

Section C

Conservation programmes

1 Introduction

The SoW-AnGR reporting process has significantly contributed to increasing the awareness of threats to the diversity of AnGR and the need for their conservation. In many countries, it resulted in the approval of national strategies for the management of AnGR conservation programmes, and better coordination of the existing often scattered activities. In countries with weak involvement of the state, it led to the establishment of national bodies for AnGR conservation. The rationale for conservation varies among countries and regions. In some cases, commitment to the principles of the CBD represents the major driving force, while in other cases the prevailing motivation is awareness of the potential importance that breeds currently at risk may have for future production. In some countries, conservation of AnGR is carried out within broader programmes of rural development and environmental management. In the majority of European and in some Asian countries, conservation of AnGR is regarded as an aspect of safeguarding cultural heritage.

The significance of threats to AnGR, particularly of the pressure towards the intensification of livestock production, varies from region to region, as does the current state of genetic diversity, and the economic and social importance of livestock. From a global perspective, a lack of adequate conservation measures is generally of greatest concern when it occurs in situations where the threats of genetic erosion are great and where losses, if they occur, will have large impacts on the diversity of the world's AnGR and on the future socio-economic functions of livestock. Unfortunately, in many such locations,

governments lack awareness of the threats and their potential effects.

The prospects for a breed depend to a great extent on its present and future function in livestock systems. As circumstances change, certain breeds are set aside and are faced with the danger of extinction unless action is taken. There are several reasons why the implementation of conservation measures for a particular breed might be considered important: genetic uniqueness; a high degree of endangerment; traits of economic or scientific importance (unique functional traits); and ecological, historical or cultural value (Oldenbroek, 1999). The reason for conservation will, to some extent, determine the effectiveness of the conservation measures. This section discusses conservation from the perspective of ensuring that between and within-breed diversity is maintained for future functional use.

PART 3

The section⁹ draws on the information provided in the 148 Country Reports available by July 2005, in order to describe the state of conservation around the world. The analysis is presented on the basis of seven regions and six species. Where relevant, differences between subregions are presented, and the roles of different stakeholders are discussed.

Only a very few Country Reports provide information on the specific values of breeds included in conservation programmes, or present information on the pedigree of animals under conservation programmes, the number of males and females per generation, or on mating schemes at the species or breed levels. Thus, the status of conservation is presented here mainly by showing the number of breeds and species indicated by the Country Reports to be included in conservation programmes.

Theoretically, three types of conservation measures can be implemented: *in situ* conservation, *ex situ in vivo* conservation and *ex situ in vitro* conservation (see Box 94 in Part 4 – Section F). In practice, the distinction between *in situ* conservation and *ex situ in vivo* conservation

can be rather vague. In the Country Reports, the distinction is often not clear. Therefore, for the purposes of the quantitative analysis presented below, only two types of conservation are distinguished: *in vivo* (including both *in situ* and *ex situ in vivo*) and *in vitro (ex situ)* conservation. Another problem relates to the difficulty of distinguishing *in situ* conservation from “sustainable utilization” (see Part 4 – Section 1 for a discussion of this issue). It is therefore possible that some of the examples of *in situ* conservation mentioned in the Country Reports would in fact be better described as instances of sustainable utilization of the breeds in question.

2 Global status

Fifty-two percent of Country Reports indicate the presence of *in vivo* conservation measures, while only 37 percent indicate the presence of *in vitro* conservation (Table 77).

For *in vitro* conservation well-established genebanks are present in Japan, India, the Nordic countries, France, the Netherlands, Poland, the Czech Republic and Hungary. In some countries, the establishment of genebanks is planned: the United States of America, China, the Republic of Korea and Viet Nam. Semen is preserved from all the main species, and embryos of cattle, sheep and goats are also stored. Only a few genebanks store poultry and horse semen. Sometimes tissue DNA samples are also collected in the main species. Genebanks have been initiated by governments or NGOs supported by universities and research centres. In a number of countries the SoW-AnGR reporting process accelerated measures aimed at ensuring coordination among genebanks and the establishment of national databases. In developed countries, there is strong collaboration between genebanks and the animal breeding industry and breeders' associations with respect to the collection of genetic material. In developing countries that

⁹ Notes on the analysis.

The quantification and assessment of conservation programmes is hampered by the following factors, which make it difficult to formulate strong conclusions.

Not all countries use the same definition for local breeds (e.g. all breeds present, breeds originating from the country, or breeds adapted to the local conditions). Thus, the numbers presented for local breeds in conservation programmes have to be treated with caution, and this is the reason why the proportion of local breeds conserved was not calculated.

There is some inconsistency in the Country Reports regarding the definition of *in vivo* conservation programmes. Some countries consider that a breed is being conserved *in vivo* when it is kept by small holders or hobbyists, whereas other countries do not consider this type of activity to be a conservation programme. Some countries classify the storage of semen stock at an AI centre as an *in vitro* conservation programme, while others consider that an *in vitro* conservation programme exists only if there is a separate genebank facility.

The data are extracted from individual Country Reports written between 2002 and 2005. In this period conservation programmes were under development in many countries. So, for some regions the state of conservation programmes will already have progressed since the analysis was carried out.

TABLE 77
Number of countries with conservation programmes

Region	Subregion	Number of Country Reports analysed	Number of countries with <i>in vivo</i> conservation	Number of countries with <i>in vitro</i> conservation
Africa	East	7	2	1
	North & West	24	10	4
	Southern	11	6	4
	Subtotal	42	18	9
Asia	Central	6	2	2
	East	4	3	3
	South	7	4	3
	Southeast	8	4	4
	Subtotal	25	13	12
Europe & the Caucasus		39	33	25
Latin America & the Caribbean	Caribbean	3	0	0
	South America	10	5	5
	Central America	9	3	1
	Subtotal	22	8	6
Near & Middle East		7	1	0
North America		2	2	2
Southwest Pacific		11	2	1
World		148	77	55

implement *in vitro* conservation measures, activities are limited to storage of semen from some local cattle and sheep breeds at private or governmental institutions.

3 Stakeholders

The Country Reports indicate that many stakeholders are involved in conservation: national governments, institutes for research and education such as universities, NGOs and breeders' associations, farmers and pastoralists, part-time farmers and hobbyists, and breeding companies. This chapter provides a brief overview of the roles of the various stakeholders.

3.1 National governments

In countries where conservation programmes for AnGR are established, it is national governments that play the crucial initiating role. They provide the legal base for conservation programmes either under legislation relating to the protection of biodiversity or under legislation regulating the management of AnGR, livestock production and breeding. They are partners in the development of national strategies for the management of AnGR, and they also provide funding for implementing institutions, including partial funding of conservation activities carried out by NGOs.

