 2010, the gene bank has built up a collection that covers 40% of all breeds of domestic animal species across the globe. All material is cryo-preserved in liquid nitrogen. Breeds from the developed countries are much better represented in the gene bank, because it was easier for these countries to provide some back-up material from their normal breeding activities. As artificial insemination was less practised in developing countries in the early days, their breeds have been stored less frequently. However, recent years have seen more somatic cells from developing country breeds being deposited, as they can be easily collected through a biopsy in the ear.

At the present time, the Ripah-virus threat has triggered rare breed and animal welfare NGOs to establish breed rescue teams which collect genetic material in the affected countries, in collaboration with the veterinary services. The geo-referenced database held by the Trust also helps to locate breeds in remote areas, and the Material Acquisition Agreements are simple and can be used even within the short time available in such emergency situations. These teams had managed to save the genetic material of a further 42 breeds in 20 countries before the disease hit, and thus saved our global biodiversity heritage for future use.

Annex II.
Stakeholder consultations

Stakeholder consultation among representatives of a range of stakeholder groups (e.g. government officials, scientists in the public and private sectors, representatives of breeding organisations and livestock keepers or representatives of their organizations) have been undertaken in:

- four case study countries (Brazil, Ethiopia, India, the Netherlands)
- an e-conference inviting a large number of experts and stakeholders
- additional interviews in other OECD countries, Africa, Asia and Latin America

All stakeholders consulted are listed in Table II.1. We wish to acknowledge that the number of case study countries was limited and e-conference participation and additional stakeholder interviews in non-case study countries did not cover the entire world and may have missed some important viewpoints and specific situations.

Case study countries

Within the time and funding constraints of the project, we selected a range of country types and consulted with a wide range of stakeholders to allow for a balanced analysis that can support informed decision-making with regards to policy and regulatory options for AnGR.

Case study countries Brazil, Ethiopia, India and The Netherlands were chosen based on:

- their status of economic development (i.e. being least developed, developing and developed, the idea being to ensure representation across the three development categories)
- the importance of their livestock sector (at least three of the major livestock species)
- covering a range of production systems (intensive and extensive) and producers (small- scale and large-scale)
- concern about genetic resource issues but having different policies or legal approaches (open versus closed)
- different stages of livestock sector development, different degrees of biotechnology capacity and different vulnerability to climate change or disasters.

Brazil is the largest country in South America and is nowadays the largest exporter of beef and poultry products. The size of Brazil's cattle herd is second only to India, Brazil has the third largest horse herd in the world and the largest herd of buffaloes outside Asia. Most of the domestic animal species were introduced into Brazil in the colonial period since 1500. Criollo cattle populations, originally from Europe, are local/indigenous to Latin-American countries and have declined in numbers due to the competition by more productive cattle breeds as well as by the massive introduction of *Bos indicus* cattle during the beginning of the 20th century. Original sheep, goat, pig, horse and poultry breeds that came to the country in the early 1500's have almost disappeared due to indiscriminate cross-breeding with later introduced exotic breeds.
Brazil has approximately twenty animal breeding programmes, with different focal points, for the distinct breeds and species; most of them are for cattle, but also for buffalo, pigs and poultry. Brazil has 86 recognised Artificial Insemination Centres selling over 7.0 million doses of semen (2002) with annual exports of 82,000 doses. Animal genetic resources conservation is included in the national strategies from 1983 onwards and is implemented by the National Centre for Genetic Resources and Biotechnology - Cenargen, a branch of the public agricultural research corporation Embrapa.

Ethiopia is at the bottom 10 countries on the UN's Human Development Index, with 80% of the population living in rural areas. Livestock provides approx. 30% of GDP and is important in different but mainly low-input production systems: mixed crop-livestock, agro-pastoral, pastoral and peri-urban and urban (some species only). The diverse topography has added to the existence of a large diversity of l local/indigenous breeds of cattle, sheep, goats, camels, donkeys, horses, mules and chickens. Ethiopia has one of the most detailed policies in Africa relating to agrobiodiversity; relevant issues are included in the constitution, the five year development plan, the environmental

policy and seed industry policy and a clear institutional responsibility for its implementation. However, national breeding programmes and a livestock breeding policy are not in place and the institutional and human resource capacity to utilize and conserve the country's animal genetic resources is very limited.

India is a mega biodiversity centre and rearing of domesticated cattle, buffalo, sheep, goat, pig, camel, horse, donkey, yak and mithun has been practiced since the old cultures developed. In poultry, apart from chicken, domesticated birds such as ducks, geese, quails, turkey, pheasants and partridges are also kept. Elephant, dog, rabbit and pigeon are also important in some of the regions.
India's livestock and agro-biodiversity policies, including access laws, are well developed and based on several years of stakeholder consultations. Present livestock policies are primarily based on improvement through within population selection for local/indigenous breed and cross breeding of non descript animals with improved exotic (western) breeds. Many breeds in India have not yet been officially described. Government and local communities have established programmes for conservation of local/indigenous breeds. Implementation of these programmes in various states need to be compliant with international treaties.

Animal production in ***The Netherlands*** has developed in the past decades into a large-scale, efficient and export oriented primary production, supply and processing industry. Specialised genetic improvement companies partly operating in vertically integrated chains have earned an important position in the international markets, especially for cattle, pigs and layers and broilers. Local breeds are conserved through a combination of *in situ* and *ex situ* approaches, supported by the Government based on heritage, landscape and production functions. *Ex situ* conservation using cryogenic conservation of genetic material in a gene bank was formally introduced in the Netherlands in the 1990's and further developed and institutionalized since then.
Under its sovereign rights over genetic resources, the Netherlands Government enables the responsible exchange of genetic resources while supporting benefit sharing.

E-conference

A further method of data collection was through the organization of an electronic conference (e-conference). The objectives of the e-conference were to verify and refine draft report findings, to collect additional ideas and opinions, and to involve a wider group of stakeholders.

The e-conference was organised in four substantive phases. Phase I involved a survey of participants' perceptions of past, current or future exchange mechanisms and their relationship with conservation and sustainable use of AnGR. Phase II examined the degree to which participants considered the four future scenarios and their driving forces to be realistic, as well as the associated implications for exchange, conservation and use. Phase III involved a further survey, this time of participants' positions with regard to a series of exchange and use examples. Finally, Phase IV identified participants' perceptions of the need for policies, regulatory options and potential measures to address the issues raised during the e-conference.

The target groups for the e-conference were: i) professionals in the livestock and development sector; ii) experts from other sectors with experience regarding similar issues; and iii) policy- and decision makers from different stakeholder groups. The e-conference itself involved approximately 200 participants, from 43 countries. 40% of participants were found to be from Europe, with 60% of the total representing "research and education" stakeholder groups, with the next largest group being those with a government background. As might be expected from the use of a consultation methodology dependent on stakeholder internet access and English language use, there was much more limited participation from "breeders", "livestock keepers" and "NGOs".The e-conference nonetheless provided a useful complement to the other stakeholder analysis approaches described above.

List of stakeholders

The list of stakeholders below consists of i) interviewees in case study countries (case study), ii) additional interviewees (additional) in non-case study countries and iii) contributors to the e-mail consultations (e-conference).

Table II.1 List of stakeholders consulted.

