Section F

Threats to livestock genetic diversity

1 Introduction

Genetic diversity is potentially threatened by a variety of factors, whose effects may be felt in a number of ways – undermining the production systems of which AnGR form a part; physically destroying livestock populations; or provoking responses that are in themselves a threat. Driving forces of genetic erosion are also diverse in terms of the extent to which they are amenable to influence by policy interventions or, if they cannot be prevented, with respect to whether measures can be put in place to lessen their effects on AnGR diversity. In the literature, there is broad agreement regarding the general trends and factors threatening AnGR. For example, Rege and Gibson (2003) identify the use of exotic germplasm, changes in production systems, changes in producer preference because of socio-economic factors, and a range of disasters (drought, famine, disease epidemics, civil strife/war) as the major causes of genetic erosion. Tisdell (2003) mentions development interventions, specialization (emphasis on a single productive trait), genetic introgression, the development of technology and biotechnology, political instability and natural disasters. Analyses of the specific threats faced by particular livestock breeds, and of the reasons for past breed extinctions are, however, quite rare. For at-risk cattle breeds in Africa, Rege (1999) lists replacement by other breeds, cross-breeding with exotic breeds or with other indigenous breeds, conflict, loss of habitat, disease, neglect and lack of sustained breeding programmes among the threats. Similarly, Iñiguez (2005) identifies displacement by other breeds, and indiscriminate cross-breeding as threats to small ruminant breeds in West Asia and North Africa. These examples illustrate that there are a number of ways in which threats to genetic resources can potentially be classified, but for the purposes of the following discussion, three broad categories are distinguished: trends in the livestock sector; disasters and emergencies; and animal disease epidemics and control measures.

Driven by economic, social, demographic and political factors, the livestock sector is undergoing many changes. Trends include quantitative and qualitative changes in demand for livestock products and services; changes in the availability of natural resources, external inputs or labour; changes affecting livestock trade at national and international levels; and shifts in the policy environment which, directly or indirectly, affect the nature of livestock production systems (see Part 2 for a further discussion of trends in livestock production systems). In addition to threats associated with these general trends affecting the sector as a whole, inappropriate policies and methods within the more specific field of AnGR management can have severe consequences for genetic diversity.

Disasters and emergencies are distinguished from the more "gradual" trends on the basis of several factors. First, disasters and emergencies involve a distinct precipitating event or set of events. The occurrence of such events is relatively unpredictable, at least in terms of the intensity of their impact, and the specific locations that are affected. Hence, foreseeing their effects on AnGR presents a rather different (arguably more difficult) challenge. Second, disasters and emergencies are by their nature undesirable events, which give rise to responses aimed at alleviating their humanitarian, economic and social impacts. These responses are often hastily organized, have short-term objectives, and are unlikely to be particularly focused on AnGR. Third, in the context of disasters and emergencies, the possibility of valuable AnGR populations being wiped out in a very short period of time has to be taken into account. Disasters and emergencies potentially affecting AnGR include both the natural (e.g. hurricanes or tsunamis), and the human-induced (e.g. wars) (Goe and Stranzinger, 2002).

Livestock disease epidemics share with disasters and emergencies the characteristics of being relatively unpredictable, having the potential to devastate livestock populations in a short period of time, and provoking "emergency-type" responses (the specific nature and focus of the responses are, however, distinct from those that are implemented for other types of emergency). Eradication campaigns for endemic diseases fit less well into the pattern, being driven by a variety of factors – technological developments, marketing and trade-related issues, human health concerns etc. rather than arising as a rapid response to an emergency. Nonetheless, in some cases (e.g. scrapie) rigorous efforts to eliminate such diseases are a potential threat to AnGR diversity.

A classification framework of this kind inevitably involves some simplification of a complex situation. Different driving forces will interact with each other. For example, a breed population may only be vulnerable to an acute disaster because its numbers and range have declined as the result of gradual changes to the production systems in which it is kept. Inappropriate policies and management approaches may exist under "normal" conditions, but may be particularly prevalent or damaging in the aftermath of an emergency. Similarly, disasters and emergencies may destroy the infrastructure and human and technical resources required to implement or develop appropriate management approaches. Moreover, the boundary between chronic emergencies on the one hand, and the negative effects of ongoing or diffuse trends on the other, is not always clear cut. Similarly, there may be "higher-level" driving forces which operate through more than one of the mechanisms outlined above. A notable example is climate change, which has the potential both to increase the frequency of weather-related disasters, and gradually to affect the distribution and characteristics of production systems (FAO, 2006a).

Given the unpredictability and complexity of many of the forces threatening livestock genetic diversity, assessing their relative significance, and hence identifying priorities for their alleviation, presents a great challenge. Impacts are likely to be affected by the spatial scale of the threat; the speed with which the threat arises; for periodic threats, the frequency with which they occur; the intensity with which the threat strikes the affected populations; and by whether in the future threat is likely to increase or decrease in magnitude. Additionally, the significance which should be attached to a threat relates to the characteristics of the livestock affected. Concern should be greater if the populations affected contribute greatly to the world's genetic diversity, are particularly well adapted to local conditions, or include breeds that are rare or have unique characteristics. Finally, the significance of a threat is affected by the state of existing capacity to respond – either by removing or alleviating the threat, or by putting measures in place to protect the threatened genetic resources.

2 Livestock sector trends: economic, social and policy factors

The outlook for a breed depends to a great extent on its present and future role in livestock systems. The decline of certain livestock functions as alternatives become available is often a substantial threat. Perhaps the most obvious example is that throughout much of the world, specialized draught breeds are threatened by the expansion of mechanization in agriculture (FAO, 1996);

see also CR India (2004) and CR Malaysia (2003). Similarly, breeds developed for wool and fibre production may be threatened by the availability of alternative materials. Availability of alternative sources of fertilizer or financial services also shift the objectives of livestock keepers and may affect their choices regarding breeds.

The increased demand for livestock products in many parts of the developing world drives efforts to increase the output of meat, eggs and milk for the market (Delgado *et al*., 1999). Replacing local breeds by a narrow range of high-yielding breeds is a very widespread consequence of efforts to increase output (in fact, there is also a narrowing of within-breed diversity in many popular international transboundary breeds). The rapid expansion of industrialized pig and poultry production systems in a region such as East Asia, which has a great diversity of indigenous pig and chicken breeds, is a concern. Cross-breeding with exotic animals is also widely practised as a means of increasing production levels. If, as is often the case, this takes place in an indiscriminate manner, it can be a major threat to local breeds. Stricter requirements for product uniformity and food hygiene limit the range of marketable livestock products and restrict the production conditions under which livestock are kept (FAO, 2006b). CR Zimbabwe (2004) for example, notes that the current carcass grading system discriminates against small animals, and therefore discourages the production of some indigenous cattle breeds. Other trends in consumer demand can threaten breeds that do not supply products with the desired characteristics. For example, consumer preference for leaner meat has led to the decline of pig breeds that have carcasses with a higher fat content (Tisdell, 2003).