In some African and Asian countries, national governments are involved in breeding activities, often with the aim of increasing national self-sufficiency in food of animal origin. In most cases

PART 3

they own nucleus farms, where local or exotic cattle are kept. These nucleus farms sell breeding stock (males) to improve populations owned by (often small) farmers. The system plays an important role in the conservation of the breeds in question. The farmers keep a large number of animals, and the nucleus farms take care of the genetic diversity of the populations.

In a number of European countries, government policies are increasingly focused on conservation and landscape enhancement in rural areas where the economic viability of farming is limited. These policies are supported by state funds and, in case of the EU, by communitary funds (see the discussion of Council Regulation (EC) No. 870/2004 in Section E: 3.2).

Grazing animals, particularly well-adapted breeds of sheep, cattle and horses play an important role in nature management. This role offers an excellent opportunity for the conservation of these species as large numbers of animals are potentially involved. In parts of Europe, governments are also motivated to maintain livestock breeds for socio-economic or cultural and historic reasons. There are many types of governmental institutions, including therapeutic farms, prisons, demonstration farms, farm parks and museums, at which local breeds may be kept. The number of animals conserved in such locations is generally low, leading to risks of inbreeding and random loss of alleles that have a low frequency in the population.

Box 35 Mali – role of the government

In Mali, conservation activities have been initiated by the government on research stations and experimental farms. These actions have mainly involved Maure, Peul Soudanais, Peul Toronké and N'dama cattle breeds.

Source: CR Mali (2002).

3.2 Universities and research institutes

Farms linked to universities and research institutes are often involved in selling breeding animals or conserving local breeds. They combine these activities with their primary tasks of educating students and carrying out research. Many universities and research institutes try to conserve locally developed breeds, which are no longer used by the industry. They pay a lot of attention to the maintenance of genetic diversity within these populations. However, their role is threatened by cuts in public funding.

3.3 Civil society organizations and breeders' associations

In many developed countries, NGOs conserve and stimulate the keeping of local breeds by (often part-time) farmers and hobbyists. These NGOs and their members play an important role in the conservation of local breeds of chickens, horses, sheep, goats and cattle. One of their objectives is to demonstrate the cultural and historic aspects of breeds for the purpose of education and recreation; another is to produce special products for niche markets. In general, their knowledge of conservation genetics is limited, and the participation of individual breeders in breeding and conservation programmes is often on a voluntary basis. As such, the activities of these organizations do not guarantee the conservation of genetic diversity for future commercial/productive use. However, in many countries (e.g. the Czech Republic) research institutions and universities provide expertise and professional support for conservation activities carried out by breed associations. In addition, national coordinating bodies, governmental inspections, and control of state subventions ensure adherence to national conservation plans.

3.4 Farmers

In Europe and in North America, some farmers target niche markets where they can sell speciality products from local breeds, often

kept without heavy use of external inputs. In these circumstances, the local breeds are often an integral part of the brand – this provides an opportunity for profitable production utilizing breeds that would otherwise be uneconomic. Strict regulation of food production and the associated high levels of investment required can, however, present hurdles to the profitable exploitation of niche markets. In many countries, farmers or farmers' organizations have become involved in organic production. In some cases, traditional breeds are favoured in organic systems because of their good adaptation to the management conditions, and for marketing reasons. Potential opportunities to export organic products are increasingly recognized in many eastern European countries. These developments stimulate interest in a range of traditional or locally adapted breeds, and create a base for breeding and *in vivo* conservation programmes.

In a number of African countries, the continued use of local AnGR within traditional low external input production systems is considered to be the form of conservation that best suits the local conditions, and avoids problems related to the lack of financial resources for other forms of conservation. Uncontrolled mating, changes to traditional production systems and indiscriminate cross-breeding are, however, among the significant risks in this form of conservation.

3.5 Part-time or hobby farmers

The number of part-time farmers and hobbyists keeping farm animals is increasing in the Europe and the Caucasus, North America and Southwest Pacific regions. Most livestock species except the pig are kept for hobby purposes. These hobbyists play an important role in the conservation of local breeds. However, conservation is not their major goal, and their knowledge of the genetic management of populations is rather limited. Conservation programmes performed by hobbyists require special attention from the responsible authorities to make them effective.

3.6 Breeding companies

In Europe, North America and Australia, pork production is highly industrialized and a few transnational breeding companies dominate production chains. These companies develop a few lines from a limited number of breeds which are then used globally. Frozen semen is used for the dissemination of genetic progress, and frozen semen and frozen embryos are used to transfer genetic material on an international scale. In the poultry industry, only three transnational companies are actively selling highly specialized hybrid layers and broilers at the global level. The number of these specialized chickens is increasing very quickly, mainly as the result of intensive marketing by the layer and broiler industries. Specialized dairy and beef breeding is also a transnational activity in which frozen semen and embryos are used to disseminate the genetic progress achieved in the countries and herds of origin. In the pig and poultry sectors, the top-ranking animals in the breeding populations are owned by the large breeding companies. In genetic improvement programmes for the pure lines, attention is paid to the effective population size in order to avoid inbreeding. The companies do not want to limit their future scope for selective breeding. Genetic diversity within the breeds kept is therefore conserved within these programmes.

4 Conservation at species level – status and opportunities

Table 78 gives the number of breeds per species conserved *in vivo* and *in vitro* at the global level.

4.1 Cattle

For high-input systems, specialized breeds of dairy or beef cattle are developed through intense selection, and their genetic material is widely disseminated. Nucleus breeding has started in dairy cattle, but there are still a lot of dairy farmers who participate in breeding activities. On a global level, intense selection for a few production traits, and

PART 3

TABLE 78

Conservation activities at the global level

Breeds	Cattle	Sheep	Goat	Pig	Chicken	Horse
Local	897	995	512	541	1 077	570
Regional transboundary	93	134	47	25	55	63
Conserved <i>in vivo</i>	324	261	109	120	194	149
Conserved <i>in vitro</i>	225	111	44	140	87	33

Regional transboundary breeds are defined as breeds that occur in more than one country but only within one region (see Part 1 – Section B). The countries will probably consider most of these breeds to be local breeds with regard to their origin, as they have a limited regional distribution and have been developed under specific environmental conditions. The number of conserved local breeds stated in the Country Reports, may therefore include regional transboundary breeds. More than one country within a region may conserve the same “local” breed. Thus, the number of distinct breeds conserved may be lower than the number given in the table, which was obtained by summing the number of local breeds conserved in each country. In some countries, even international transboundary breeds (see Part 1 – Section B) might have been counted as locals if they have been in the country for a long time and have adapted to the local conditions. For example, some West African countries consider their Jersey cattle introduced 100 years ago as adapted local breeds.

a large exchange of semen from the best bulls has led to low effective population sizes in the most popular dairy breeds – with a real risk of losing genetic diversity in these breeds. The problem can be avoided by better genetic management at the global level, or by the use of breeding goals with multiple objectives, such as are utilized in some Nordic dairy cattle populations – best illustrated and documented in the Norwegian Red Cattle (Box 83 in Part 4 – Section D).

