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Item 5.1 of the Provisional Agenda

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Twelfth Session

Rome, 19-23 October 2009

THE ROLES OF SMALL-SCALE LIVESTOCK KEEPERS IN THE DEVELOPMENT, USE AND CONSERVATION OF LIVESTOCK RESOURCES

INTRODUCTION

1. This document contains a report on the roles of small-scale livestock keepers in the development, use and conservation of livestock genetic resources, for information of the Commission. Small-scale livestock keepers, including smallholder farmers and pastoralists, contribute greatly to food security and rural development, particularly in developing countries. This contribution is recognized and supported by a number of international bodies and international agreements. The *Global Plan of Action for Animal Genetic Resources (Global Plan of Action*) adopted by the International Technical Conference on Animal Genetic Resources for Food and Agriculture, acknowledges the contribution of livestock keepers in indigenous and local production systems to the domestication, development, maintenance and conservation of animal genetic diversity. Strategic Priority 5 and Strategic Priority 6 of the *Global Plan of Action* make particular reference to indigenous and local production systems and smallholder farmers and pastoralists.

2. The FAO Conference, at its Thirty-fourth Session, recognized the important role of small-scale livestock keepers, particularly in developing countries, as custodians of most of the world's animal genetic resources for food and agriculture, in the use, development and conservation of livestock resources. The Conference requested the Commission "to address this issue in its report to the 2009 Session of the FAO Conference."[1]

3. The Fifth Session of the Intergovernmental Technical Working Group on Animal Genetic Resources considered the roles of small-scale livestock keepers as custodians of animal genetic resources and the contributions of smallholder farmers and pastoralists to the development, use and conservation of animal genetic resources.[2]

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[1] C 2007/REP, paragraph 146.

[2] CGRFA/WG-AnGR-5/09/5 and CGRFA/WG-AnGR-5/09/Inf. 4

4. The Working Group noted the important contributions of small-scale livestock keepers, particularly in developing countries. It recommended that the Commission acknowledge the important contributions of small-scale livestock keepers, particularly in developing countries, as custodians of much of the world's animal genetic resources for food and agriculture. It stressed the importance of capacity building in the field of improving local and multi-functional breeds in low and medium input farming systems, and institutional support to address the particular needs of small-scale livestock production systems, while ensuring respect for the knowledge, innovations and practices of indigenous and local communities, and the application of relevant national legislation and international agreements.

5. The Working Group recommended that the Commission note the need for countries to take into account the contributions of small-scale livestock keepers and promote their full and effective participation in the implementation of the *Global Plan of Action*; in the preparation and implementation of National Strategies and Action Plans for Animal Genetic Resources; and as appropriate, food security, poverty alleviation and livelihood security policies and programmes. The Working Group noted that countries might also consider ways to reinforce the sustainable use of local breeds in cross-sectoral policies and programmes directed to rural poverty alleviation and food security.

6. The Working Group recommended that the Commission invite FAO to compile ways and means small-scale livestock keepers are being involved in the implementation of the *Global Plan of Action* and to provide this information to the Commission, so that the Commission can continue to inform the FAO Conference of the many contributions of small-scale livestock keepers, as well as the contributions of other types of livestock keepers and breeders and other institutions that are involved in the management of animal genetic resources.

THE ROLES OF SMALL-SCALE LIVESTOCK KEEPERS IN THE DEVELOPMENT, USE AND CONSERVATION OF LIVESTOCK RESOURCES

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1 Background

In the course of 12 millennia, livestock keepers have diversified a handful of species into more than 7600 reported breeds. They achieved this by introducing livestock into new ecological zones and by subjecting them to both natural and culturally defined selection pressures. These biocultural processes have always been dynamic: new breeds emerged and old ones disappeared as the needs of society changed. However, currently there is an alarming trend towards uniformity in the world's production systems – driven by the globalization of livestock production inputs and livestock markets. As a result, breeds are disappearing rapidly – 20 percent of known breeds are now classified as being at risk, and 9 percent are reported to be extinct (FAO, 2007a). The world's commercial supply of animal products has become dependent on a narrow range of breeds and strains, mostly limited to those that are profitably utilized in high external input production systems.

Simultaneously, the production systems that have supported livestock diversity in the past are disintegrating. Pastoralists are especially affected by loss of access to natural resources, particularly grazing land and water. Small-scale livestock keepers are driven into market economies on unfavourable terms or pushed out of existing local markets. Mechanization of farm activities and transportation threatens draught breeds and species (although rising fuel prices in some countries are already reversing this trend). Inappropriate policies and management practices, including subsidies favouring large-scale production and indiscriminate cross-breeding, significantly contribute to genetic erosion.

These developments are of great concern for the future of humanity, because without a broad portfolio of animal genetic resources we will limit the options available for adapting the livestock production systems of the future to challenges such as climate change and emerging diseases. Breeds that are of little practical use today may prove valuable under future conditions. The value of animal genetic diversity thus goes beyond benefits derived from its current use: so-called "option values" are also important.