Production systems can be affected not only by demands in local markets, but also by trends at the international level (FAO, 2005a). Greater economic globalization may contribute in several ways to genetic erosion: it encourages regional specialization and, hence, within a given region, may lead to the decline of specialized breeds associated with an unfavoured type of production; it promotes trends towards specialization in a single product at the farm level and, hence, may threaten multipurpose breeds; it promotes capacities to control the production environment and, hence, to utilize a narrower range of breeds; and it facilitates the transfer of genetic material across international boundaries (Tisdell, 2003). The latter factor also promotes the operation of the so-called "Swanson dominance-effect". This term describes a situation in which choices made in the earliest-developing societies strongly affect later patterns of development elsewhere. In the face of a need to rapidly increase production, the choice of transboundary breeds which have already been subjected to many years of intense genetic improvement, and from which genetic material is readily available, is liable to prove attractive to livestock producers and policy-makers in developing countries, even if the development of local breeds might in the longer term provide better adapted animals (ibid.). Indeed, a similar process can operate to reduce within-breed diversity in high-output transboundary breeds – an example being the very widespread use of North American genetic stock in European Holstein-Friesian cattle.

In the context of increased international trade, the nature of livestock production and the choice of breeds may also be influenced by factors such as market trends in importing countries, increased competition from imported products, fluctuations in the prices of imported inputs, and trade restrictions associated with zoosanitary measures. Small-scale livestock keepers will often be poorly placed to respond to the challenges and opportunities posed by these developments, and may, therefore, lose out in competition with industrial producers (FAO, 2006). Legal frameworks affecting international trade in livestock and livestock products are discussed in greater detail in Part 3 – Section E.

The significance of demand-driven threats to livestock genetic diversity varies with location, being most significant where access to markets is easier. Here, increased demand and competition are highly important drivers of the transformation

Box 15
Mongolian reindeer under threat

For millennia, reindeer have been the basis of the livelihoods and culture of nomadic peoples in the taiga and tundras of Eurasia. The Tsataan, or Dukha, people of Mongolia, for example, rely on their animals for transport – reindeer are ridden and used as pack animals, and food – largely in the form of milk. When a reindeer is culled, meat, hides and virtually every part of its body is utilized. As with many nomadic societies, a range of factors threaten the Dhuka's traditional way of life – including a fall in reindeer numbers that has occurred during recent decades.

Several threats to the herds have been identified. The region's wildlife population is declining due to commercial hunting. In the absence of wild game to hunt, the herders are forced to slaughter their animals at an unsustainable rate. Other economic developments such as mining are a further threat, as grazing areas are destroyed or migration patterns are disrupted. Reduced mobility as herders stay close to towns to take advantage of education services and access to consumer goods may negatively affect the reindeers' nutrition, as they are unable to access remote lichen-rich grazing areas. Traditional knowledge regarding breeding and husbandry may have been lost during the collectivized period, meaning that the new private herders are less adept at reindeer management than were their predecessors. At the same time, problems related to the health of the reindeer are exacerbated by the decline of government veterinary services and predator control measures.

There have also been suggestions that inbreeding is contributing to the reindeer's decline, by increasing vulnerability to diseases such as brucellosis. In 1962, and again in the late 1980s, the Mongolian government brought reindeer from Siberia to replenish the herds. Since the end of the Soviet era, no such inflows have occurred. Proposals that there should be renewed import of reindeer or reindeer semen, from Siberia or from more distant places such as Scandinavia or Canada, have provoked some debate. Arguments have been put forward that cross-breeding has the potential to restore beneficial traits that have declined over time, including disease resistance, high milk production, and large body and antler size. Conversely, others argue that to introduce exotic genetic material may be inappropriate, as local reindeer have been selected for local requirements, in particular for riding and transporting goods. Molecular studies have indicated that the Dhuka's herds are no more inbred than many other reindeer populations. Further research is being undertaken by various NGOs, scientists, and Mongolian government authorities to explore in greater depth the best approaches to managing the reindeer genetic resources. Efforts are also being made to assess the animal health needs of the Dhuka and to provide improved veterinary care.

Advice on the preparation of this text box was provided by Brian Donahoe, Morgan Keay, Kirk Olson and Dan Plumley.
For further information see: Donahoe and Plumley (2001 and 2003); Haag (2004); Owen (2004); Matalon (2004).

or marginalization/decline of traditional production systems. More remote (inaccessible) locations may be less affected by threats related to market demands. However production systems in these areas, which are often the home of specifically adapted genetic resources, face other threats. Degradation of the natural resource base, exacerbated by increasing pressure of population and the absence of suitable methods and strategies for managing grazing or soil fertility, can threaten sustainability (FAO, 1996). Lack of access rights to grazing land and water sources are increasingly threatening the livestock-keeping strategies of pastoralists (Köhler-Rollefson, 2005). Climate change is also a potential contributing factor. A decline in rainfall predicted to affect the main semi-arid zones of Africa has the potential to adversely affect the livelihoods of pastoralists in these areas (Hiemstra *et al*., 2006). Apart from natural resource-related problems, constraints related to production (e.g. endemic diseases), marketing, the availability of external inputs, and a lack of the necessary infrastructure and services for breed improvement, can all decrease the economic viability of these production systems. Migration to urban areas in search of employment may result in the loss of the labour force and traditional knowledge associated with livestock keeping (Daniel, 2000; Farooquee *et al*., 2004). The effects of such constraints on AnGR tend to be two-edged: while they may hinder economic sustainability, they normally promote the retention of indigenous breeds as they are the only ones that can flourish in the difficult production conditions.

It should also be noted that apparently minor and innocuous changes to production practices can lead to the decline of breeds or strains adapted to specific systems. Dýrmundsson (2002) reports that in Iceland, increased hay and silage production during the mid-twentieth century led to a decline in the population of the unique "leadersheep" strain, which played an important role during winter grazing.

The above discussion has indicated that increased demand and greater globalization have tended to favour the industrialization of production systems and the use of a narrow range of genetic resources that are highly productive under these conditions. While this process is a threat to the diversity of AnGR, it has also contributed greatly to increasing the supply of food of animal origin in the face of rapidly growing demand. It might, therefore, be argued that a decline in AnGR diversity seems to be no great problem. Clearly, this perspective gives little weight to potential future benefits that may be foregone if a broader range of genetic diversity is not maintained. However, even from a short-term perspective, it is possible to identify a number of factors which may distort breed choice in favour of exotic high-producing breeds. These factors include: information deficits – a lack of knowledge regarding the relative performance of an exotic vs. a local breed leads to an inappropriate choice of the exotic; market failures – the presence of external costs or benefits associated with the keeping of a particular breed or the practising of a particular form of livestock production (e.g. environmental damage associated with industrial production systems); and policy distortions which promote inefficient resource allocation in the livestock sector (FAO, 2002).

Overt or hidden governmental subsidies have often promoted the development of industrial systems at the expense of the small-scale producer. In some countries, livestock sector policy decisions are strongly motivated by a desire to increase the export of animal products (see Box 16). These subsidies can take a variety of forms including grants and loans for capital investments, subsidization of inputs such as imported feed, provision of free or subsidized livestock services (such as AI), and support prices for animal products (Drucker *et al*., 2006).

More broadly, awareness of the significance of conservation and sustainable use of AnGR is often limited at the policy level (see Part 3 – Section A). This weakness contributes to the current lack adequate characterization of local breeds, and to a lack of consideration of AnGR in all policy decisions. Moreover, public sector investment in AnGR development is declining. There is an increased emphasis on biotechnology, and less attention is paid to more holistic breed improvement activities involving the design of breeding programmes, establishment and support of animal recording schemes, testing of alternative AnGR, and the involvement of local farmers and traditional breeds (FAO, 2004c). The result is that AnGR development is left to the commercial sector, with its focus on the (primarily temperate) international transboundary breeds. There is also a concern that if public sector research is focused heavily on expensive biotechnologies, this may reduce the availability of resources for research into broader aspects of AnGR management.