In the dairy sector, the Holstein-Friesian breed dominates, and in the beef sector, French beef breeds are likely to obtain a similar position in the future. In many countries, these specialized breeds are used for upgrading to improve the performance of local breeds. Only in a few situations are stable cross-breeding systems developed, in which populations of the local breeds are used and conserved. In some countries, dual-purpose cattle breeds are used for organic farming, for emerging functions such as landscape and nature management, or are kept as suckler cows by hobbyists. In all regions, conservation programmes need to be developed for local cattle breeds and for multipurpose breeds that will no longer be used for their original functions (e.g. traction).

In the development and use of specialized breeds, artificial reproduction techniques in

combination with cryostorage play an important role. The availability of this technology has created the option of cryoconservation, which has been widely used in the case of semen, and to a lesser extent in the case of embryos and oocytes. Relatively large numbers of cattle breeds are involved in *in vitro* conservation programmes. However, in Africa, Asia, Latin America and the Caribbean, the Near and Middle East and the Southwest Pacific, the development of cattle conservation programmes should be further encouraged, particularly in view of the high adaptation of local breeds to the low to medium external input production systems which prevail in these regions.

4.2 Sheep

In regions and countries with high external input livestock systems, such as Europe and the Caucasus, North America and Australia, the number of sheep has declined in recent years. Sheep wool now has a low economic value, and this is a threat to some breeds. In Europe, nature management is emerging as an important function for this species. This role offers an excellent opportunity for *in vivo* conservation, because of the large flocks required for these purposes.

In small-scale farming systems in Africa, Asia and the Near and Middle East, as well as in eastern

parts of the Europe and the Caucasus region, sheep are still important for meat or milk production, and in some religions have a ceremonial function. These roles guarantee continued utilization of the species. Nonetheless, *in vivo* conservation programmes need to be developed in regions such as the Southwest Pacific and Central Asia, where there are major declines in sheep numbers, and in regions or subregions with a high diversity in their sheep populations, such as the Near and Middle East.

AI and freezing techniques for sheep genetic material are well developed, but are not widely used. Semen is stored only in the genebanks of developed countries as a means to protect AnGR against disasters such as major disease epidemics. *In vitro* conservation programmes with similar objectives should be established in developing countries.

4.3 Goats

The goat's importance in small-scale farming systems for milk and meat production, and the wide variety of conditions under which it can be kept, guarantee continued utilization. In general, this species is not faced with very significant threats. As such, *in vivo* conservation activities targeting goats do not generally seem to be a particularly high priority. AI is only practised in a limited number of breeds, almost exclusively in developed countries. This is the reason why only a few breeds are preserved by *in vitro* methods. As a precautionary measure, *in vitro* conservation of goat genetic material should be given more attention globally.

4.4 Pigs

As discussed above, in Europe, North America and Australia pork production is dominated by a few transnational companies. As the breeding industry becomes more concentrated, many breeds and lines are taken out of production. In a number of regions including Europe and the Caucasus, Africa and North America, relatively few local pig breeds exist. Conversely, in East Asia

there are many local pig breeds. The latter need careful monitoring, and may require additional attention in future conservation programmes because of the threat posed by the increased use of exotic breeds.

The speed of industrialization and specialization, in combination with the lack of opportunities for the *in vivo* conservation of pigs means that this species requires special attention in conservation programmes. Frozen semen is used for the dissemination of genetic progress, and frozen semen and frozen embryos are used for intercompany exchange of genetic material between populations present in different countries. These activities have created a base for *in vitro* conservation in pigs. In Europe and Asia, many of the lines and breeds that are set aside in breeding and cross-breeding programmes, are conserved *in vitro*. However, the status of conservation measures should be monitored in order to identify additional activities that may be required.

4.5 Chickens

In Europe and North America many universities and research institutes try to conserve locally developed (dual-purpose) breeds of chicken that are no longer used by the industry. Many universities have developed experimental lines for a variety of purposes. In many cases, the birds are now scheduled to be culled for budgetary reasons. In eastern Europe, many highly selected lines, bred in the period of the "cold war", are still in existence and should be considered for conservation. In some European countries, some small companies remain involved in the production of layers and broilers, but their number is rapidly declining. In developing countries, the role of chickens in small-scale farming, and the preference of local people for meat from local birds will promote the continued use of many local breeds. In the developed world, many people keep chickens as a hobby, and this provides an opportunity for *in vivo* conservation.

For chickens, *in vitro* conservation of semen is a recent development. Frozen semen from local

PART 3

breeds is stored only in a few Asian and European countries. *In vitro* conservation of local breeds, recently developed dual-purpose breeds, and lines which are set aside, should get a high priority at the global level. The spread of highly pathogenic avian influenza (HPAI) in 2005/2006 illustrates the risks for a species kept at high densities all over the world.

4.6 Horses

In the past, horses were mainly used for draught and transport. The mechanization of transportation, and later of agriculture, has meant that in many parts of the world horses are now bred almost entirely for leisure purposes and are mainly kept by hobbyists. Many breeds are used in several countries, but international breeding management is rarely reported. The only exceptions are the Icelandic Horse and the Friesian Horse, for which the Icelandic and the Dutch herd books, respectively, coordinate breeding activities and keep control of genetic diversity within the breeds.

The existence of a wide variety of leisure activities involving horses may stimulate the maintenance of genetic diversity within the species. In general, however, the genetic diversity within local horse populations is threatened by the wide use of a few popular stallions. "Heavy" (cold blood) breeds, originally bred for draught purposes, are often threatened; in some countries they are now kept only for meat production.

For horses, *in vitro* conservation of semen is a recent development. In a few countries, frozen semen from local breeds is stored. *In vitro* conservation of local "heavy" breeds should be treated as a priority.