Country	Category	Institution/Organization	Position	Name
Bhutan	Additional interview	National Biodiversity Centre	Director	Ugyen Tschewang
Bolivia	E-conference		National Coordinator AnGR	José R. Campero
Brazil	Case study	Fazenda São Gabriel	Breeder	Armando Teixeira Primo
Brazil	Case study	Fazenda Igrejinha	Breeder	Márcio Camargo
Brazil	Case study	Fazenda Porta da Cadeia	Breeder	Nelson Camargo
Brazil	Case study	Brazilian Association of Criollo Lageano Breeders	Technical Director	Edison Martins
Brazil	Case study	Brazilian Association of Zebu Breeders	Technical Director	Luiz Antonio Josahkian
Brazil	Case study	National Association of Breeders "Herd Book Collares"	Technical Diretor	Leonardo Collares
Brazil	Case study	Brazilian Association of Sheep Breeders	Responsible for Breed Registration	José Pereló Medeiros
Brazil	Case study	Environmental Ministry	Head of Genetic Resources Division	Lídio Coradin
Brazil	Case study	Embrapa Intelectual Property	Researcher	Maria Isabel de Oliveira Penteado
Brazil	Case study	Embrapa Meio Norte	Researcher	Adriana M. Araújo
Brazil	Case study	University of Brasilia	Researcher/Teacher	Concepta McManus Pimentel
Brazil	Case study	Embrapa Amazônia Oriental	Researcher	José Ribamar Felipe Marques
Brazil	Case study	Embrapa (Headquarters)	Director	Kepler Euclides Filho
Brazil	Case study	Embrapa Pantanal	Researcher	Sandra Aparecida Santos
Brazil	Case study	Embrapa Pantanal	Researcher	Urbano Gomes Pinto de Abreu
Canada	Additional interview	Agriculture Canada	Researcher	F. Silversides
Canada	Additional interview	Agriculture Canada		C. Davidson

Country	Category	Institution/Organization	Position	Name
Canada	Additional interview	Agriculture Canada		Y. Martell
Canada	Additional interview	Agriculture Canada	Head gene bank	K. Richards
Canada	E-conference			V. Houle
Canada	E-conference		Writer/researcher	J. MacLeod
Czech Republic	E-conference	Research Institute of Animal Production	National Coordinator AnGR	V. Matlova
Ethiopia/ International	Case study	ILRI	Domestic Animal Genetic Resource Information System Database (DAGRIS) Administrator/Research Officer	Workneh Ayalew
Ethiopia	Case study	Ministry of Agriculture and Rural Development	National Livestock Development Project Coordinator	Hassen Ali
Etiopia	Case study	Ministry of Agriculture and Rural Development, Livestock and Fishery Market Department	Livestock and Fishery Market Team Leader	Tesfaye Desta
Ethiopia	Case study	Jimma College of Agriculture and Veterinary Science, Jimma University	Lecturer (currently pursuing a PhD in Animal breeding)	Aynalem Haile
Ethiopia	Case study	OXFAM, GB (Previously Hhead of National Artificial Insemination Center of the MoARD)	National Pastoral Program Co-ordinator	Biruk Yemane
Ethiopia	Case study	Somali Region Pastoral and Agro- pastoral Research Institute (SoRPARI)	Deputy Director General	Abdul Khalif Ahmed
Ethiopia	Case study	Somali Regional State, Livestock, Crop and Natural Resources Development Bureau.	Livestock Resources Development Department Head	Getahun Bezabih
Ethiopia	Case study	Pastoralist Forum Ethiopia (Umbrella NGO)	Executive Director	Tezera Getahun
Ethiopia	Case study		Agro-Pastoralist	Farah Abdi Ies
Ethiopia	Case study		Commercial Farmer	Gadissa Gobena
Ethiopia	Case study		Smallholder Farmer	Dejene Tulu

Country	Category	Institution/Organization	Position	Name
European Commission	E-conference	DG Sanco		K.U. Sprenger
France	E-conference	BRG	Director	D. Planchenault
Germany	E-conference	Goettingen University	Retired Chair Animal Husbandry and Breeding in the Tropics and Subtropics	J. King
Germany/ International	Additional interview	European Forum of Farm Animal Breeders	Board member	P. Knap
Germany	Additional interview	Georg-August-Universität Göttingen Institute of Animal Breeding and Genetics Institute of Agronomy and Animal Production in the Tropics	Professor	Clemens A. Wollny
Germany/ International	E-conference and additional interview	League for Pastoral Peoples and Endogenous Livestock Development/LPP	Project coordinator	I. Köhler-Rollefsen
Germany/ International	E-conference and additional interview	League for Pastoral Peoples and Endogenous Livestock Development/LPP	Member	E. Matthias
Ghana	Additional interview	Animal Production National Directorate Ministry of Agriculture Ghana	The national coordinator for FAO-SoW and Senior Animal Husbandry officer	Richard Osei-Amponsah
India	Case study	Veterinary Council of India	President	Dr. A.L. Chaudhary
India	Case study	Kerala Agricultural University	Vice Chancellor	K.V. Peter
India	Case study	KRAPAVIS		Aman Singh
India	Case study	National Bureau of Animal Genetics Resources	Scientist	M.S. Tantia
India	Case study	CALPI	Programme Officer	Padmakumar V.
India	Case study	Forum for Biotechnology & Food Security	Chairman	Devinder Sharma
India	Case study	National Research Centre on Yak (ICAR)	Director	Mohan Bhattacharya
India	Case study	GENE CAMPAIGN	President	Suman Sahai

Country	Category	Institution/Organization	Position	Name
India	Case study	Central Avian Research Institute	Director	Rajvir Singh
India	Case study	Planning Commission	Member	V.L. Chopra
India	Case study	Indian Dairy Association	Vice President	N.R. Bhasin
India	Case study	Department Animal Genetics & Breeding	Professor	Tejendra Bardoloi
India	Case study	Rajiv Gandhi College of Veterinary and Animal Sciences	Dean	Guntur Butchaiah
India	Case study		Animal Husbandry Commissioner	Santanu Kumar Bandyopadhyay
India	Case study		Joint Director, In charge Animal Genetic Resources	Shiv Kumar
India	Case study	Animal Welfare Board of India	Secretary	R. Balasubramanian
India	Case study	Tamilnadu Veterinary and Animal Sciences University (TANUVAS)	Director of Research	Mahalinga Nainar
India	Case study	Madras Veterinary College	Dean	P. Thangaraju
India	Case study	Konar Community Breeders Association		
India	Case study	Sustainable – agricultural and Environmental Voluntary Action (SEVA)	Executive Director, SEVA	Shri P. Vivekanandan
India	Case study	Katchakatti Sheep Herders Association	President Village Panchyat	P. Ranganathan
India	Case study	Tamilnadu Livestock Development Agency	Chief Executive Officer	M. Kunju
India	Case study		Professor and Head	N. Kandasamy
India	Case study	Late Mr. N. Nallathambi Sarkari Manradiar		N. Kumararathinam
India	Case study	Karnataka Veterinary, Animal and Fishery Sciences University	Vice Chancellor	R.N. Sreenivas Gowda
India	Case study	Livestock Breeder Association (Burghur Cattle)	Farmer & Chairman	Shri Nachimuthu Gounder

Country	Category	Institution/Organization	Position	Name
India	Case study	National Dairy Research Institute	Head	M.K. Rao
India	Case study	National Dairy Research Institute, Southern campus (SRS-NDRI)	Principal Scientist	A. Obireddy
India	Case study	Karnataka Veterinary Animal Sciences University	Dean	M.G. Govindaiah
India	Case study	Veterinary College	Dean	K.S. Prathap Kumar
India	Case study	Animal Husbandry Services	Deputy Director	N.S. Parameshwar
India	Case study	Shree Ramachandrapura Math		Shree Raghaveshwara Bharathi Swamiji
India	Case study	A.P. Livestock Development Agency	Chief Executive Officer	Y. Eswaraiah
India	Case study	Animal Husbandry	Director	L. Mohan
India	Case study			V. Anjaneyulu
India	Case study	Acharya NG. Range Agricultural University	Ex-Associate Dean & Professor & University Head	Shri G.N. Rao
India	Case study	World Buffalo Trust	Chief Scientist	A. Varma
India	Case study		Independent consultant	R.M. Acharya
India	Case study and E-conference	Indian Council of Agricultural Research	Deputy Director General	V.K. Taneja
Kenya	Additional interview	Kenya Livestock Marketing council	Chief Executive Officer	Abass S. Mohammed
Kenya	Additional interview	Kenya Agricultural Research Institute (Animal Breeding and Genetics)	Research Scientist	Douglas Indetie
Mauritius	Additional interview	Agricultural Research and Extension Unit	Research Scientist / alternate National Coorinator AnGR	Regis LAM
the Netherlands	Case study	Ministry of Agriculture, Nature and Food Quality, Department of Agriculture	Policy advisor	L.J. Habing