At the international scale, regulatory frameworks for AnGR covering exchange, and access and benefit sharing (ABS) have been slow

Box 16
Policy distortions influencing the erosion of pig genetic resources in Viet Nam

There are around 25 breeds of pig in Viet Nam – 15 local and 10 exotic breeds. The latter are imported to "improve" the performance of the local breeds through cross-breeding. Of the estimated 21.5 million pigs in Viet Nam, about 28 percent are local breeds, 16 percent are imported breeds, and 56 percent are various crosses. Among the local breeds, three are considered technically extinct, four are classified as critical–declining, two as endangered–declining and four as vulnerable–declining (CR Viet Nam, 2003). In 1994, local breeds comprised around 72 percent of the sow population in north Viet Nam. By 1997, this level had decreased to 45 percent. The decline of local breeds stems from both market forces and government policies that distort the relative profitability of production using local or exotic breeds.

The government recognizes the importance of maintaining local breeds in order to conserve genetic diversity and provide material for cross-breeding programmes. Support and credit are provided to breeding stations, organizations and individuals that keep local breeds (ACI/ASPS, 2002). However, the level of support for local breeds is low compared to the incentives aimed at the export-oriented keepers of exotic breeds.

The livestock breeding programme of the Ministry of Agriculture and Rural Development (MARD) is geared towards ensuring the supply of good quality breeds for domestic production as well as for export. Towards this end, two state-run breeding farms are subsidized to provide exotic breeds and crosses for sale to commercial pig producers (Drucker *et al*., 2006). A number of decrees that have been issued by MARD also favour export-oriented pig farming. These measures have included preferential investment incentives from the Export Support Fund; loans from the Development Assistance Fund of up to 90 percent of the value of investment capital for projects involving the development of pig production for export; and incentives of VND (Viet Nam Dong) 280 (US$0.02) per US$1 export value of suckling pigs, and VND900 (US$0.06) per US$1 export value of pig meat (ACI, ASPS, 2002a,b).

A recent study (Drucker *et al*., 2006) based on a case study in Son La province and interviews with key-informants at the national and local government levels assessed the significance of government subsidies for "high-quality" pig breeds. The total subsidy level was estimated to be around US$31/sow/year (VND460 000/sow/year). Eleven types of subsidy were identified: more than half of the total (54 percent) came from direct subsidies for the rearing of breeding stock. Other significant sources included direct subsidies of the purchase price of breeding stock (from national and provincial government grants) (17 percent); subsidized loans for the purchase of pigs and farm infrastructure (16 percent); and subsidized AI services (9 percent). It was estimated that the subsidy/sow/year would constitute between 19 percent and 70 percent of gross margin.

Provided by Achilles Costales.
For further information see: ACI/ASPS (2002); Drucker *et al.* (2006).

to emerge relative to developments in the plant sector (see Part 3 – Section E:1 for a discussion of the main international legal frameworks affecting AnGR). Policy options are, however, increasingly being discussed (Hiemstra *et al*., 2006). Clearly there is potential for developments in this area to impact the utilization of particular genetic resources or to affect the sustainability of particular livestock production systems, but there is as yet little concrete evidence as to how changing regulatory frameworks might increase or diminish threats to AnGR diversity.

Box 17
Which dairy breeds for tropical smallholders?

Smallholder dairy development in Kenya promotes the use of exotic dairy cattle. A recent study shows that these animals are of higher milk potential than tropical climates and feed resources can support.

Models of nutrition and energy balance in Friesians and their Zebu cross-breeds in zero-grazing units showed that daily milk yields greater than 18 litres cannot be supported by the energy density of available feed. Improving feed quality would raise daily yields above 22 litres, but would generate more heat than the cow could dissipate, even in the cool highlands. The cow's appetite would, therefore, be depressed and she would draw on her energy reserves to support higher yields. In coastal areas, nutrition is worse and cows producing as little as 11 litres per day suffer continuous, moderate stress in the hot season. To avoid these adverse effects, daily yield should not exceed 20 litres in the highlands and 14 litres at the coast, giving annual maxima of 4 500 litres and 3 000 litres respectively.

The drawback to exceeding these ceilings was not apparent at the start of lactation, when a cow with a daily yield of, for example, 35 litres had the lowest direct cost per litre, and provided sufficient milk for sale, home consumption, and reimbursement of family labour. However, a steep decline in lactation revealed the energy deficit, which also caused infertility and extended the calving interval to 460 days. The outcome of poor reproduction was reduced cull sales and a failure to breed a heifer replacement during the cow's productive life, which was shortened to less than four years by stress and under nutrition. This resulted in a high total cost per litre and a decline in herd size. The energy deficit faced by high-yielding Friesians explains why their average annual milk yield in smallholder zero-grazing units is only 1 500 litres in the highlands and 1 000 litres at the coast, and the replacement rate is one heifer bred for every two cows leaving the herd.

The annual milk yields for these Friesian are no better than those of dairy Boran, Nandi and Jiddu cows under improved management 50 years ago, and their fecundity and longevity are considerably worse. The performance of indigenous cows was illustrated by a Zebu cross-bred in the study. Her annual milk yield of 1 570 litres from a maximum daily yield of 11 litres incurred high direct costs, but these were offset by the birth of two heifer calves at an interval of 317 days, to give the lowest total cost per litre. This example demonstrates that in a low-output system, cow productivity should be redefined as efficient use of low inputs, increased herd life and number of calves, with less emphasis on maximum daily yield.

Provided by John Michael King.
For further information see: King *et al.* (2006).

The above-mentioned threat posed by indiscriminate cross-breeding may also be exacerbated by policy measures. Food security at the national level is a strong motivating factor for livestock development policies in developing countries. The desire to achieve rapid progress has meant that the use of genetic material from high-producing exotic breeds has often been favoured. Policies promoting the use of AI increase the rate with which exotic germplasm can be disseminated. An exacerbating factor can be the promotion of exotic germplasm by breeding companies from developed countries; in some cases this is supported by development agencies seeking to promote use of their national products (Rege and Gibson, 2003). In the absence of measures to ensure that the use of exotic genetic material is well planned, the impacts on local breeds can be serious. Moreover, indiscriminate cross-breeding with animals not adapted to the local environment may not achieve the desired effect in terms of increased production, and may leave the small-scale producer in a more vulnerable position (for example with regard to animal health problems). The problem is succinctly described in CR Botswana (2003):

> *"The Animal Breeding Section of the DAHP [Department of Animal Health and Production] facilitates the importation of cattle semen for farmers that do AI. The semen is also subsidized to help farmers afford improve genetic materials of fast growing breeds. There is no monitoring in terms of how the progeny of AI bulls do in terms of their survival and growth rates in communal production system. The importation of semen and live bulls has resulted in uncontrolled cross breeding of beef cattle and as a result the indigenous Tswana cattle are under threat."*

As noted above, the livelihoods of pastoralist livestock keepers in semi-arid areas are increasingly disrupted, which in turn threatens pastoral livestock breeds. These problems are often exacerbated by policy measures. Access to grazing resources is a key issue. Crop production, wildlife parks, and mineral extraction often take precedence in policy decisions about land use (FAO, 2001a). Such developments often impede traditional grazing strategies, which enabled the pastoralists to make effective use of rangeland vegetation. Inappropriate water developments can also have adverse effects. The mobile nature of traditional pastoral livestock keeping does not make for easy relationships with the state; the focus of development efforts has often been on promoting sedentary livelihoods, and pastoralists are rarely well represented at policy level or well served by livestock services.