5 *In vivo* and *in vitro* conservation programmes – regional analysis

5.1 Africa

A large part of the human population of Africa is poorly nourished, and self-sufficiency in food production is a major objective for many governments. Policies aimed at increasing food production, have encouraged local breeders to use exotic germplasm to replace local breeds (chickens), or for cross-breeding/upgrading (cattle and sheep). These activities are not accompanied by adequate breeding and conservation programmes, and threaten many local breeds. The expansion of high external input livestock systems using exotic breeds, along with the threats to local breeds posed by droughts, disease epidemics and political instability reinforce the need to implement *in vivo* and *in vitro* conservation on a wide scale as soon as possible. Achieving this, however, will require a greater awareness of the issue.

Eighteen out of the 42 Country Reports from Africa describe *in vivo* activities. In nearly all these countries the conservation activities are restricted to a few breeds in each species. The number of breeds conserved in goats, pigs, chickens and horses is very low (Table 79).

In comparison to other species, phenotypic and genetic characterization in cattle and sheep is relatively well documented in past and recent literature. For the other species, some phenotypic characterization of local breeds can be found in (historic) handbooks and in recently developed databases. Breeding theory is well developed in various institutes and universities. However, breeding and conservation programmes are difficult to perform, because of a lack of data on population sizes, identification systems and pedigree recording. The knowledge and skills required to implement such programmes are scarce, and the necessary infrastructure is not available. Some countries mention that *in vivo* conservation is performed by pastoralists and small-scale farmers who keep the breeds. However,

TABLE 79
Conservation activities in Africa

	Cattle	Sheep	Goat	Pig	Chicken	Horse
East Africa						
Local breeds	59	30	35	2	14	4
Conserved <i>in vivo</i>	4	1	1	0	0	0
Conserved <i>in vitro</i>	0	0	0	0	0	0
North & West Africa						
Local breeds	44	49	29	25	49	24
Conserved <i>in vivo</i>	27	10	6	4	0	3
Conserved <i>in vitro</i>	5	1	1	0	0	0
Southern Africa						
Local breeds	51	30	22	22	26	8
Conserved <i>in vivo</i>	12	7	3	2	1	2
Conserved <i>in vitro</i>	6	0	0	0	0	0
Africa						
Local breeds	154	109	86	49	89	36
Regional transboundary breeds	35	27	15	2	6	7
Conserved <i>in vivo</i>	43	18	10	6	1	3
Conserved <i>in vitro</i>	11	1	1	0	0	0

Refer to footnote under Table 78.

it is doubtful whether it is really appropriate to describe these activities as conservation programmes.

Most of the programmes described in the Country Reports, include an important role for nucleus herds of local animals kept at governmental or institutional farms. These farms

sell breeding material and are used to educate local farmers. None of the Country Reports document a well-established conservation plan.

The analysis reveals major differences with respect to conservation activities between the three African subregions. Only 9 of the 42 Country Reports indicate the presence of *in vitro* activities (Table 77). In nearly all these countries the conservation activities are restricted to a few cattle breeds (Table 79). The knowledge necessary to implement such programmes is scarce, and the required infrastructure (e.g. liquid nitrogen facilities) is not available, or cannot be adequately maintained. *In vitro* activities are limited to the storage of semen from some local cattle breeds at private or governmental institutions. Some countries also mention the storage of semen from imported exotic breeds as a strategic activity. Tissue DNA of individuals from local breeds is preserved at a few research stations.

Box 36 Ethiopia – *in situ* conservation

In Ethiopia, four cattle ranches and one sheep ranch are operating *in situ* conservation measures. The overall objectives of these ranches are the multiplication and cross-breeding of Boran, Horo, Fogera and Arsi cattle, and Menz sheep.

Source: CR Ethiopia (2004).

PART 3

Box 37

Morocco's Plan Moutonnier – designated breeding areas to sustain local sheep breeds

Morocco has made great efforts to establish sustainable management of its sheep genetic resources. An important development was the establishment in 1980 of a programme known as the Plan Moutonnier. The main element of the plan has been the partitioning of the country into zones according to the genetic resources present and the nature of the agricultural systems. Each zone has its own set of rules regarding sheep breeding. In the "breeding zones" (zones berceaux de race) only the breed that has existed in the local area for many years is allowed to be kept. In the "cross-breeding zones" (zones de croisement) cross-breeding is permitted without restriction on the choice of breeds. Elsewhere, in the "traditional sheep breeding zones" (zones d'élevage traditionnel), several varieties of sheep are permitted with no specific breed predominating.

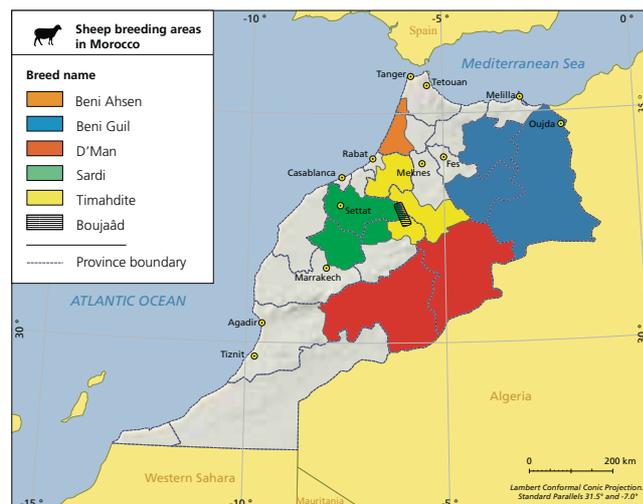
The breeding zones are established in well-delineated geographical areas where a homogenous type of animal has been raised for a long period of time. The zones cover about 54 percent of the country's territory (see map). The breeds for which breeding zones have been established include the main local breeds – Timahdite, Sardi, Béni Guil, D'man, Béni Ahsen and Boujaâd. Some mountain breeds (Atlas Mountain or Berber breeds) are also included, but the programme is mainly focused on the aforementioned six breeds.

The plan has also included selection programmes for the improvement of local breeds in their home areas; the organization of farmers' associations; and encouragement for farmers to improve their local breeds. The plan has met with success thanks to the dynamic role of the sheep keepers' organizations and the support of the state. Largely as a result of the plan and the geographical restrictions

on cross-breeding, the impact of exotic breeds on the indigenous sheep population has been limited. Indigenous breeds accounted for 53 percent of the total population in 1996/97 (the most recent census in Morocco categorizing sheep by breed). Since 1970, the Sardi population has increased, Timahdite and D'man have stabilized, and Béni Guil has decreased only slightly. However, the Béni Ahsen breed population decreased tremendously following the introduction of irrigation in its home zone, which caused a shift to the growing of fruit trees and the keeping of dairy cattle. The latter example illustrates that even if protective measures are in place, a major re-orientation of the farming system is liable to threaten the continued existence of traditional breeds.