Country	Category	Institution/Organization	Position	Name
the Netherlands	Case study	Ministry of Agriculture, Nature and Food Quality, Department of International Affairs	Head Global Cooperation	M.L. Vernooij
the Netherlands	Case study	Ministry of Agriculture, Nature and Food Quality, Department of International Affairs	Policy co-ordinator	D.J. de Jong
the Netherlands	Case study	Ministry of Agriculture, Nature and Food Quality, Department of Food Quality and Animal Health	Policy advisor	W. Pelgrim
the Netherlands	Case study	Ministry of Agriculture, Nature and Food Quality, Department of Industry and Trade	Policy advisor	G. Westenbrink
the Netherlands	Case study	Vereenigde (Patent Office)	European Patent Attorney	J. Renes
the Netherlands	Case study	CRV Holding BV	Chairman executive board	J. Jansen
the Netherlands	Case study	Alta Genetics	Director	B. Verbeek
the Netherlands	Case study	Veepro Holland	Director	J. Venneman
the Netherlands	Case study	Topigs	Head Service & Development Department	A. de Vries
the Netherlands	Case study	Institute for Pig Genetics	Director	J. Merks
the Netherlands	Case study	FPS (Royal Friesian Horses Stud Book)	Director	I. Hellinga
the Netherlands	Case study	Nutreco	Head Animal Breeding Research	G. Albers
the Netherlands	Case study	Centre for Genetic Resources, the Netherlands	Director	L. Visser
the Netherlands	Case study	Centre for Genetic Resources, the Netherlands	Senior scientist biopolicies	N. Louwaars
the Netherlands	Case study	Animal Sciences Group of Wageningen UR	Director Animal Production Division	P. Vriesekoop
the Netherlands	Case study	International Agricultural Centre of Wageningen UR	Project leader / consultant	A.J. Nell
the Netherlands	Case study	International Agricultural Centre of Wageningen UR	Project leader / consultant	H. Schiere
the Netherlands	Case study	Wageningen University, Animal Production Systems	Professor	A. van der Zijpp

Country	Category	Institution/Organization	Position	Name
the Netherlands	Case study	Product Board for Livestock, Meat and Eggs	Policy advisor	P. Vesseur
the Netherlands	Case study	Dairy farmer and Board member of Dutch Farmers Association	Commercial farmer	J. Brandsma
the Netherlands	Case study	Mega breeders	Members are commercial farmers	Group of farmers
the Netherlands	Case study	Dutch Foundation for Rare Domestic Animal Breeds	Board member	G. Kuit
the Netherlands/ International	Additional interview	European Forum of Farm Animal Breeders	General Manager	A. Neeteson
the Netherlands	E-conference	Centre for Genetic Resources, the Netherlands	Bacherlor student	E. de Haas
Malawi	Additional interview	Department of Agricultural Research Services, Ministry of Agriculture.	National coordinator-AnGR National Research coordination livestock and pastures commodity Group Head	Noel Chintsanaya
Nepal	E-conference		Veterinarian/researcher	Krishna Kaphle
Norway	Additional interview	Nordic Gene Bank Farm Animals	Director	E. Fimland
Pakistan	E-conference	National Research Institute		Abdul Ghaffar
Philippines	E-conference	Benguet State University		Sonwright B. Maddul
Senegal	Additional interview		Senegal Secretary of NCC-SoW	Diop Mamadou
Sri Lanka	E-conference		National Coordinator AnGR	S. Gamage
Tanzania	Additional interview		Livestock Research Scientist / Coordinator AnGR	Hassan Mruttu
United Kingdom	E-conference	Fell Pony Society	Chairman, Overseas Sub Committee	Sue Millard
United Kingdom	E-conference	The Sheep Trust	National Coordinator	S. Jones
Thailand	E-conference		Advisor/lecturer/consultant	D. Steane
Uganda	E-conference and additional interview	KISUP ATEKER, Peace and Endogenous Development organization	Member and also a livestock keeper/pastoralist	Thomas M. Loquang

Country	Category	Institution/Organization	Position	Name
USA	Additional interview	National Animal Germplasm Program, National Centre for Genetic Resources Preservation	Coordinator	H. Blackburn
USA	Additional interview	National Centre for Genetic Resources Preservation		H. Shands
USA	Additional interview	National Centre for Genetic Resources Preservation	Director	D. Ellis
USA	Additional interview	University of California, Davis, Biotech lab		J. Murray
USA	E-conference	Society for the Preservation of Poultry Antiquities	Publicity Director	C. Heinrichs
Zambia	Additional interview	National Farmers Union		L. Simwanda

Stakeholder analysis

In this section a synthesis of findings from i) stakeholder interviews in four case study countries, ii) views of stakeholders collected in the e-conference and iii) additional interviews in OECD and African, Asian and Latin American countries will be presented.

We acknowledge that the number of case study countries was limited and e-conference participation and additional stakeholder interviews in non-case study countries do not cover the entire world and may have missed some important viewpoints and specific situations. Within the time and funding constraints of the project, we selected a range of country types and consulted with a wide range of stakeholders to allow for a balanced analysis that can support informed decision-making with regard to policy and regulatory options for AnGR.

The development and discussions of the scenarios in the consultative process proved to be a useful tool. The discussion of policies and regulations seeks to adhere not only to solve current challenges but also to anticipate future ones.

The findings are presented by topic, presented in three sections, i) exchange, use and conservation, ii) scenarios and iii) policy and regulatory options.

Exchange, use and conservation

Exchange

Almost all stakeholders across countries and regions agree that exchange is and has been of vital importance for breed and livestock sector development. A majority of stakeholders feels that international exchange should not be unnecessarily restricted. Some stakeholders argue however that most of the international exchange of AnGR today is not to the benefit of smallholders, pastoralists or livestock keepers in general. For breeders or breeding organisations gene flow is important for breed improvement or development of new breeds or lines. On the other hand, with increased industrialized animal breeding there is a tendency to close and protect breeding populations and rely on within breed selection. Both Brazilian and Dutch stakeholders put this forward as an important issue.

Brazilian stakeholders argued that exchange can contribute to maintenance of genetic variation within populations and it allows comparison and evaluation of a wider range of the existing genetic diversity. In Brazil, where all AnGR were imported in the past, exchange was vital for the establishment of present stocks. Zebu breeders are today responsible for 85% of beef production in the country and there is an active gene flow of *Bos indicus* breeds from Brazil to other Latin American countries. The Zebu breeds were imported from India into Brazil in the past and have a narrow genetic base in Brazil. There is a restriction of export from India and surrounding countries, while additional import of Zebu genetic resources into Brazil would support further breed development and better management of genetic variation. In the Brazilian case study it was argued that there is commercial interest for importation of *Bos indicus* (Zebu) breeds from India, the achievement of which would be a major breakthrough.

Exchange between Brazil and neighbouring countries is not very important in terms of numbers of animals brought to Brazil. Even though some Brazilian cattle breeders buy animals in neighbouring countries, most of the importations (mostly semen) come from UK, USA and Canada. Lately, there has been an increase in the South-South gene flow for cattle breeds. Where breeders imported breeds from UK in the past, now they import the same breeds from Australia and South Africa. Native, Brazilian breeds are only found within the country and for those breeds gene flow with neighbouring countries does not exist.