Another area of policy that can have a major impact on AnGR is the relief and rehabilitation measures that are implemented in response to disasters and emergencies. This aspect of policy is discussed in the following chapter.

3 Disasters and emergencies[5]

Disasters such as droughts, floods, hurricanes, tsunamis, earthquakes, war and civil unrest have devastating impacts on lives and livelihoods around the world. Moreover, the frequency of many types of disaster is increasing. Hydrometeorological and geophysical disasters became, respectively, 68 percent and 62 percent more frequent over the decade between 1994 and 2003 (IFRCS, 2004). The numbers of people affected by disasters also shows an upward trend over this period, with an average of 213 million per year affected during the first five years of the decade and an average of 303 million per year during the second five years. During these ten years, drought and famine were the most deadly "natural" disasters accounting for at least 275 000 human deaths (ibid.). Subsequently, the Indian Ocean tsunami of December 2004 which killed over 100 000 people showed the massive destructive potential of geophysical disasters. Figure 36 illustrates the frequency of various classes of disaster over three decades.

Despite a vast output of literature on disasters, emergencies and recovery efforts, the impact of such events on the livestock sector has received relatively little attention. Accurate data are vital for identifying trends in disaster impacts, and for prioritizing risk reduction strategies (IFRCS, 2005). Useful disaster-related data are increasingly available, but coverage of the livestock sector remains quite limited. Publicly available sources of data include the Emergency Disasters Data Base (EM-DAT), maintained by the Brussels-based Centre for Research on the Epidemiology of Disasters (CRED) (www.em-dat.net/index.htm) and DesInventar, a database managed by a coalition of non-governmental actors, which covers 16 countries in Latin America and the Caribbean (http://206.191.28.107/DesInventar/index.jsp). Interestingly, the latter resource includes figures

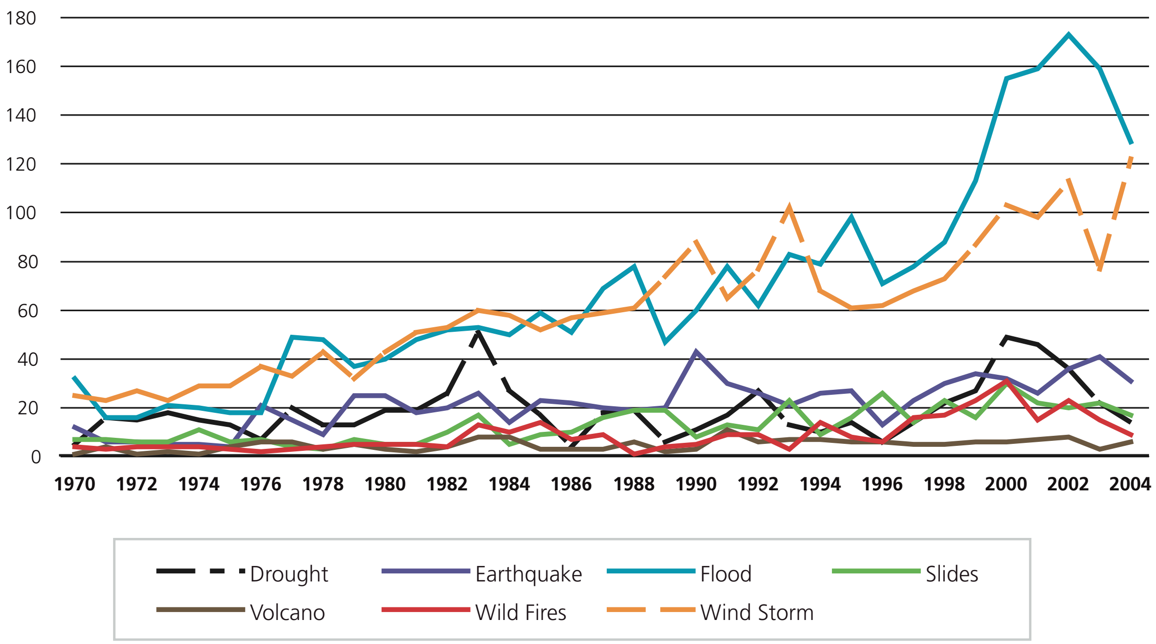
[5] For a more detailed discussion of the impact of disasters and emergencies on AnGR, see FAO (2006c).

for the numbers of livestock dying in disasters. However, only a limited number of countries are covered, and the heavy dependence on media sources means that details of losses may not be completely reliable. Figures that break down livestock deaths by breed are even more difficult to obtain. It is, therefore, rarely possible to assess in detail the impacts of specific disasters on AnGR. Similarly, it is difficult to estimate the overall significance of disasters and emergencies as a threat to AnGR diversity on a global scale.

The literature on disasters and emergencies is filled with a variety of competing terms: natural disasters, geophysical hazards, climatic hazards, complex emergency, complex political emergency, crisis, etc. (Oxfam, 1995; PAHO, 2000; Von Braun *et al*., 2002; Shaluf *et al*., 2003). There is, however, generally a distinction made between disasters and the consequent state of emergencies which they engender.

Historically, disasters have been categorized into two types: natural and human-made (ADB, 2005; Duffield, 1994). Within this typology, both forms of disasters were largely conceived as distinct and discreet events. In recent years, however, the division has been recognized as too rigid. Both natural and human-made events can have inter-related impacts. For example, severe drought in pastoralist rangelands often creates situations of social instability and unrest. Human-driven crises can be exacerbated by natural phenomenon. For example, civil unrest and the subsequent breakdown of disease control strategies can set up conditions for livestock epidemics. Moreover, primary events can set up secondary hazards such as fires and

FIGURE 36
Number of disasters by type and year



Source: EM-DAT: The OFDA/CRED International Disaster Database – www.em-dat.net – Université Catholique de Louvain, Brussels, Belgium. Criteria for the inclusion of a disaster in the EM-DAT database are ten or more people reported killed, 100 or more reported affected, a call for international assistance OR a declaration of a state of emergency.

pollution. A further important consideration is that disasters do not exist in isolation from the conditions under which they occur. For example, disaster impacts will frequently be more severe when they occur against a background of severe poverty, environmental degradation and/or weak institutional structures.

In contrast to "disasters" which are defined by the inciting event, the term "emergencies" is used to describe societal impacts, and in relation to the need for external intervention. Given this definition, it is clear that an assessment of the effects of emergencies on AnGR has to consider not only the immediate physical impact on livestock populations, but also how social changes induced by the emergency may affect livestock production, and importantly, the effects of the interventions which take place in response to the emergency. In particular, responses that involve the provision of livestock to a household or community by external agents – a process referred to as "restocking" (Heffernan *et al*., 2004) have to be carefully assessed. In this context, it is useful to draw a distinction between "acute" and "chronic" emergencies. In the following discussion, the importance of the distinction relates to the intensity of impacts. For example, following an acute emergency, restocking activities tend to be large-scale and, in terms of population dynamics, the influx of new genetic material into the livestock population can be viewed as a single, discreet event, occurring over a limited time period. Restocking activities after the Balkan wars of the 1990s were largely concentrated during a three-year period (Box 18). Similarly, after the super-cyclone that hit coastal Orissa, India in 1999, large-scale restocking activities were generally completed within a few years. As such, the short-term impacts of these acute events on AnGR are high. Longer-term effects are largely dependent on how well the introduced animals survive in their new environment and on the breeding strategies farmers pursue (whether the restocked animals are preferentially selected for breeding).