Provided by Ismail Boujenane.

For further information see: Boujenane (1999 and 2005).

Distribution of breeding zones for local sheep breeds

Source: adapted from Boujenane (2005).

Note that D'Man are only present in the oases and valleys of the depicted zone, and that the delimitations of areas for Boujaâd have been estimated.

5.2 Asia

In this region, approximately 50 percent of countries have *in vivo* conservation programmes. In the developing countries of the region, identification of animals and the recording of pedigree and performance are lacking. Therefore, for many local breeds the basic information required to improve conservation measures is absent. *In vivo* conservation is restricted to state farms or university and institutional experimental farms. Within these programmes, phenotypic and genetic characterization has commenced.

Urbanization, the growth of the human population and increased income levels are leading to greater demand for animal products, and result in the intensification of production

systems and the more widespread use of exotic breeds. Pigs and chickens play a major role in meat production in Asia. A rich diversity of breeds exists. The conservation of these two species gets a lot of attention in a small number of countries: China, Japan and Viet Nam (Table 80). Many Country Reports indicate the preference of local people for the meat of local pig and poultry breeds. This preference facilitates their future use and conservation. The speed of industrialization and specialization in the pig sector, however, gives rise to a need for special attention to be paid to the establishment of local and regional *in vitro* conservation programmes. This need is emphasized by the lack of opportunities for *in vivo* conservation of the species.

TABLE 80
Conservation activities in Asia

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Central Asia						
Local breeds	29	74	28	3	12	32
Conserved <i>in vivo</i>	6	18	6	0	6	2
Conserved <i>in vitro</i>	11	11	0	0	0	0
East Asia						
Local breeds	74	72	71	156	125	57
Conserved <i>in vivo</i>	22	12	13	51	80	8
Conserved <i>in vitro</i>	28	3	3	92	73	5
South Asia						
Local breeds	86	106	64	18	45	20
Conserved <i>in vivo</i>	10	18	7	1	4	0
Conserved <i>in vitro</i>	8	8	6	0	0	0
Southeast Asia						
Local breeds	50	13	19	52	61	32
Conserved <i>in vivo</i>	11	5	4	8	8	0
Conserved <i>in vitro</i>	8	4	2	0	0	0
Asia						
Local breeds	239	265	182	229	243	141
Regional transboundary breeds	19	13	11	2	2	10
Conserved <i>in vivo</i>	49	53	30	60	92	10
Conserved <i>in vitro</i>	55	15	11	92	73	5

Refer to footnote under Table 78.

PART 3

Box 38

Conservation strategies in China

The People's Republic of China has more than 1.2 billion people – about 22 percent of the world's population, but only around 10 percent of global farmland. The need to feed a growing population has resulted over the last 25 years in emphasis being placed on farm output. This resulted in a major importation of exotic breeds and considerable unplanned cross-breeding. However, the government realised that there was potential for a serious loss of livestock genetic diversity and, in 1994/1995, made several crucial decisions. In 1994, after drawing up a list of 576 farm animal breeds, the government issued the Regulations on Breeding Livestock Administration. Special funds were allocated to maintain indigenous breeds on state farms. The government established a National Commission for Domestic Animal Genetic Resources Administration, which hosts the National Focal Point for AnGR. A list of conservation areas for farm breeds was also produced, and state farms were linked with local farms. In 1999, a major survey was initiated in North Western and South Western Provinces, which identified 79 previously unknown breeds. The government also recognized the extinction of seven breeds to add to the ten lost up to 1983. As a result, there are around 600 recognized breeds in China.

Financial support was initiated in the Eighth Five-Year Plan (1991–1996), during which the government recognized 83 state-level key breeding farms and undertook the provision of infrastructure for several farms and conservation areas as well as some new AI stations. This support (legal and financial) has enabled Provinces, Prefectures and Counties to establish conservation areas and farms for their local breeds. In addition, pedigree (herd book) registration schemes and breed improvement schemes have been established. At present, the government is drafting an "Animal Husbandry Law", which integrates AnGR activities into mainstream animal production. It requires conservation activities and prescribes legal requirements. The proper study of local and exotic breed performance is also a requirement.

The direct result of the funding is 83 projects – most are concerned with breed conservation; about 10 percent are linked to cryoconservation schemes. Genebanks have been established, with the main mammalian bank located in Beijing, and the poultry work being carried out in Jiangsu province. Sampling of breeds for cryoconservation started in the mid-1990s and the procedures have been improved over time as a result of experience and scientific advice. The requirement is now that 250 embryos and 1 600 doses of semen are stored for each breed kept. Seventeen endangered breeds have had semen stored, and embryos are stored from 16 different breeds. This exemplifies the dilemma of whether to sample a limited number of breeds fully, or to sample more breeds, but in a limited manner. In the long term, there is a need to cover all breeds with both techniques.

China has strengthened its basic research, although comprehensive breed comparisons between local and exotic breeds remain rare. The proposal is to fully characterize and evaluate breeds in a Test Centre located in Beijing. However, the replication of the proper environments for each breed involved is problematic.

The Ministry of Agriculture (MOA) has nominated 78 breeds at national level as Key Farm Animal Breeds. For poultry, some 40 breeds are proposed for *ex situ in vivo* flocks in Jiangsu province, with each breed having at least 300 hens and the relevant number of males. The recent avian influenza outbreak has raised questions about security and the need for *in vitro* conservation alongside *in vivo* work.

The development and industrialization of China has meant that the MOA is aware of the need to ensure public awareness of conservation and the importance of livestock genetic diversity. To mark the tenth anniversary of the China National Commission for Management of Farm Animal Genetic Resources, the government released a stamp collection of the

• *continues*

Box 38 cont.**Conservation strategies in China**

78 key breeds. Future plans include the "China Farm Animal Diversity Network". Personnel training will be maintained to continually improve the expertise available to ensure the appropriate management of AnGR. Improved liaison between all those involved is required to achieve the most cost-effective means of maintaining China's rich store of animal genetic diversity.

Provided by Hongjie Yang and David Steane.

The conservation of cattle, sheep, goats and horses requires more attention in Asia, particularly in the western part of the region, where a rich diversity exists, without any significant conservation activities.