With regard to gene flow in general, a number of the interviewees in Ethiopia believed that there is a Northern need for genes from the South, for traits such as disease tolerance. It is also believed that there is a small South to South flow (e.g. Dorper sheep from South Africa, Begayit or Barka cattle from Northern Ethiopia and Eritrea). In Ethiopia, there is some quantitative data for gene flow (including North-South), covering mainly cattle, sheep, goat and poultry, as well as the number of semen doses for artificial insemination use. However, further dissemination of imported germplasm is not monitored.

Most of the Ethiopian interviewees agreed that there is currently no significant out-flow of genetic material for breeding purposes, although legal exports have included some semen export to Eritrea (Friesian and Boran). A number of interviewees raised that sometimes live animals, exported for consumption, can still be used for breeding purposes.

Interviewees in Ethiopia emphasized the importance of focusing on fulfilling zoo-sanitary regulations with regard to the export market. Ethiopian livestock keepers consider exchange as important and particularly argue that the introduction of exotic breeding *animals* is desirable, and policies should be put in place to regulate the importation of competing animal *products*.

A majority of interviewees in the Netherlands argued that international exchange of AnGR is mainly driven by developments in livestock production systems and by other major trends in the global livestock sector. Dutch breeders have always been export oriented and Dutch breeders benefited from both import and export of breeding stock in the past. Dutch breeding organizations have developed international business.

The breeding industry interviewees in the Netherlands stated that currently they see no substantial benefits from introgression of other (exotic) breeds into their breeding programmes. Genetic variation is maintained within breeding populations. A number of breeders indicated that veterinary issues are the main limitations for international exchange and for successful penetration of new markets.

Government representatives in the Netherlands said maximum 'transparency' of exchange of AnGR should be the first aim, which is the starting point for identification of (potential) problems related to exchange.

The Indian country case study also illustrated that the flow of animal genes has a long history. Breeds from India have contributed to the development of breeds in Europe and Latin America. In the past exchange was characterized by free access. Indian stakeholders observed that countries in Europe and Latin America are currently marketing breeds globally, which are partly based on Indian genetic resources from the past.

Indian stakeholders agreed that currently gene flow is mainly from North to South as the animal agriculture is more advanced in the North. In case of cattle in India, Northern exotic semen is extensively used to produce crossbreds. Transfer of genes from North to South is now regular. No permission or license is needed to import breeding stock into India except a sanitary clearance from the Indian authorities. However, export of genetic material, including livestock, from India is banned.

Indian stakeholders recognized that free and open genetic resource markets are essential for effective genetic conservation, livestock sector growth, economic viability of private companies and for poverty alleviation on a national level. Most of the exchange is considered to be from N-S and is commercially governed. A general feeling was that exchange of germplasm should be unrestricted between researchers but could be restricted or regulated for the purpose of trade.

Trade in livestock breeds between India and neighbouring countries is currently restricted through a policy platform which permits export of breeds on a case to case basis. The export of livestock is otherwise banned. Indian stakeholders also said that currently, there are not very large demands for Indian livestock, except from some Latin American countries.

E-conference participants supported the statement that there is limited, but sufficient, knowledge and data on exchange patterns and exchange practices. It is rather clear that N-S exchange and exchange among developed countries are dominant flows. On the other hand there was less consensus about current and expected future S-N and S-S exchange.

Stakeholders from the South often argue that they expect the most valuable AnGR being located in the South and future (biotech) developments might result in an increasing demand for unique local/indigenous breeds. Regarding S-S one contributor emphasized that we should learn from the past 25 years and start realizing that exchange and improvement of for example local Zebu breeds will give the best opportunities for livestock development in southern parts of the globe.
Most of the participants agree that exchange is important, although one participant from an NGO seriously questioned the statement that there is 'mutual interdependence between countries which requires openness and exchange without too many limitations'.

The increasing demand for animal protein in the South requires further development of (new) breeds, which also implies increased exchange between regions. One contributor added that open genetic resource markets are essential for effective genetic conservation.

Participants generally feel comfortable with current exchange practises and conditions. On the other hand, several contributors said - pointing at exchange between countries - that we need better regulation of exchange. Several examples were mentioned, *inter alia,* i) exchange (import/export) sometimes has harmful effects on local AnGR, ii) introduction of breeding stock is often promoted by unsustainable subsidies or dump prices, iii) breeding collaboration projects often benefit only one of two countries involved, iv) livestock germplasm could be illegally exploited by breeders without benefit sharing, v) commercialization of a breed under a new name or vi) breeders prohibiting buyers to use offspring for further breeding.

Breeding and use

A limited number of commercial breeds produce an increasing percentage of global livestock products. Dutch breeders purchase, sell and exchange breeding material on a global scale and there is a trend towards an increasing within-company exchange of AnGR across countries. In the Netherlands, there are one or two dominant breeding companies each, for dairy, pigs and poultry, which are active globally. Acquisition of breeding companies in other countries or regions is one strategy to get access to breeding programs of other breeds. For other species (sheep, goats, horses) the system of herd books on a national scale is dominant in the Netherlands.

Breeding goals are related to production environments. On a global level, a trend is observed towards more uniform (intensive) livestock production systems creating an extended market for the breeding industry to provide breeding material across the globe. On the other hand, Dutch breeders, especially cattle breeders, stated that there is an increasing trend towards more differentiation of breeding goals on a global scale, from production only to more emphasis on health/welfare traits and depending on the specific production environments.

The experience of exporters of live animals or semen from the Netherlands is that the demand of importing countries is driven by the need to become self-sufficient and to produce animal products with low labour costs. Their choice of breeds is maybe not always a rational decision, but fashion, politics and price of the material play a role. Dutch exporters of live animals offer accompanying technical support or training courses to importing countries on management of these animals under their local circumstances. Due to strong competition on the international semen market and 'overproduction', semen that can not be sold at the home market is sometimes 'dumped' in the international market.

In the 1970s, Dutch research institutes imported exotic breeds or lines for research purposes, mostly from other developed countries. Some of this material was use to develop new breeds or lines. Nowadays, the breeding industry argues that there is no need for introgression of foreign breeds, since sufficient genetic variation is maintained within and between their own breeds or breeding lines. So far, breeding companies have not incorporated breeds lines/genes from developing countries in their breeding stock. The only serious attempt, the introgression of the Meishan breed in Western pig lines was not successful, because of the big gap in production traits between Meishan and Western pig lines.

Dutch interviewees with research and education background emphasized the need for development of sustainable breeding programmes for local breeds in developing countries, including controlled cross-breeding systems to maintain local pure-breds.

The government in the Netherlands takes no direct responsibility for animal breeding, which is considered to be primarily a private/commercial activity. The socio-economic context determines whether the use of a breed will decrease or increase. On the other hand, the Dutch government is monitoring the status of local breeds and supports *in situ* and *ex situ* conservation of AnGR. Several interviewees were positive about recent development in Europe and the Netherlands: agriculture, rural development and consumers' attitudes are changing, which provide new opportunities for (in situ) conservation of breeds.

The present livestock policies in India are primarily based on improvement through within population selection for local/indigenous breeds and cross breeding of non-descript animals with improved exotic (western) breeds to produce genotypes with improved traits for milk production, meat, wool and pelt production. Many of the local/indigenous livestock resources today are not sustainable because of their poor economic viability and little potential to respond to changing production needs. Interviewees stated that the indigenous AnGR are sure to get replaced with superior genotypes over time. Breeds that generate livelihood for small holders are viable only because of local markets and specific functions. Indian stakeholders argue that local/indigenous breeds should be further improved to a standard where they will be competitive, using available technologies.
There was another view that local/indigenous breeds are highly sustainable in low input system. It would be desirable to screen these breeds for use in difficult and low input ecologies including methods of improvement so that they continue to be part of the production system and be sustainable. It was emphasized in the Indian case study that sustainability issues have to be looked at in a very holistic manner.
Brazilian stakeholders pointed out that - although there is a tendency to close and protect breeding populations and to rely on within breed selection - the search for animals tolerant to arid climates and high temperatures certainly will intensify AnGR exchange, increasing the value of adapted breeds. In the Brazilian case study it was also revealed that research leading to sustainable utilisation of livestock germplasm is relatively expensive and requires long-term investment and commitment. The potential for Northern breeding industry in making a profit by selling improved germplasm in the South is very limited. The potential for profit in the North is higher, but there is little or no demand in the North for the traits of local/indigenous livestock that make them so valuable in the South. The net result is that Northern business continues to show little interest in Southern livestock genetic resources.