Conversely, the response to chronic emergencies (such as the effect of HIV/AIDS or intermittent, low-level drought) tends to be much more sporadic, small-scale, and takes place over a longer duration. For example, restocking activities among subsistence farmers are often designed to "pass on the gift" i.e. transferring young stock to new beneficiaries (Heffernan *et al*., 2004). Some projects of this nature have been up to a decade or more in length. Hence, the initial impact on AnGR under such conditions may be lower than in an acute emergency, simply because of the smaller numbers of animal involved. However, the long-term effects should not be underestimated. The introduction of relatively small numbers of exotic animals can have a large effect on the genetic composition of the population over the longer term, particularly if they are favoured by the livestock keepers. Further, secondary impacts of chronic emergencies such as changes to the livestock sector labour force also have implications for AnGR and therefore, must be taken into account. HIV/AIDS, for example, can lead to the loss of family labour. The nature and extent of the impact of the disease on livestock management and breeding practices in countries with high incidence rates is, however, still not well understood (FAO, 2005b; FAO, 2005c).

The first question to consider with respect to impacts on AnGR, is the extent to which livestock populations are affected by the various types of disasters and emergencies. Within the wider agricultural sector, there is a notion that geological natural disasters are of lesser importance than those created by adverse climatic events (ECLAC 2000). However, in the case of livestock it is important not to dismiss the potential of geological events such as earthquakes, volcanic eruptions and tsunamis to kill large numbers of animals.

A further issue is whether raw figures for livestock mortality can be differentiated in any way that is useful with respect to assessing potential impacts on AnGR diversity. There is little evidence for differential impacts on different breeds or types of animal. Quantitative data for disaster impacts at the breed level are, perhaps unsurprisingly, very hard to come by. It is possible to speculate that different management practices could differentially expose animals to risks (FAO, 2006a; RamaKumar, 2000), or that for some types of emergencies animals with specific adaptations could have greater survival capacities, but drawing any conclusions regarding the significance of such effects is difficult. Aside from any such potential differences in terms of susceptibility, the size and the distribution of breed populations is a factor to be considered. Small populations, and particularly those concentrated within a limited geographical area, would seem to be the most threatened. Further, if the small populations happen to be located in disaster-prone areas, the risk will be greater. FAO (2006a), for example, notes that Yucatan, Mexico where many backyard pigs were lost as a result of Hurricane Isodara in 2001, is home to the endangered Box Keken pig. While in the case of disease epidemics, there is some evidence of adverse impacts on small breed populations, it is difficult to find comparable accounts for other types of disaster. Given that for much of the world, information on the geographical distribution of livestock breeds is limited, assessing the extent of such risks, and taking any measures to alleviate them is problematic.

Where emergency response interventions are concerned, safeguarding AnGR will rarely be a high priority. Nonetheless, it is likely that informed decisions on the part of the livestock practitioners involved in such actions could greatly obviate negative effects on AnGR without disrupting humanitarian objectives. It is, therefore, important that the potential impacts of such actions with respect to breed diversity are explored.

Actions to alleviate the effects of disasters generally consist of a number of phases. Prior to an emergency, preparedness and risk-management strategies may be implemented. During and immediately after the event, the focus is on providing relief to the victims and assessing levels of damage and/or loss of life. At a later stage, efforts are made to restore and rebuild damaged infrastructure and economies. Historically, preparedness and risk-management activities were often created for the wider agricultural sector, but with few specific recommendations for livestock. In recent years, there have been efforts to redress this deficiency by a variety of international agencies (FAO, 2004b; Oxfam, 2005). However, the influence of this work on policy is not yet clear. Further, emergency response activities in developing countries are generally geared toward saving human lives, while animal medical emergency teams are restricted to wealthier countries. Conversely, rehabilitation activities generally do include livestock-related activities – mainly restocking. Historically, therefore, this has been the phase with the greatest potential impact with respect to AnGR.

Without external interventions, recovery of the livestock sector is a slow process, with the restoration of herds taking place over many years. Where restocking is undertaken by external agents such as donors and NGOs, recovery of the livestock economy is rapidly accelerated. While farmers generally cannot obtain animals from outside the locality, external agents can and do. Local livestock economies destroyed by the catastrophe can, thus, be rapidly jump-started. However, the unintentional consequence may be large-scale and irreversible changes to the genetic make-up of local livestock populations.

The question of AnGR diversity is not widely discussed in the literature on restocking. However, it is often argued that effects are minimal with regard to the overall size of the local livestock population, as animals used for restocking are purchased locally (Kelly, 1993; Oxby, 1994; Toulmin, 1994). If animals are sourced locally, then impacts on the genetic constitution of the livestock population will also be small. However, it is far from clear that this is always the case. Restocking projects require large numbers of breeding-age females, which are often unavailable in a post-disaster situation (Heffernan and Rushton, 1998).

For example, Hogg (1985) describing a restocking project in northern Kenya, notes that there was an inability to fulfil project quotas using only local sources. Livestock traders from nearby districts were required. In other cases, livestock may be imported from neighbouring countries or from further afield. Restocking projects carried out in the countries of former-Yugoslavia following the wars of the 1990s relied heavily on Simmental and other exotic cattle breeds imported from other parts of Europe (Box 18). Similarly, Hanks (1998) describes the use of cattle from Zimbabwe for restocking projects in Mozambique.

The next question that has to be considered, is whether the introduction of exotic animals through restocking projects has an important impact on the genetic composition of the local population. Using a simple population model tracing the progeny of the restocked animals, it can be shown that even a relatively small initial population of restocked animals can have a considerable impact on the indigenous gene pool, with the proportion of pure-bred indigenous animals in the local population declining markedly within a relatively short period of time (FAO, 2006c). The extent of the effect is heavily dependent on the breeding strategies adopted following the restocking, being greater if the restocked animals are favoured by the livestock keepers involved (ibid.).

Aside from potential impacts on AnGR diversity, there can be other reasons why choosing exotic animals for restocking projects may not be appropriate. In the case of the above-mentioned restocking projects in Mozambique, efforts were seriously disrupted by high mortality rates among the imported animals (Hanks, 1998). Longer-term socio-economic outcomes may also not be desirable. As Köhler-Rollefson (2000) notes:

> *"There are many cases where the substitution of native breeds through high-input-dependent exotic breeds or their dilution through cross-breeding has rendered communities dependent upon outside supplies and subsidies, as well as vulnerable to ecological calamities. Once the inputs stop or the economic scenario changes, keeping 'improved' animals is no longer technically feasible and economically viable."*

If the introduced animals are unable to survive or are immediately unpopular with the local livestock keepers, this may reduce the impacts of the restocking projects in genetic terms. However, there is a danger that such problems may not be immediately evident, and that indigenous breeds, well adapted to the needs of the local population may be lost (ibid.). As such, inappropriate decisions regarding the breeds used for restocking can have negative impacts both in terms of genetic diversity and on the well-being of the human populations affected.

The importance of well-designed measures for the management of AnGR in the context of disasters and emergencies is therefore clear. As the previous discussion illustrates, activities are required in three phases: preparedness (prior to the emergency); salvage operations during the emergency; and rehabilitation (in the recovery phases).