Fifty percent of countries in Asia have an *in vitro* conservation programme. The state of *in vitro* conservation at the national level is very variable. Well-established genebanks exist in Japan and India, and genebanks are under establishment in China, the Republic of Korea and Viet Nam. Semen is preserved from all the main species, and embryos from cattle, sheep and goats are also stored. In a few countries (e.g. Japan) tissue DNA is collected from all the main species. Governments undertake these *in vitro* activities in collaboration with industry. In some other countries, there is limited storage of semen at AI stations, while elsewhere, particularly in the western part of the region, no *in vitro* activities exist.

5.3 Europe and the Caucasus

Throughout the Europe and the Caucasus region there is considerable awareness of conservation, and many breeding and conservation plans have been developed. Phenotypic characterization is carried out and several molecular genetic characterization studies have been undertaken. With the exception of the southeastern part of the region, recording of population sizes, animal

identification and pedigree recording are well established.

In all important species many *in vivo* conservation programmes have been established for local breeds (Table 81). However, substantial differences exist between western and central Europe, and the countries of the eastern parts of the region. In western and central Europe 27 countries have *in vivo* conservation programmes (Table 77). A few countries (e.g. Ireland, Finland and Germany) base their conservation policy heavily on the number of males and females in the population (effective population size). Some reports mention the low effective population size of popular cattle breeds such as the Holstein-Friesian and the Belgian Blue because of the use of a limited number of sires. Some countries (in western, northern and central Europe) have a history of AnGR conservation, and some have joined forces for reasons of efficiency (Nordic countries). In some countries, *in vivo* conservation is limited to a few species. It is performed in number of different ways. Animals are kept at a variety of farms (research farms, education farms, museums, prison farms), or are kept for nature management or as hobby animals. Part-time farming is increasing. Many of these small-scale farmers keep local breeds and try to sell regional products under quality labels in niche markets. In many Country Reports organic farming is mentioned as an opportunity for the use of local breeds. Many private organizations (NGOs) play a decisive role in *in vivo* conservation. However, the genetic management of the populations under programmes run by these organizations needs to be improved.

Political instability in the eastern part of the region and the dissolution of the Soviet Union had a serious impact on livestock systems and animal numbers. Many existing breeding and conservation programmes and the institutions involved were destroyed. Many competitive breeds and lines of cattle, pigs and chicken were developed in the Soviet Union, and were bred entirely separately from the breeds and lines of

PART 3

Box 39

Denmark – opportunities for *in vivo* conservation

In Denmark, beef cattle, horses, sheep, goats, rabbits, ducks, geese, turkeys, ostriches and deer are mainly kept by part-time, leisure-time and hobby breeders. There are a number of industrialized production enterprises, especially among beef cattle, turkeys and ducks, but most herds are small with medium or low levels of investment. The part-time, leisure-time and hobby breeders keep many different breeds. They constitute an important target group with respect to conservation and utilization of AnGR. Leisure-related aspects of livestock keeping are of considerable significance in Denmark. Keeping farm animals is an important recreational activity for many people, and many others appreciate the effects that, grazing cattle, horses, sheep and goats have on the landscape and environment.

Source: CR Denmark (2003).

the Western World. These breeds and lines still exist, but are threatened by the introduction of Western genetics.

Most *in vitro* conservation programmes are found in western and central Europe. In many cases this is restricted to the storage of semen from a limited number of cattle and sheep breeds. A few countries (the Nordic countries, France, the Netherlands, Poland, the Czech Republic and Hungary) have genebanks preserving semen from

the main species. In some cases, embryos of cattle, sheep and pigs are also preserved, and in a few countries, cattle oocytes or tissue DNA are stored. These banks are recently founded or are under construction. A strong collaboration with the animal breeding industry exists in most countries. The genebanks need to be further developed – with respect, for example, to ownership and access, information and documentation, and optimization of the core collection and the ratio between gametes and embryos. Despite the presence of a rich AnGR diversity in combination with real threats (such as political instability) *in vitro* conservation programmes are largely absent in the eastern parts of the region, with the exception of Ukraine.

5.4 Latin America and the Caribbean

In this region, the number of countries with active conservation programmes is low, although many countries report a very rich national biodiversity. Most of the species and breeds present in this region were imported from other regions hundreds of years ago. Some breeds were further developed in straight-breeding programmes. New composite breeds adapted to the specific and often extreme local conditions were also developed. In other cases, continuous cross-breeding takes place. As straight-breeding plays a less significant role than in Europe, conserving (pure) breeds is often not regarded as such a high priority. This does not apply to South America's unique domesticated species (e.g. llamas, alpacas and guinea pigs).

TABLE 81

Conservation activities in Europe and the Caucasus

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Local breeds	277	458	170	165	608	269
Regional transboundary breeds	28	79	13	17	45	38
Conserved <i>in vivo</i>	137	175	51	47	101	113
Conserved <i>in vitro</i>	106	51	15	28	6	23

Refer to footnote under Table 78.

TABLE 82
Conservation activities in Latin America and the Caribbean

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Caribbean						
Local breeds	19	5	3	11	7	1
Conserved <i>in vivo</i>	0	0	0	0	0	0
Conserved <i>in vitro</i>	0	0	0	0	0	0
South America						
Local breeds	74	36	20	35	43	39
Conserved <i>in vivo</i>	43	5	7	2	0	5
Conserved <i>in vitro</i>	15	5	6	2	0	5
Central America						
Local breeds	36	6	3	21	34	25
Conserved <i>in vivo</i>	33	5	2	5	0	16
Conserved <i>in vitro</i>	1	0	0	0	0	0
Latin America & the Caribbean						
Local breeds	129	47	26	67	84	65
Regional transboundary breeds	8	2	2	3	1	5
Conserved <i>in vivo</i>	76	10	15	7	0	21
Conserved <i>in vitro</i>	16	5	6	2	0	5

Refer to footnote under Table 78.

The quality of *in vivo* conservation activities is highly variable. Brazil has an intensive programme of *in vivo* conservation, while some countries lack any activity. In much of the Caribbean and Central America, animal identification and registration, performance recording and breeding are not developed, and this creates a weak base for conservation activities. In many South American countries, the export market makes it attractive to invest in animal identification and performance recording, and this contributes to the establishment of active breeding and conservation programmes.

In vivo conservation is mainly limited to cattle and horses kept at university and institutional farms (Table 82), which often function as nucleus breeding herds. In a few countries, molecular characterization activities have been initiated to

support conservation decisions. In the countries which do have conservation activities, initiatives are taken by governments, universities and institutes.