There certainly is strong evidence that, in all global regions there will be a continued strong demand for productive breeds and genes (e-conference). Both (controlled) introduction of productive breeds and development of suitable genetic improvement and characterization programmes could contribute to increased productivity. Wild relatives are currently not important in animal breeding and most of the participants agree that this is not expected to change.

Conservation

All stakeholders consulted agree that farm animal genetic diversity is under pressure and that action is needed to halt the loss of animal genetic diversity, through the development of conservation programs. On the other hand there is lack of adequate information and subsequently not a clear understanding of the current global status of AnGR. A general feeling is that we may end up with undesirable losses before we know what we have.

According to Dutch scientists, similar developments as in Europe during the last century are also likely to happen in the developing global regions. The general trend is that food of animal origin will be produced with a decreasing number of breeds or lines. Socio-economic factors determine which breeds farmers choose and this has a negative impact on local/indigenous breeds. These scientists stated that genetic diversity in Asia and Latin America is mainly threatened by the change in livestock systems and in Africa mainly by diseases and political instability. Accompanied with a further urbanization this could result in a rapid decrease in the number of local breeds.

All stakeholder groups in the Netherlands believe that the government is primarily responsible for long term conservation of AnGR. Government representatives add that they expect co-responsibility for conservation of farm animal genetic diversity from a variety of (other) stakeholders. Breeding industry/organizations in the Netherlands currently take (financial) responsibility for *(ex situ)* conservation of AnGR but also clearly state that long term conservation is by definition a task of the government. Dutch stakeholders consider *in situ* and *ex situ (in vitro)* conservation as complementary approaches. Breeding organisations said that they are willing to provide (technical) assistance for the conservation and sustainable development of native breeds, both in the Netherlands and possibly in developing countries. European farm animal breeders (EFFAB) recently agreed on a Code of Good Practice, setting out the goals of animal breeding, indicating how these goals are pursued and the rules and standards that govern the activities of breeders. Implementation of such a code is expected to influence conservation of AnGR positively.

Farmers/breeders in Brazil agree with farmers/breeders in the Netherlands that their first concern is current and future livelihood and profits. Although tradition, personal reasons or specific preferences play an important role, breeds and breeding strategies are first of all chosen from the perspective to generate income and to maintain their livelihood. Farmers/livestock keepers are, however, also concerned about loss of genetic diversity in AnGR, but they consider the government (or mankind as a whole) primarily responsible for conservation of AnGR.
In Brazil there was consensus about the general tendency towards a reduction in (within-breed) diversity, especially with the increasing use of reproductive technologies and intensive selection in breeding programmes. Therefore, conservation of AnGR is of fundamental importance as gene reservoirs for future use as environments, feed and management systems are constantly changing and adaptation traits are needed. Since the future and its needs can not be predicted, and because farmers tend to have no interest beyond the short term, the government and philanthropic organizations should be aware of the importance of conservation. Genetic characterization was considered as a powerful tool to indicate which breeds should be considered as conservation priority. Brazilian stakeholders also recognized that there are examples of special products or markets that give added value to specific breeds or populations and therefore contribute to *(in situ)* conservation.

Most of the interviewees in Ethiopia agree that there is a high loss of genetic diversity as a result of cross-breeding. However, there are also those who felt that the rate of cross-breeding is too low to threaten genetic diversity. They believe that there is insufficient exchange to cause influence on AnGR, particularly in the pastoral areas where there is practically no exchange. However, in other areas (more intensive production systems), the in-flow of poultry germplasm is very high, closely followed by the in-flow of exotic cattle and possibly sheep germplasm.

A majority of Ethiopian interviewees believe that there is an urgent need for conservation of animal genetic diversity in farm animals but most of them are unaware of potential strategies to achieve that. One interviewee was aware of some conservation initiatives with regard to local breeds (e.g. Borana and Fogera cattle, Bonga and sheep in Bale region) but stated the approach is flawed as the animals are not maintained in their original environment and the sustainability of the programme is questionable as *ex situ in vivo* conservation is expensive. In any case, it was considered that satisfying human basic needs was most important, rather than the conservation of genetic diversity *per se.* As such, as long as the importation of exotic breeds could play a better role in this regard than the local/indigenous breeds, conservation of AnGR should not be of concern, particularly in areas of high potential.

A number of interviewees in Ethiopia emphasized the need for studies to have adequate knowledge of the diversity before making a decision on what to conserve. Livestock keepers in Ethiopia did not recognise any decline in the diversity of AnGR as they consider that inflow is not significant enough to threaten the genetic diversity in their particular (extensive) production systems. Nevertheless, policies which support the introduction of exotic breeds would be welcomed if they could increase productivity within the context of the existing land scarcity.

All interviewees in Ethiopia held the view that conservation activities should be carried out for those AnGR with desirable adaptive and productive qualities and the priority was given to conservation in marginal/pastoral areas. Conservation should involve all stakeholders, although with differentiated responsibilities. For example, governments and private commercial companies may need to be more involved in *ex situ* conservation, while *in situ* conservation would be more closely associated with local communities.
Furthermore, the need for sustainable resource allocation for the conservation of endangered resources was stressed, as well as those which are economically important. Communities should be involved in conserving AnGR, supported by a specialised public institution.

Indian stakeholders indicate that Indian rich resources are at the cross road and on brink of severe erosion. The population of many breeds is gradually reducing due to several reasons, e.g. (i) declaration of Sanctuaries or National Parks in their natural habitats or (ii) implementation of Joint Forest Management programme, which restrict seasonal animal grazing, practiced by pastoral communities over many generations. Because of grazing problems camels and local cattle are sent to slaughter houses. Figures indicate an alarming scale of reduction of native animal breeds and species.
It was argued that genetic diversity should be defined in terms of special traits possessed by species or breeds. Genetic diversity is under pressure and breeds with special characteristics should be conserved on priority basis. Among e-conference participants there was a general feeling that we have lost farm animal genetic diversity (within and between breed diversity), but it was also said that a better understanding of global status of AnGR is needed. We can not conserve everything but above all should conserve what could be useful, now or in the future, which requires priority setting.

Global AnGR face many threats, but one question still is what exactly happens or will happen to farm animal genetic diversity. Changes in global production systems and loss of economic viability for local/indigenous breeds seem to be among the most important factors threatening farm animal genetic diversity.

Both during the e-conference as in country case studies it was emphasized that we should not only worry about the animal genetic part of conservation but also look at the experiences and traditional knowledge and practices of livestock keepers. This was brought forward from the perspective of both developed and developing countries.

Future scenarios

Most of the respondents to the e-conference could imagine that all four scenarios might become true in one way or another and may affect exchange, use and conservation of AnGR. The on-going globalization process will certainly affect exchange patterns and will negatively affect conservation of farm animal genetic diversity. Diseases and disasters have happened but are unpredictable. It is clear however, if such a scenario happens, this could seriously threaten AnGR. The effects of biotechnology and climate change were generally considered as long term. Both

scenarios are rather unpredictable but might have a tremendous effect on exchange, use and conservation of farm animal genetic diversity but could also have a positive effect on conservation or development of adapted breeds.