Disaster preparedness activities can focus on several areas. First, an appropriate legislative environment for saving threatened AnGR under disaster conditions should be fostered. This can be particularly valuable in the case of disasters that unfold over an extended period of time such as drought or epidemic diseases (see following chapter) and where there is sufficient time to implement conservation measures during the emergency. Second, a variety of risk mitigation strategies can be undertaken such as the creation and support of fodder banks in areas affected by climatic hazards such as drought or severe winter snows – see, for example, CR Mongolia (2004). A further key activity is the characterization of the genetic resources in potentially affected areas. In many countries rare or priority AnGR have not been sufficiently identified – making informed choices during the emergency and during any subsequent restocking activities difficult. Finally, pre-emptive measures can be undertaken to establish *ex situ* conservation programmes, thereby seeking to ensure that some genetic material from the local breeds is maintained outside the areas affected by the emergency.

During an emergency, genetic salvage operations may be appropriate if rare AnGR are affected and there is a continuing threat to the animals that have survived the initial catastrophe. Operations of this kind are, however, likely to be logistically almost impossible in many countries. The most feasible approach is probably the collection of genetic material for cryoconservation. Effective action at this stage is only possible if accurate information is available regarding the characteristics of the affected animals and the extent of the threat faced. In the absence of such information it may still be feasible to collect genetic material for conservation, but measures will be less well targeted, and can be regarded as a last-resort attempt to reduce the impact of the emergency on AnGR.

The task of repopulating herds post-disaster is likely to require a commitment of several years on the part of the donor agency to establish a viable support programme for the intended beneficiaries. A first step for decision-makers is to consider the role of livestock within the production system in question. In the wake of an acute emergency it is generally not advisable to initiate a restocking project that changes the production orientation of the livestock keepers involved. For example, introducing dairy breeds in a post-disaster situation among households not previously involved in dairying is not likely to be successful. Many of the inputs required to support such a change are usually unavailable in a post-disaster situation. Thus, the objective of restocking in an acute emergency should, generally, be to restore previous production levels, rather than dramatically to alter the production system or livelihoods of the affected households. This should be done using breeds that are suitable for the local environment and existing levels of management. A failure to match the restocked animals to the prevailing production conditions is likely to present many of the restocked households with considerable problems (Etienne, 2004).

Conversely, in a chronic emergency there is more leeway for a change in the role of livestock. Indeed, there have been many cases of restocking projects that have introduced dairying to support local livelihoods with much success (HPI, 2002). Nevertheless, insufficient labour and access to inputs can remain important limitations. Hence, decisions regarding the appropriate genetic resources for such projects require careful consideration of the constraints and potentials of the local production environment. Additionally, an understanding of farmer perceptions regarding the breed and/or species to be utilized is required. This is an important consideration not only for the success of the project in livelihood terms, but also with respect to the impact of restocking on AnGR, as the latter will be affected by the breeding strategies that farmers pursue (FAO, 2006c).

An additional issue in an acute emergency is the quantification of livestock losses. Estimations of losses after disasters are often extrapolated from limited field surveys, and the reliability of the figures is often uncertain. An accurate estimation of livestock losses enables the scope of the required restocking to be determined. Further, the extent of the losses will determine whether animals can be sourced locally, or whether regional, national or even international populations have to be tapped. Also important is the identification of a population base-line against which future changes in the livestock population can be measured. Consequently, within the potential project area, the existing breeds should be catalogued and any at-risk breeds identified prior to restocking. These arguments, however, have to be balanced against the pressing demands on time and resources that prevail in an acute emergency situation. Information will never be completely accurate, and less formal methods of assessing losses will at times be the most appropriate.

Box 18
War and rehabilitation in Bosnia and Herzegovina

During the 1992–1995 war in Bosnia and Herzegovina the livestock sector was seriously affected. Cattle numbers are thought to have declined by 60 percent, sheep by 75 percent, pigs by 90 percent, poultry by 68 percent and horses by 65 percent. A nucleus herd of pure-bred Busa cattle near Sarajevo was destroyed along with the herd book and other documentation. The breeding and conservation programme for the Bosnian Mountain Horse was also severely disrupted. Additionally, a number of flocks of pure-bred Sjenicka sheep were completely eradicated.

In 1996, a three-year programme for the rehabilitation of the animal production sector was adopted. It envisaged the import of 60 000 high-quality cows, 100 000 sheep and 20 000 goats. During the first year of the programme (1997) around 10 000 heifers were imported, 6 500 of which were financed by the International Fund for Agricultural Development (IFAD) and coordinated by the Project Implementation Unit of the Federal Ministry of Agriculture. The remaining numbers were made up of donations from various governments and humanitarian organizations. Heifers were imported from Hungary, Austria, Germany and the Netherlands. Seventy-five percent were Simmental, 10 percent Holstein-Friesian, 10 percent Montafona (Alpine Brown) and 5 percent Oberinntal (Grey Tyrolean). Semen was also imported. Farmers who had lost over 50 percent of their farms' production assets and who had sufficient land to keep animals, could obtain soft loans from the government. In general, the policy was to supply one cow per family, but later more commercially oriented units with three to five cows were preferred. While the imported breeds clearly have the potential to increase milk and meat production, insufficient feed resources, poor management practices and a lack of animal health and milk collection services have in some cases limited the success of the restocking projects.

Numerous organizations have been involved in the distribution of animals in Bosnia and Herzegovina during the years following the war, and imports by the private sector have also sought to meet demand. The full extent of these imports and the breeds involved is not well recorded. Nonetheless, it is clear that the war and the subsequent rehabilitation efforts have led to considerable changes in to the composition of the livestock population over recent years. The population of Busa cattle, for example, estimated to be above 80 000 in 1991, fell to below 100 by 2003.

For further information see: CR Bosnia and Herzegovina (2003); FAO (2006c); SVABH. (2003).

4 Epidemics and disease control measures

Throughout the world, and in all production systems, livestock diseases lead to mortality and reduced productivity in farm animals, necessitate expenditures for prevention and control, constrain the objectives of livestock keepers, limit economic development, and threaten human public health. Animal health constraints greatly influence decision-making with respect to livestock keeping and the utilization of genetic resources. Some disease epidemics have a devastating impact in terms of livestock deaths in the affected locations. Diseases posing a severe threat to the livestock economy provoke concerted control efforts, which may include large-scale slaughter programmes, in addition to other measures such as surveillance, vaccination and controls on the movement of animals. The diseases in question are, in many cases, transboundary diseases, outbreaks of which have severe consequences for international trade. Serious threats to human health from zoonotic diseases, particularly on an international scale, also motivate strong disease control measures. In recent years, numerous economically disastrous livestock disease epidemics, and particularly the emergence of highly pathogenic avian influenza (HPAI), have focused attention on the need for better control and prevention of transboundary diseases (FAO/OIE, 2004).

Epidemics potentially threaten AnGR as a result of livestock deaths from disease or slaughter policies. Alternatively, the effects of diseases may be less direct. Livestock breeds are often adapted to providing a particular set of products or services within a particular production environment. If conditions change – for example because of emerging animal health problems or the burdens imposed by disease control measures – existing livestock keeping practices may be adapted, replaced or abandoned, and the associated livestock breeds may be placed at risk. Additional costs or restrictions related to disease control may arise as a result of trade or food hygiene-related requirements, in addition to the immediate effects of disease on livestock productivity. Although the discussion here focuses on the threat of genetic erosion as a result of livestock diseases, it should be recognized that in many circumstances, the presence of diseases inhibits the introduction of susceptible exotic animals, and thereby necessitates the continued utilization of locally adapted breeds.