In vitro conservation is limited to the storage of semen and sometimes also of embryos from a few breeds. The initiatives for establishing cryobanks are mainly taken by governments with help from universities and institutes. Brazil is the first country in this region to have established a genebank.

PART 3

Box 40 Brazil – implementation of a genebank

To minimize the threat of extinction faced by locally adapted breeds, the National Research Centre for Genetic Resources and Biotechnology – Cenargen, of the Brazilian Agricultural Research Corporation (Embrapa), included, from 1983, the conservation of AnGR in its conservation programme, which up to that date had included only plants. From that time, the conservation of AnGR began to be carried out, under the coordination of Cenargen, by various Embrapa research centres, universities, state research corporations and private farmers. The animal conservation programme includes the following stages: (a) identification of populations in an advanced state of genetic dilution; (b) phenotypic and genetic characterization; and (c) evaluation of their production potential. Conservation is being carried out in conservation nuclei, maintained in the habitats where the animals were naturally selected (*in situ*). At the same time, embryos and semen are stored (*ex situ*) at the Animal Germplasm Bank (AGB) in Brasilia. It is important that economic use for each one of the breeds being conserved is identified. Research alone is not able to conserve the endangered breeds, and a partnership with private breeders is of fundamental importance to the success of the programme.

Source: CR Brazil (2003).

5.5 Near and Middle East

The primary aim of the governments of the countries in this region is to increase animal production to decrease imports of food of animal origin. Thus, there is a focus on high-input systems. High-output exotic cattle and chicken breeds are imported. There is very little drive to improve or to conserve the local animals despite a rich breed diversity (Table 83).

CR Iraq (2003) mentions some *in vivo* conservation activities in the main species – cattle, sheep and goats, but details are not provided. In other countries, there is generally a lack of awareness of the value of the local breeds and the possibilities to improve and conserve them. Throughout most of the region, no identification, registration or performance recording exist. Characterization activity is extremely limited. No *in vitro* conservation programmes exist in this region.

5.6 North America

The United States of America and Canada have a close inter-relationship with respect to livestock. Canada provides a lot of livestock and livestock products to the United States of America. The latter is the base for breeding stock used in Canada.

Both countries have very active NGOs playing an important role in the *in vivo* conservation of the many local breeds. Support from scientists for these organizations in terms of their genetic management activities could, however, be improved. Universities and institutional farms

TABLE 83
Conservation activities in the Near and Middle East

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Local breeds	43	50	34	1	24	14
Regional transboundary breeds	0	4	0	0	0	0
Conserved <i>in vivo</i>	5	4	3	0	0	0
Conserved <i>in vitro</i>	1	0	0	0	0	0

Refer to footnote under Table 78.

TABLE 84
Conservation activities in North America

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Local breeds	29	35	3	18	12	23
Regional transboundary breeds	3	6	5	1	1	3
Conserved <i>in vivo</i>	1	1	0	0	0	2
Conserved <i>in vitro</i>	36	39	11	18	8	0

Refer to footnote under Table 78.

Box 41 United States of America – priorities in conservation programmes

Priorities are subdivided into biological issues and physical capacity issues. From the biological perspective, priorities include:

- completing breed-level collections of cryopreserved germplasm and tissue;
- increasing levels of *in situ* conservation by private and public entities;
- creating a more thorough understanding of within and between-breed genetic diversity; and
- developing more efficient and reliable cryoconservation protocols for semen, embryos and oocytes.

Physical capacity priorities include:

- continuing the development of NAGP (National Animal Germplasm Program) infrastructure and staffing;
- increasing awareness and support for university conservation efforts;
- leveraging the complementarities of different federal agency programmes; and
- increasing industry awareness of, and involvement in, various aspects of managing animal genetic diversity.

Source: CR United States of America (2003).

take care of the conservation of dual-purpose breeds and experimental selection lines of chickens. However, many of them are threatened by limited budgets for these activities. A lot of work on breed characterization is carried out by universities and research institutes.

In the United States of America and Canada, AnGR are seen as a strategic resource for national food security, which may be threatened by bioterrorism. This is one of the reasons why the United States of America invested in the establishment of an *in vitro* conservation programme and a genebank (Table 84). Collections are being built up very quickly, in close collaboration with the industry. Breeding companies use the genebank as a back up of their breeding work. In Canada, a programme for *in vitro* conservation has been developed and will be implemented in the near future. There will be close collaboration between the United States of America and Canada in genebank activities. They share information and documentation programmes, and are discussing taking care of each other's back-up *in vitro* collections.

5.7 Southwest Pacific

In general, governments in this region show little awareness of the strategic value of the genetic diversity of livestock. In Australia, private farmers and NGOs are active in the conservation of small populations of threatened cattle breeds, and private breeding companies and NGOs store cattle semen and embryos.

PART 3

TABLE 85

Conservation activities in the Southwest Pacific

	Cattle	Sheep	Goat	Pig	Chicken	Horse
Local breeds	26	35	11	12	17	22
Regional transboundary breeds	0	3	1	0	0	0
Conserved <i>in vivo</i>	13	0	0	0	0	0
Conserved <i>in vitro</i>	0	0	0	0	0	0

Refer to footnote under Table 78.

Box 42 Australia – involvement of diverse stakeholders

In Australia, mainstream breeding of livestock has focused on achieving sustainable industries through adapted and productive livestock. Genetic inputs from many continents have been used to achieve this goal, and conservation of adaptive genotypes has been achieved by making the animals desirable for production purposes and ensuring their presence in sufficient numbers to provide responses to selection over the long term. Conservation of rare breeds in Australia is largely in the hands of private breeders and breed societies, or NGOs such as the Australian Rare Breeds Trust. These special interest groups support the *in situ* and on-farm conservation of breeds through breeding plans and genetic advice. *Ex situ* conservation is effected through genebanks maintained by breeding companies and conservation NGOs.

Source: CR Australia (2004).

6 Opportunities for improving conservation programmes

The effectiveness of the conservation of genetic diversity can be measured utilizing criteria such as the effective population size, the number of sires and dams used in each generation, and the mating schemes practised. Unfortunately, information on the number of animals conserved in *in vivo* programmes and the number of sires and dams from which genetic material is conserved *in vitro* is available only in a few countries. Thus, it is difficult to assess the effectiveness of existing activities. Some of the improvements required to establish sound conservation programmes can, however, be identified and are discussed below.