A general conclusion from stakeholder consultations was that (perceived) short term problems are limited but scenarios may have substantial longer term effects on exchange, use and conservation. Exchange may increase or exchange patterns may change, together with changes in (Intellectual) Property Rights protection and an increasing imbalance in power between the richer and poor countries of the world. Interviewees were most outspoken about the need for strengthening of a AnGR regulatory framework in the biotechnology scenario. Such scenarios or developments raise equity issues.

Globalization

A large majority of stakeholders believes that the current globalization trend will continue. Globalization will bring in considerable uniformity in animal products. Current niche products could become global and uniformity will lead to dominance of fewer breeds. Although one interviewee indicated that dominance of a small number of breeds not necessarily results in a decrease of global genetic diversity, the majority of interviewees believe that uniform, intensive production systems (in family owned or corporate farms) with the same breeds all over the world will have a strong negative effect on native breeds. Therefore it would be necessary to strengthen conservation strategies in respect to local/indigenous breeds and to create a repository of gene pools.

There was also a strong belief in the perspective of regionalization and niche markets based on AnGR. Much will depend on the viability of regional or local markets and products. The trend towards regional products is currently mainly localized in Europe but stakeholders from other regions also have a positive view on development of niche products or local markets.

It was brought forward that national governments should mainly focus on development of rural areas and of associated animal genetic diversity and livelihoods, because rural development is – compared to peri-urban developments - less attractive for the private sector and therefore lacks investments. The challenge is to support livestock development and to protect pastoralists, small holders and their breeds at the same time.

Current trends towards uniform production systems, standardization of consumer products and a move towards large scale production are expected to continue. In this respect, developing countries become increasingly dependent on developed countries providing the resources or products and they may not benefit much from globalization.
There was generally agreement that universalized demands and concepts create space for niche markets or local markets. However, in general, globalization hampers the development of local systems and the use of local breeds for food production.

Retailers and supermarkets will be leading in the globalization process. Vertical integration is expected to become the primary business model on a global scale. Small farmers and local breeds will have problems to meet the requirements for food safety and product uniformity, and to compete in global markets with corporate or large scale operations with vertically integrated enterprises. It is expected that developments in agriculture in developed countries will also happen in other parts of the world but local consumer demands in developing countries may not be strong enough to sustain specialty products.

Different views were expressed by NGO and farmers' representatives with regard to the strategies to cope with globalisation, i.e. whether the focus should be on improving competitiveness (farmers), or on protection of local producers from the impact of globalization (e.g. imports of competing goods) and from the expanding vertical integration within the livestock production and marketing sectors (NGOs). Some livestock keepers viewed globalization as advantageous in terms of increasing market opportunities, but expect the government to address issues related to animal health.

Finally, comments were made as to the lack of equal conditions to cope with globalisation, in which developing countries stay behind because richer countries have initial technologies and capital and poorer countries don't. It is expected that globalization will result in degradation of ecosystems and ecosystem services which poor people depend upon for their survival.

Biotechnology

Reproductive technologies have revolutionized the animal breeding sector and facilitated exchange of genetic material between countries and regions of the world. However, scientists are yet unclear about whether the technologies currently available or in the pipeline will find a practical application in the foreseeable future. Some claim that some of these are already there or will become available for animal breeding which could have serious impact on the characteristics and structure of animal breeding. Indian stakeholders argued that if the investments become available in identifying the genes for disease resistance, adaptability, fertility and growth, leadership of animal industries will shift to developing countries that have dense and diverse populations of AnGR.

Breeders and breeding industry realize that biotechnology has led to reduced genetic variability, mainly through widespread multiplication of individuals. Such a trend may be extrapolated when new techniques become available and when the concentration in breeding industry for cattle, pigs and poultry will further increase. Breeders in the Netherlands generally think that consumer pressure may reduce the impact of new biotechnological developments as genetic modification or cloning on developments in the breeding industry. Cloning is expected to give slightly better consumer perception than genetic transformation (GM animals).

Government representatives were less outspoken on this scenario than other stakeholders. Some consider that despite the current restrictive nature of the regulations on these technologies, the application of biotechnology in breeding and use can not be stopped in the long run. However, they also realize that animals are much more complex organisms than plants in terms of reproduction control, which will reduce the speed of application of biotechnology.

A number of stakeholders caution about serious ethical problems and potential conflicts between breeding industry and farmers. Important issues are 'food safety' or 'squeezing poor countries out of animal production'. Some claim that the major beneficiaries of biotechnology application will be the resource rich stakeholders. Poorer countries and the poor within these countries are likely to loose out. On the other hand, several biotech developments have been much slower implemented than predicted in the past. Several respondents felt they were insufficiently informed about these developments.

Biotechnology is also considered to be important for conservation, evaluation and utilization of AnGR. However, advanced (reproductive) technologies are not frequently used for local breeds (in developing countries). Others stated that those technologies are particularly well suited to further develop local breeds and that insight in resistances in diseases and abiotic stresses may even help to increase leadership in animal breeding in developing countries.

Comments were made that the impact of biotechnology may be either positive or negative depending on how it is used or regulated. Biotechnology developments will also trigger further discussions about benefit sharing arrangements and IPR.

Climate change

A majority of stakeholders involved in this study could imagine that climate change will have serious impact on exchange, use and conservation of AnGR. Especially stakeholders in India and Ethiopia were very much outspoken on this topic and mentioned climate and environmental change as one of the major future driving factors.

According to government representatives, when climate is changing drastically, adaptability of breeds will become more critical. Climate change could result in rapid and significant changes in livestock systems and their dynamics.

Such a scenario underlines the mutual dependency of countries in genetic resources. The main effect of climate change is expected to be seen in extensive livestock systems.

Breeders on the other hand stated that modern/science based breeding will go faster than climate change and can be handled by breeding companies. They realize that it will require faster adaptation of breeds than today to be able to serve a variety of production systems. Prevalence of (new) diseases might however complicate the breeding of adapted breeds.

Scientists argued that climate change will affect livestock systems mainly by effects of prevalence of diseases, but also that e.g. animals from lowland areas may replace those in the cooler highlands. Some think that climate change will lead to more frequent drought but this may affect population sizes rather than AnGR diversity *per se.* In this respect we can learn from current restocking programmes after drought. Conservation of AnGR may become a major issue when we realize that both crossbreds and traditional breeds could get lost due to lack of suitable environment.

Livestock keepers consider that the effect of climate change will be more positive than negative or are not aware of any significant change in climate. One interesting dilemma here is whether climate change will go faster than adaptation capacity of breeds or breeding programmes. A pastoralist said that effects may be less than mentioned in the scenario.

Diseases and disasters

Some case study countries have recently faced problems as a result of outbreaks of animal diseases. In the Netherlands and Brazil, such diseases were a threat to unique farm animal populations and seriously affected the export of animal products. On the other hand, in the Netherlands, recent disease outbreaks resulted in an increased interest in (conservation of) farm animal genetic diversity.

Dutch government representatives said that very strict veterinary regulations are needed and (harmonisation of) veterinary issues should play a more prominent role in WTO. Others expect that stricter zoo-sanitary regulations will operate as non-tariff trade barriers. Some scientists claim that this might strengthen the utilization of locally adapted breeds, due to their tolerance/resistance to diseases and parasites. Some southern stakeholders seek a solution in disease free-zones that could form part of a 'fair trade' framework, while others thought that this would be difficult to implement and may create an additional trade barrier. It was also argued that such disease free zones might work against the need for the free movement of livestock keepers, particularly in pastoral areas.

Many contributors underlined the threat of diseases and disasters and the impact of disease eradication programmes on local/indigenous breeds. However, evidence on such impact is limited. It is important to anticipate these serious threats and conserve animal genetic diversity through various strategies. Several contributions indicated that we need national, regional and global systems for monitoring and conservation of important AnGR.