Recent years have seen a number of serious epidemics, which have led to the death or preventive slaughter of millions of animals. The HPAI outbreak in 2003/2004 in Thailand resulted in the loss of around 30 million birds (Ministry of Agriculture and Cooperatives, 2005). Between January and June 2004, 18 million native chickens were slaughtered in an effort to control the disease, a figure which amounted to approximately 29 percent of the country's native chicken population (ibid.). Approximately 43 million birds were destroyed in Viet Nam in 2003/2004, and 16 million in Indonesia – roughly equivalent to 17 percent and 6 percent of the respective national populations (Rushton *et al*., 2005).

An outbreak of classical swine fever (CSF) in the Netherlands in 1997 resulted in the slaughter of almost 7 million pigs (OIE, 2005). The 2001 foot-and-mouth disease (FMD) epidemic in the United Kingdom resulted in the slaughter of around 6.5 million sheep, cattle and pigs (Anderson, 2002). The 1997 outbreak of African swine fever (ASF) in Benin resulted in the deaths of 376 000 pigs, with a further 19 000 slaughtered for disease control purposes (OIE, 2005) – this in a country where the total pig population at the time was only around 470 000 (FAOSTAT). Other recent epidemics causing high levels of mortality have included an outbreak of contagious bovine pleuropneumonia (CBPP) in Angola in 1997; outbreaks of CSF in the Dominican Republic in 1998 and in Cuba in 2001/2002; ASF epidemics in a number of African countries, such as Madagascar in 1998 and Togo in 2001; and FMD outbreaks in Ireland and the Netherlands in 2001, and in the Republic of Korea in 2002 (OIE, 2005). Table 40 shows the impacts, in terms of deaths and culls, of recent major disease epidemics. Unfortunately, the effects on genetic resources are often difficult to assess, as breed-specific information is unavailable. Other things being equal, impacts are likely to be high where a large proportion of the animal population dies. To give some indication of the relative impact of different epidemics in this respect, Table 40 presents the figures for deaths and culls as a proportion of national animal population figures for the species and year in question in addition to the raw mortality figures. The most serious recent outbreaks in terms of number of deaths relative to national population sizes for the affected species are shown.

The impact on genetic resources cannot be quantified simply in terms of the numbers of dead animals. The risk of erosion is likely to be greatest where rare breeds are confined to areas severely affected by a disease outbreak, or where a disease disproportionally affects production systems where rare genetic resources or those with specific adaptations are to be found. The extent to which epidemics have an impact on genetic resources is also likely to be influenced by the nature of the restocking policies implemented in the wake of the outbreak (see previous section).

The extent to which diseases have affected AnGR is often difficult to assess fully because of a lack of data differentiating or characterizing the animals affected. For example, in Ngamiland, Botswana more than 340 000 uncharacterized cattle were slaughtered in 1995 because of an outbreak of CBPP (CR Botswana, 2003). However, there are some cases where there is evidence that disease mortality, slaughter programmes and/or subsequent restocking programmes have had a marked adverse impact on specific genetic resources.

CR Japan (2003) mentions that in 2000 approximately two-thirds of the population of the rare Kuchinoshima cattle breed on Kuchinoshima Island died as the result of a disease epidemic. Cattle populations in Zambia, particularly the indigenous Tonga breed, are reported to have been badly affected by corridor disease (a tick-borne disease) during the last ten years, with the number of cattle in Southern Province reduced by 30 percent (Lungu, 2003). Details of the

TABLE 40
Impact of recent disease epidemics

Disease	Year	Country	Number of animals [1 000s]		Proportion of the total population size [%]	
			Culls	Deaths	Culls	Deaths
African Swine Fever	1997	Benin	18.9	375.9	4	80
African Swine Fever	1998	Madagascar	0	107.3	0	7
African Swine Fever	2001	Togo	2.2	15	1	5
African Swine Fever	2000	Togo	10	0	3	0
Avian Influenza	2003	Netherlands	30 569	76.2	30	0
Avian Influenza	2003/4	Viet Nam	43 000*	-	17	-
Avian Influenza	2003/4	Thailand	29 000**		15**	
Avian Influenza	2003/4	Indonesia	16 000*	-	6	-
Avian Influenza	2000	Italy	11 000	0	9	0
Avian Influenza	2004	Canada	13 700	0	8	0
CBPP (cattle)	1997	Angola	435.2	0.2	12	0
Classical Swine Fever	2002	Luxembourg	16.2	0.04	20	0
Classical Swine Fever	1997	Netherlands	681.8	0	4	0
Classical Swine Fever	2002	Cuba	65.5	0.7	4	0
Classical Swine Fever	2001	Cuba	45.8	1.5	4	0
Classical Swine Fever	1998	Dominican Republic	8.7	13.7	1	1
FMD (cattle)	2001	United Kingdom	758***	0	7	0
FMD (pigs)	2001	United Kingdom	449***	0	8	0
FMD (sheep)	2001	United Kingdom	5 249***	0	14	0
FMD (sheep)	2001	Netherlands	32.6	0	3	0
FMD (cattle)	2002	Republic of Korea	158.7	0	8	0

Sources: OIE (2005) for mortality figures; FAOSTAT for population figures.
*Rushton *et al.* (2005) – number of culls only, no figures for deaths from the disease.
** FAO (2005d) – figure includes both culls and deaths from the disease.
***Anderson (2002) – figures exclude newborn lambs and calves slaughtered along with the mother, for which accurate figures are not available (ibid.) so actual number of culls would have been higher.

TABLE 41
Examples of breeds affected by the FMD outbreak in the United Kingdom in 2001

Breed	Total number of breeding females in 2002	Estimated reduction of breeding females in 2001 [%]
Cattle		
Belted Galloway	1 400	approx. 30
Galloway	3 500	25
Whitebred Shorthorn	120	21
Sheep		
British Milksheep	1 232	< 40
Cheviot (South Country)	43 000	39
Herdwick	45 000	35
Hill Radnor	1 893	23
Rough Fell	12 000	31
Swaledale	750 000	30
Whitefaced Woodland	656	23

Source: Roper (2005).

impact of disease on genetic resources tend to be best recorded in countries such as the United Kingdom where there are well-established NGOs active in the conservation of rare breeds. The slaughter programmes enacted at the time of the FMD epidemic in the United Kingdom in 2001, threatened breed populations that were largely confined to the affected areas. Affected populations included endangered breeds such as the Whitefaced Woodland sheep and Whitebred Shorthorn cattle (see Table 41). Similarly, during the FMD outbreak in the Netherlands, flocks of rare breeds such as the Schoonebeker sheep were culled in the Veluwe National Park (CR Netherlands, 2002).

An extreme example is presented by the case of the Haitian Creole pig. During the late 1970s there were outbreaks of ASF in several Caribbean countries (FAO, 2001b). In Haiti, slaughter programmes to eradicate the disease, implemented between 1979 and 1982, led to the elimination of the local Creole pigs. The country was first restocked with Yorkshire, Hampshire and Duroc breeds brought in from the United States of America. Attempts to establish large peri-urban piggeries proved unsustainable, and the breeds were not suited to the management conditions found in local small-scale production. Later, Gascon × Chinese × Guadeloupe Creole pigs, more appropriate to the local conditions, were introduced (CR Haiti, 2004).