The intensification of animal production results, in some countries, in large areas of land being given over to nature conservation. Nature management facilitates *in vivo* conservation of herbivore species, but in some cases, the animals are kept outside their original environment and are not used for the type of production for which they were developed. Large populations of animals are needed for these activities, which, if managed properly (in genetic terms), offer a great opportunity to conserve genetic variation for future use.

While at a global level, food of animal origin will to a large extent be produced in high-input high-output systems with highly specialized breeds or cross-breeds, small-scale farming continues to be important, and the significance of organic farming is increasing. These systems require well-adapted

dual-purpose or multipurpose breeds. These breeds are better fitted to the production goals of less-intensive farming systems than are highly specialized breeds or cross-breeds. However, transnational breeding organizations rarely invest in these breeds because of the limited size of the markets. More emphasis should be given to the development of these breeds and to the conservation of their genetic diversity.

The development of special products for niche markets offers the possibility to use local breeds and to make them profitable again. This strategy can be enhanced by fostering the notion of “terroir” or the use of labels of origin. Conservation on a small scale on farms oriented towards producing for niche markets can lead to a profitable use of local breeds, but often results in a loss of genetic variation within the population. This can also be the case in small populations kept by hobby farmers if inbreeding is not properly controlled. However, small farmers and hobbyists play a very important role in the conservation of between-breed variation in chickens, horses, sheep, goats and cattle. The education of these livestock keepers in the genetic management of small populations should be improved, as should professional support from governmental and academic institutions. Proper breeding strategies coupled with AI and ET could effectively be used to maintain if not increase genetic diversity under the conditions of small-farm conservation or niche-market production.

In modern breeding schemes carried out by breeding organizations, the conservation of within-breed genetic diversity is often taken into account. Optimization techniques are well developed and effective. When, for example in cattle breeding, these techniques are introduced in the mating schemes used by farmers, inbreeding problems at the production level can be minimized. At present, there is a tendency to broaden breeding goals to include fitness traits as well as production traits. This will have a positive influence on the effective population size and on the maintenance of the genetic diversity within the breeds in question. For some breeds, it

might be wise to use breeding stock from related populations to enlarge the effective population size. Another alternative is to select the semen of “lost” founders from genebanks, and use these sires again.

Cryoconservation is a proven technology and is an important complement to *in vivo* breed conservation. Up to the present time, it has been used mainly to conserve genetic diversity within breeds; it is attractive to the breeding industry as a back up for their breeding material. The management of genebanks has to be further developed, with respect, for example, to ownership and access, storing back-up collections, information and documentation, optimization of the core collection, and the ratio between gametes and embryos.

7 Conclusions and priorities

In many countries in Africa, eastern parts of the Europe and the Caucasus region, the Near and Middle East, Central and South Asia, and the Caribbean, conservation programmes need to be developed. These regions and subregions have a rich diversity of AnGR, but its value is not sufficiently recognized by the national authorities. In most countries, awareness has to be increased in order to obtain financial resources for the improvement and conservation of local breeds. Capacity to develop animal breeding and production, and to implement the genetic management of local populations should be a high priority. In many developing countries, multilateral or bilateral aid programmes for conservation are necessary. Inter-country, subregional and regional programmes should be encouraged and supported through external technical and financial assistance. The establishment of regional conservation programmes and genebanks for regional transboundary breeds should be a high priority particularly in developing countries.

The number of breeds that are potential candidates for conservation is large, and conservation programmes for animals are

PART 3

expensive. Thus, in national conservation programmes, careful attention should be paid to the selection of breeds and methods for conservation. Effective prioritization of breeds for conservation programmes is facilitated by phenotypic and genetic characterization, and by knowledge of the size and structure of the population. Obtaining information on population structure and effective population size is a great challenge and requires cooperation with breeders and their registries.

To implement an adequate breed conservation programme (in which the conservation of the diversity within the breed is very important), the pedigree of the individual animals must be known, a required minimum number of males and females per generation must be kept to avoid random drift, and a mating scheme should be introduced to avoid inbreeding. *In vivo* conservation programmes must include identification and registration of animals, performance recording, and monitoring of populations and population sizes. Regional cooperation in the establishment of intercountry or regional genebanks for cryoconservation is of particular importance.

In poultry, pigs and (beef and dairy) cattle, transnational companies develop only a limited number of breeds and lines. The breeding and production activities of these companies are spreading in Asia and Africa. Improved, highly selected breeds and lines will be used to meet the growing demand for meat, milk and eggs in the coming years. In these circumstances, many recently developed (dual-purpose) and local breeds of cattle, pigs and poultry have to be considered for conservation. The high speed of industrialization and specialization in pig breeding, in combination with a lack of *in vivo* conservation opportunities for this species requires that special attention should be paid to the *in vitro* conservation of pig populations (local breeds and recently developed lines). For all species, breeding programmes to improve and conserve local breeds and to enhance their performance in cross-breeding systems with exotics should be developed.

For local and recently developed breeds and lines that will not be used extensively in the future, opportunities for *in vivo* conservation should be further explored: nature management, organic farming, participatory breeding, niche markets and hobby farming. In sheep and in horses, production and breeding objectives have changed dramatically in recent years, with major consequences for the use and conservation of genetic resources. These developments illustrate the importance of maintaining the genetic diversity necessary to meet new objectives. In sheep, between-breed diversity is threatened by a sharp decrease in the size of the population in many regions.

Education programmes on genetic management should have a high priority. In all regions, farmers and their organizations and advisors, require instruction on sustainable use, development and conservation of AnGR. Support for hobbyists and NGOs to improve their genetic management is also required. In many universities in developed countries these topics are increasingly integrated in the curricula for agricultural students. However, the number of these students is decreasing.

To safeguard genetic diversity, all countries should have their own or shared genebanks that contain cryopreserved material of their locally developed breeds and lines, to protect them against unpredictable threats. Because many transboundary breeds exist, coordination between countries is required. Cooperation would be facilitated if national and regional genebanks operated under internationally agreed protocols. These should include zoosanitary requirements for cryoconserved material, in addition to phenotypic description and genetic characterization. However, in some circumstances, it may be appropriate for countries to decide to immediately commence the establishment of a national gene bank, and tackle sanitary requirements and characterization at a later stage.

The operation of genebanks would also be improved by the regulation of ownership, access and documentation, and by the optimization of the contents of the collection. To facilitate the

establishment of genebanks, training facilities are needed for cryoconservation techniques such as the sampling of breeds and individuals within breeds, and freezing and maintenance of semen, oocytes and embryos. *In vivo* and *in vitro* conservation sites and collections should be protected against human-induced and natural calamities by variety of measures, including the use of widely separated locations at both national and international levels.

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