Policy and regulatory aspects

As the CBD is an important international legally binding framework for AnGR conservation and use, it comes as no surprise that several interviewees in all case study countries have heard about the CBD. However, most of them had limited knowledge about the CBD and had limited awareness of discussions on access and benefit sharing in the context of the CBD and how this Convention could regulate AnGR. This general remark does not apply to India, where awareness was high with all interviewed stakeholders. Several respondents claimed that there is a great divide - in terms of interests in a better policy and regulatory framework for AnGR - between policy makers or institutions and the people/farmers who have to live with the policies.

Conservation and sustainable use

Various stakeholders consider national governments as primary responsible for conservation and for coordination of national, regional and/or global conservation programmes for AnGR. The Dutch government expects a co-responsibility of the private sector in conservation of AnGR. Respondents in Ethiopia said that the private sector could be engaged in cryo-preservation but only in a regulated manner.

Many respondents stress that national sovereign rights on genetic resources as defined under CBD should always go hand in hand with the responsibility to protect these resources and promote their use in a sustainable way. All case study countries have general policies for genetic resources which are usually the same for animals, plants and micro-organisms. Many respondents called for more appropriate policies at national level to enhance and control sustainable use and conservation of AnGR. There were different opinions about the appropriate level to develop policies or regulations. Some said that conservation and sustainable use should be dealt with at national level, but there are also many issues which should be dealt with both at national and international levels.

Possible policies or regulatory options should be dealt with at national level first, but several options have an international dimension. The majority of stakeholders from the south argue that an international regulatory framework should be further developed for AnGR. Others warn that new regulation might hinder or block exchange or did not consider further international regulations useful as they rarely have an effect at the local level. An international financing mechanism to support conservation was considered helpful though. The development of international gene banks was not considered realistic as countries may want to retain their sovereign control over access. One interviewee emphasized the importance of bilateral or multilateral cooperation to preserve genetic diversity still existing in the South. The conservation of regional transboundary breeds may require regional cooperation especially where pastoralists cross borders. A global over-arching AnGR committee was suggested to monitor trends and intervene where necessary.

A majority of stakeholders feel that special provisions are required for agricultural genetic resources, and within that AnGR. Most policies are directed solely to plant genetic resources and as such inadequate in the present and future scenarios in the livestock sector. Some argue that such policies should even accommodate the enormous differences between the different animal species in terms of available diversity, organization of breeding and conservation, and opportunities to apply complementary conservation strategies (*ex situ* and *in situ*).

Policies should assist a good balance between *ex situ* and *in situ* conservation. *Ex situ* should complement *in situ* and should be supported by government and commercial users. Emergency cryopreservation programmes created debate among stakeholders as there was concern that developing countries do not have the capacity to implement actions to conserve their genetic resources.

In situ conservation should get the highest priority in the countries of origin of the breeds and the primary responsibility lies with the communities who already have a tradition of managing such breeds. When traditional knowledge is associated to genetic resources, the responsibility to guarantee protection of this knowledge lies with the governments. Government and civil society should support these communities. Regulations may be needed to support different conservation objectives.

Exchange

Views on whether exchange, import and export should be regulated differ widely and diverging views can often be related to the stakeholder group of the respondent. For example, several stakeholders from the North believe that there is no need to interfere in animal breeding and exchange with further legal or administrative means and that 'access and benefit sharing' is above all a question of supply and demand. In this view there are serious doubts about the appropriateness of a similar regulatory framework as for PGR. The ownership and exchange situation of AnGR is totally different from that for PGR.

Dutch government representatives argued that governments should want to be involved only in case of problems and they are not aware of any substantial problems in trade of AnGR. They suggested to first of all promote

'transparency' and 'information exchange' about exchange, use and conservation of AnGR, before going into complicated processes towards new policy or regulatory frameworks.

In a majority of countries, introduction/import of foreign/exotic genetic material is primarily a decision of the breeder, regulated through veterinary law only. There is usually no restriction, except for zoo-sanitary reasons, on the import of semen. Sometimes veterinary and zoo-technical (breeding) regulations are used by importing countries for breed protectionism purposes, as was argued by breeding organizations. Animal diseases and sanitary regulation could seriously impact AnGR, it was observed that veterinary officers seem have limited knowledge and interest in biodiversity issues.

Dutch interviewees, especially with a background in research and education, argued that breeding companies who sell genetic material all over the world should also feel a social responsibility when they sell exotic breeding material to developing countries. On the other hand developing countries should regulate the import and use of exotics and the conservation of their local breeds themselves. The joint responsibility of exporters and importers with regard to the potentially negative impact of exchange was also supported in the e-conference. It should be investigated whether 'soft instruments', such as protocols, declarations, a code of conduct for exchange or a model MTA could work out well.

Most of the interviewees in Ethiopia were not aware of any policies, regulations and laws (both at national and international levels) which affect exchange, conservation and use and many consider it important to raise awareness. Import of semen is regulated by zoo-sanitary regulations and there is no official import of live animals (many border crossings), with the exception of day old chicks. It is thought that necessary productivity increase and germplasm exchange (import) will necessarily result in breed dilution. Government representatives mentioned that policies and regulatory options are needed which encourage the sustainable use and conservation of local/indigenous breeds. Strategies to adapt zoo-sanitary restrictions for export and empowerment of cooperatives through credit and information are seen as useful for the promotion of AnGR. Some of the interviewees believe that ABS policies should be handled at international level, while conservation and sustainable use of transboundary AnGR and zoo-sanitary issues should be dealt with at a regional level. It was proposed (also in the e-conference) to regulate the export of threatened local breeds. In Ethiopia there is, however, no indication of any export for breeding purposes at this moment. However, the export trade in live animals for consumption could be also used for breeding purposes. A number of Ethiopian interviewees have raised this concern and if so there has to be a system to address such issues as it is a form of genetic material exchange.

In India, presently the exchange of AnGR is allowed through a system based on benefits to both the seller as well as the buyer and is regulated by Indian Biodiversity Authority through the Indian Biodiversity Act. The system is in place and interim guidelines for import and export of germplasm have been developed. The import and export of the cattle/buffalo germplasm is under restriction and is only allowed when the license is issued by government authorities.

Although a majority of respondents in the e-conference indicated that they feel rather comfortable with current exchange practices, it was suggested that streamlining of equitable ABS regulation is needed, in particular to anticipate future developments. Regarding import, evaluation of 'exotic' breeds in the relevant environment could be part of the agreement with an exporter. This may be required to establish the adaptation of the breed to the local environment and its socio-economic impact and/or to assess the potential 'genetic impact' on local AnGR, backed by a monitoring system. However, a requirement to sustainably use the imported genetic resource might be hard to assess.

Access legislation in Brazil is very restrictive, mainly developed for plants and AnGR are not specifically mentioned. It is not the intention to make access difficult. Researchers need to first obtain government authorization to access genetic resources of interest or to exchange it within the country or with foreign institutes. The legislation appears not to be clear enough, creating several obstacles. Brazilian research and education representatives indicate the need for regulations that are adapted to the animal sector.

The government view in India is that similar mechanisms as developed for plants should – with slight modifications - also be applied to AnGR. Among other countries, India developed a Biodiversity Act, which includes access legislation. Indian stakeholders argue that a multi-lateral dialogue between countries is needed to discuss AnGR issues at the international level.

Indian respondents (research and education) indicate that exchange should be restricted if there is any advantage to the country to do so. Access to germplasm within India for research and use is not restricted but access to germplasm for outside countries is restricted. Stakeholders generally agree that access could be made free if numbers of animals of a certain breed is above a certain threshold. Laws should be transparent and farmers representatives in India argue that regulations should be clearly in favour of development of genetic resources. They underline that cross-breeding programmes and development of the poultry industry would not have been possible without access to AnGR from the North.