With respect to the potential for disease epidemics to have differential impacts on production systems where indigenous breeds are kept, the case of the HPAI emergency in Southeast Asia may offer an example. Village or backyard poultry flocks are generally comprised of indigenous breeds, in contrast to the commercial hybrid birds found in large-scale poultry units. Efforts to control the disease could lead to the establishment of "poultry free zones" around large-scale production units (FAO, 2004a). The sustainability of backyard poultry production may also be constrained by changes to management practices and cultural activities enforced with the aim of minimizing the threat of HPAI. For example, the raising of multiple species, such as keeping ducks or geese alongside chickens has been prohibited in some countries in the wake of HPAI outbreaks. Cultural and social events involving the mixing of birds (for example cock fighting or the exhibition of songbirds) may be banned. Traditional mobile duck keeping on rice paddies, which involve the movement of flocks over considerable distances, is also being discouraged. In short, the ongoing threat of HPAI is likely to result in a future Southeast Asian poultry sector which has "fewer backyard producers … [and] no more ranging, herded [duck] flocks" (FAO, 2005d). Small-scale commercial poultry producers also face great difficulties in responding to the threat of HPAI, and their future may also be in doubt. However, these producers largely keep imported breeds.

In the case of ASF, CR Madagascar (2003) indicates that the appearance of the disease in the country in 1998, and subsequent regulations imposed on pig keeping, has accelerated a trend towards more intensive pig production and the disappearance of scavenging systems based on indigenous breeds. Similarly, CR Sri Lanka (2002) mentions that scavenging pig production may be threatened because of concerns about outbreaks of Japanese encephalitis in humans. A contrasting example of how the threat of disease may influence the nature of production systems, and hence the utilization of genetic resources, is an increase in the population of general-purpose sheep breeds in the United Kingdom, as a result of an increased number of self-contained flocks following the 2001 FMD epidemic (CR United Kingdom, 2002).

Genetic resources may also be threatened by efforts undertaken to eradicate diseases that have a genetic dimension to their causation. For example, the EU's regulations (EU, 2003a) related to the elimination of scrapie have raised concerns regarding rare breeds that lack or have low frequency of the resistant genotypes. Having been present in European flocks for at least 250 years, scrapie is a rather different case to the acute epidemics described elsewhere in this chapter. However, because of concerns about human health, there is a strong motivation to act rapidly to introduce rigorous control measures. Participation in breeding schemes will be compulsory for all flocks of "high genetic merit". In the United Kingdom, for example, the regulations will apply to "all purebred breeding flocks and, in addition, any other flock that produces and sells homebred rams for breeding." (DEFRA, 2005). Slaughter or castration of rams and ram lambs found to be carrying the scrapie-susceptible VRQ allele will be compulsory. The immediate removal of these genotypes would be likely to present problems for the conservation of a number of rare British sheep breeds (Townsend *et al*., 2005).

Although the picture is far from complete, the evidence indicates that in many cases it is the control measures rather than the disease itself which pose the greatest threat to AnGR diversity. Following recent severe disease epidemics, the need to address potential conflicts between veterinary and conservation objectives has begun to be recognized. For example the EU's 2003 FMD Directive provides for exemptions to the regulations requiring the immediate slaughter of infected animals, at sites such as laboratories, zoos, wildlife parks or other fenced areas, which have been identified in advance as the location of a breeding nucleus indispensable to the survival of a breed (EU, 2003b). During the 2001 epidemic in the United Kingdom measures were introduced to allow the owners of flocks of rare sheep or goats to apply for exemption to the slaughter programmes affecting animals on farms within 3 km of a site of infection, provided strict biosecurity measures were observed (MAFF, 2001). With regard to the avian influenza situation in Asia, the protection of valuable genetic material is regarded as a possible justification for pre-emptive vaccination of poultry populations against HPAI (FAO, 2004a). In the case of scrapie control programmes, further research is being undertaken to assess the probable impacts on specific rare breeds, in order to devise appropriate conservation strategies in the context of efforts to eradicate the disease (Townsend *et al*., 2005).

A number of precautionary measures aimed at minimizing the risks to valuable livestock genetic resources in the event of disease epidemics have been advocated. For example, the prospect of rare breed populations being wiped out by an epidemic can be seen as a justification for cryoconservation programmes. Further preventive actions could include ensuring that sites conserving important genetic resources are established in more than one location and preferably in regions with low livestock density; in the case of farms keeping multiple breeds, ensuring the isolation of rare breeds from other livestock; and maintaining up-to-date lists of sites keeping rare breeds (CR Germany, 2003).

It is important to note that all such measures are to a very large extent dependent on the availability of accurate information regarding the characteristics, and risk status of the threatened breeds and, importantly, of their distribution by geographical location and/or production system within the affected countries. This, again, underlines the need for effective characterization of AnGR if conservation goals are to be achieved. A further point to highlight is the need for advanced planning of any conservation actions to be implemented in the event of livestock disease epidemics. Trying to formulate and implement responses once an outbreak has started is far more difficult.

5 Conclusions

Many of the underlying factors threatening AnGR cannot easily be influenced. Change is an inevitable feature of livestock production systems, and "catastrophic" events will never be fully preventable or even predictable. Moreover, it is neither possible nor desirable that the conservation of AnGR *per se* should take precedence over other objectives such as food security, humanitarian response to disasters, or the control of serious animal diseases. Nonetheless, there are a number of measures that could be put in place to alleviate the effects of these threatening forces. Too often, however, threats to AnGR, as well as the potential contribution of local breeds to wider development objectives, are overlooked at the policy level. This tends to translate into policies that promote the increased use of a limited range of AnGR, and that fail to put measures in place to protect threatened breeds.

In many cases, a fundamental problem is a lack of sufficient knowledge regarding the characteristics of AnGR; their distribution geographically and by production system; their roles in the livelihoods of their keepers; and the ways in which their utilization is affected by changing management practices and broader trends in the livestock sector. This often means that emerging threats are not identified or that their significance is not appreciated.

It is generally difficult to quantify the impact of disease epidemics on AnGR diversity – mortality data are rarely broken down by breed. However, it is clear that large numbers of animals can be lost, and that it is often culling rather than the disease itself that accounts for the largest number of deaths. It is only recently that threats to AnGR have been given any consideration in the planning of disease control measures, and they continue to be largely ignored. The FMD epidemics of 2001 showed that even in European countries with a strong tradition of breed conservation activities, steps to protect AnGR had to be taken on an ad hoc basis, and that several rare breeds were quite seriously threatened by the culling campaign. Disease control often operates within legal frameworks that reduce the scope for flexibility in emergency response measures to account for threats to AnGR. Limited steps to address this issue have been taken in Europe (see Part 3 – Section E: 3), but the potential for conflict between animal health and breed conservation objectives remains considerable. Preparedness is essential if rare breeds are to be protected. Drawing up effective plans is, however, again hampered by a lack of relevant information regarding what breeds to prioritize and how to target them.

The impact of disasters and emergencies on AnGR is also not well documented. In the initial aftermath of a disaster collecting data on losses and protecting local AnGR will never be of high priority. Nevertheless, experience shows that post-disaster restocking activities need to be carefully considered if they are not to have an adverse effect on AnGR diversity, and to ensure that the breeds used are appropriate to the needs of the intended beneficiaries.

To conclude, it is clear that the management of threats to AnGR, needs to be better integrated into many aspects of livestock sector development. Concrete steps towards meeting this objective include:

- better characterization of AnGR and their locations;
- providing tools for the *ex ante* assessment of the genetic impact of development interventions, including post-emergency restocking measures; and
- the elaboration, in advance, of plans to

protect unique AnGR in the event of disease outbreaks or other acute threats (including where necessary a re-examination of relevant legislation).

It is likely that in many cases such measures would not only help to reduce the risk of genetic erosion, but would also promote efficient utilization of existing AnGR, and hence would be complementary to wider livestock development objectives.

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