Regarding benefit sharing, Indian stakeholders stated that ownership issues have to be clearly defined. In case of AnGR the ownership has to be recognized at two levels. The animal is owned at the individual level and ownership of the breed vests with the community. Communities which have developed particular breeds should receive benefits. This is distinct from national interests. According to Indian stakeholders, benefit sharing mechanism should be further developed; at present benefit sharing is primarily a commercial transaction. Although commercialization can create benefits and value addition for local communities, they also must have the right to deny access to biological resources and/or indigenous knowledge if they feel local interests will be adversely affected by commercialization.

In the Netherlands, government respondents confirmed commitment to the CBD, but were not in favour of developing further (binding) instruments on ABS, either national or international. Current trade practices and (potential or real) problems related to exchange should be a starting point for the discussion on regulating AnGR. One representative stated that government interference often leads to complicated rules that block rather than support development and that soft law or voluntary protocols may work out better (code of conduct, model MTA). For example, zoos have a model document stating that the ownership of animals remains in the country of origin which means that a buyer/user never can get exclusive rights on the genetic resources. Transparency, information exchange and descriptions of the origin of genetic resources need further improvement.

Dutch breeding companies also suggested the development of basic exchange rules which can be accepted by all stakeholders. No exchange should be realized without a contract or Material Transfer Agreement. Ownership and benefit sharing can be regulated in these contracts between parties.

Many e-conference participants touched upon the ethical side of exchange, conservation and use in relation to ownership, IPR and ABS. One view was that livestock are private property and owners should be able to trade their animals as they like, and ABS is a matter of supply and demand. Others however doubt whether market mechanism can be equitable when it comes to exchange between countries or regions, where countries with advanced knowledge and technology may get more benefits out of using the resources than others. Several contributions to the e-conference mentioned examples of exchange which were not considered equitable.

Many contributors were outspoken about the need to acknowledge and protect the rights of livestock keepers, pastoralists or farmers. From the perspective of livestock keepers and their communities, gene flow should remain open and property rights should be given to those who kept the genetic resources for generations.

A majority of contributors to the e-conference said that - if effective regulatory mechanisms are in place - there is no need to distinguish between N-N, N-S, S-N and S-S exchange. ABS issues may however become more relevant in a biotechnology scenario. Exchange agreements should be carefully formulated to facilitate access and guarantee equitable benefit sharing. Some suggested the need for development of a standard or model MTA which could be used by different parties for exchange purposes. Respondents from Brazil, however, claim that prices of animal products and profits are low and decreasing, which may not support high expectations regarding benefit sharing. This was supported by Dutch breeding organisations and also Indian stakeholders argue that given the present

technology there is not much to share at present. On the other hand it is suggested that special traits or genes may become important at some points in time.

Property rights

Livestock keepers generally believe that when you buy an animal or when you buy semen, you are the owner of the material and of the opportunities it provides. Livestock keepers in Ethiopia consider any other type of rights are unenforceable in their situation. This is also supported in The Netherlands, where, for example, Dutch breeders/farmers feel that they got a fair price for the exported Dutch Friesian cattle around 1880 and do not blame others for commercializing breeding materials that were developed further. Another example from the Netherlands is when farmers sell bulls to a breeding company, they have the choice to sell for a one time payment or for a lower price in combination with a royalty percentage when the bull is successful. Farmers feel that this is a fair system, but they always have to negotiate. On the other hand, farmers or farmers' representatives also say that farmers should get a reasonable share of the benefits arising out of the use or further development.

Interviewees from breeding organizations in the Netherlands stated that breeding industry needs to protect its investments. The most common way of protection of AnGR is 'biological protection'. The owner of the animal or germplasm decides whether to sell or not to sell and for which price. In addition, the selling of only one sex of a breed/line or selling hybrids only are strong forms of protection. Pig and poultry breeding companies commonly sell animals under a contract disallowing the buyer to sell breeding material from the purchased animal or involving the payment of a royalty when selling breeding stock. In addition a gentlemen agreement among pig breeders says that genetic material of competitors will not be used for further breeding.

Above all, accurate registration and maintaining reliable information is considered key to the protection of the breeders' interest. Breeding associations or herd books are strong tools in this respect. In a few horse breeds (Friesian, Icelandic) breed associatons are active at a global level and have registered their herd book as a trademark internationally. Respondents from India confirmed the potential value of breed associations, herd books and herd registration schemes.

Breeders' strategies in both The Netherlands and Brazil are based mainly on capturing the market through accelerating genetic improvement and the use of contracts rather than the protection of knowledge and breeding materials through intellectual property rights. This may however change for species with shorter breeding cycles and higher reproduction rates, and when the application of biotechnology results in increased investments in breeding.

Respondents in The Netherlands do not consider 'animal breeder's rights' (comparable to the UPOV system for plant varieties) an option in animal breeding. There is a high genetic and phenotypic variation within breeds and lines, it is not possible to make a clear distinction between offspring of different breeding programs and the ownership of a breed is not clear. However, it could be useful to have a protection system when a distinct breeding population is developed, based on one or more unique and heritable traits.

The discussion on intellectual property rights is quite complex, where interviewees in India indicated that within the national framework for intellectual property rights to AnGR, community ownership should be respected, since indigenous/local breeds have been developed by livestock keepers, communities or breeders over many years. Respondents in Ethiopia consider that this could be achieved through livestock keepers' rights and the use of prior informed consent. However, since such policies are commonly initiated from the top down instead of participatory and consultative, there could be serious problems at the implementation stage.

Government stakeholders in The Netherlands stated that there might be a conflict at first sight between the public good nature of genetic resources within national sovereignty and (multinational) private ownership of (highly) selected breeding material. Government interviewees in The Netherlands agree on the need by industry to protect their investment in a new application or intervention, but also underlined that IPRs should never prohibit original owners of resources or knowledge to continue their use of it.

Industry files patents to anticipate future developments and to stay in front of the competitors. Globalisation trends are likely to lead to more patents. The industry from the developed world, however, does not need patents to compete with the developing world. An interviewee in The Netherlands said that it is too late to keep genetic resources in the public domain, because there is no incentive for development or conservation in the public domain. It was claimed in addition that in animal breeding it is not access to the genetic resources, but the associated knowledge (on breeding value) that is the most valuable. The value of the resource is only known after extensive comparisons and characterizations and is sensitive to specific production circumstances.

Patenting of genes or breeding processes raises a lot of discussion among different stakeholder groups and regions. In the e-conference it was said that commercialisation of breeding products is - except veterinary restrictions - regulated by the market but the situation will change dramatically if more genes and breeding processes will be patented in the future. Many contributors believe that patenting promotes innovations, but others claim that they have also been used to stop innovation (by others). Several – notably (international) NGO representatives - are very critical about patenting of life forms. Countries have different patent laws and a number of contributions suggest prohibiting patents on living animals and on technologies such as terminator technologies. There is a general feeling that patent law should be amended to suit animal breeding/research on animals and to contribute to sustainable development.

Several contributions to the e-conference hold the view that non-patent IPRs, such as trademarks and geographical indications could serve as a tool to bring benefits to producers and breeders and especially to generate added value to local breeds and their products in niche markets, in particular where they cannot protect the breeds themselves. Different ideas exist on whether re-naming of exported breeds or commercial re-exporting of breeds to the country of origin should be considered fraud or robbery.

Several contributionsto the e-conference strongly called for livestock keepers/community rights which are related to several other issues as 'grazing rights', decline of commons and specifically to the conservation of local/indigenous breeds. It was stated that the first level of protection should be national. Developing countries or NGOs that emphasize the importance of livestock keepers rights also argue that – on top of the national level – an international treaty is needed that includes the rights of traditional livestock keepers, their breeds and traditional practices. How such a system would look like was however not specified. Such rights should be seen in the light of general agricultural policies: agrarian reform and land tenure issues have big influence on conservation. In Brazil there is a worry about social movements that are pushing towards agrarian reform, associated with a reduction of farm size, due to subdivision of properties among heirs these stakeholders. In stead, there is also a call for increased productivity, with harm for conservation and utilization of locally adapted breeds.