Animal health is one field in which the importance of breed diversity for future production is already recognized, as new diseases keep emerging and the sustainability of current disease management strategies is threatened by the spread of resistance to drugs and pesticides among pathogens and disease vectors. Studies have shown that particular breeds show high levels of resistance or tolerance to economically important diseases and parasites, including trypanosomosis, gastro-intestinal nematodes, tick burden and various tick-borne diseases. Such traits are prevalent among breeds kept by small-scale livestock keepers, which tend to have been continuously exposed to diseases and parasites and have over time become adapted to these challenges. In the case of emerging diseases, it can be expected that in many cases natural selection will over time give rise to adapted, genetically resistant or tolerant, populations; natural selection, however, requires genetic diversity to work upon.

Despite numerous pressures, many small-scale livestock keepers and their communities continue to manage animal genetic resources in their ecosystems of origin and thereby conserve their adaptive traits and option values. There are several international agreements and processes which seek to support this important role of small-scale livestock keepers.

The *Global Plan of Action for Animal Genetic Resources (Global Plan of Action),* adopted by the International Technical Conference on Animal Genetic Resources for Food and Agriculture, acknowledges the contribution of livestock keepers in indigenous and local production systems to the domestication, development, maintenance and conservation of animal genetic diversity. Strategic Priority 5 and Strategic Priority 6 of the *Global Plan of Action*[3] make particular reference to indigenous and local production systems and smallholder farmers and pastoralists.

[3] *Global Plan of Action for Animal Genetic Resources* and the *Interlaken Declaration.*

At its Seventh Session, the United Nations Permanent Forum on Indigenous Issues requested FAO to give priority to Strategic Priority 6, and to further develop relevant approaches to implement it, including rights-based approaches and payment for services that support the custodianship of local breeds by indigenous peoples.[4] The Forum also recommended the provision of technical and financial support to protect and nurture indigenous peoples' natural resource management, environmentally friendly technologies, biodiversity and cultural diversity, and low-carbon, traditional livelihoods (e.g. pastoralism). It further recommended that discussions and negotiations on strengthening the links between climate change, biodiversity and cultural diversity under the Convention on Biological Diversity or the United Nations Framework Convention on Climate Change ensure the effective participation of indigenous peoples.[5]

The *Convention on Biological Diversity* recognizes the important role of indigenous and local communities in achieving the three objectives of the Convention. At its Ninth Meeting, the Conference of the Parties to the Convention specifically acknowledged the many important contributions of indigenous and local communities, including farmers and livestock keepers, to the conservation and sustainable use of agricultural biodiversity, in particular in centres of origin of agricultural biodiversity.[6]

Finally, the *FAO Conference* specifically requested the Commission on Genetic Resources for Food and Agriculture to address the role of small-scale livestock keepers in the management of animal genetic resources in its report to the 2009 Session of the Conference.

The paper provides detailed information on the roles and contributions of small-scale livestock keepers including smallholder farmers and pastoralists, in breed development, use and conservation and their services to the wider society. It also discusses the reasons of stakeholders to give up their breeds and what motivates them to continue keeping them. Finally, it draws attention to specific Strategic Priorities within the *Global Plan of Action* that require particular attention to be given to the contributions of small-scale livestock keepers, provides options for involving small-scale livestock keepers in the implementation of the *Global Plan of Action* and ways and means to acknowledge their contributions, particularly in developing countries.

Acknowledgements

This paper is based on the above mentioned documents and other published literature, documents from the publicly accessible FAO databases and other Internet sites, as well as field observations by experts. It was prepared by Ilse Köhler-Rollefson and Evelyn Mathias under the supervision of Irene Hoffmann, with support by other officers of the Animal Genetic Resources Group: Paul Boettcher, Beate Scherf and Dafydd Pilling. Administrative and secretarial support was provided by Silvia Ripani and Kafia Fassi-Fihri.

2 Definitions

2.1 The livestock sector

The domestic animals important for food and agriculture are the result of domestication processes that have been ongoing for almost 12,000 years. As livestock populations spread from their centres of domestication with human migration, trade and conquest, they encountered new ecological conditions. As societies developed and diversified, new demands were placed on livestock, and knowledge and skills in husbandry and breeding were accumulated. The natural and human-controlled selection that accompanied these processes led to the development of great

[4] E/2008/43, E/C.19/2008/13 paragraph 85.

[5] E/2008/43, E/C.19/2008/13 paragraph 19.

[6] Conference of the Parties to the CBD Decision iX1: *In-depth review of the programme of workd on agricultural biodiversity* (available at http://www.cbd.int/decision/cop/?id=11644).

genetic diversity among the world's livestock. The situation was never static, breeds emerged and disappeared over time, but diversity prevailed. This process resulted in the development of today's more than 7,600 reported breeds (FAO, 2007b).

The products (meat, milk, eggs, fibres, hides, etc.) of the more than 40 domesticated livestock species account for over 40 percent of the value of world's agricultural output, and they provide one-third of humanity's protein intake. The demand for livestock products is expanding due to growing populations and incomes, along with changing food preferences. Global production of meat is projected to more than double from 229 million tonnes in 1999/2001 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1,043 million tonnes. Livestock development is the fastest growing subsector of agriculture in many developing and transition countries (FAO, 2006a), facilitated by the globalization of trade in both livestock inputs and livestock products.

In some developing countries, particularly those where pastoral systems predominate, the contribution of livestock production to the agricultural gross domestic product (GDP) can be significant. For example, livestock production is reported to account for almost 90 percent of the agricultural GDP in Mongolia, and for 80 percent in Sudan.

Raw economic figures do not, however, capture the full significance of livestock production to economies and livelihoods around the world. One important consideration in this respect is the prevalence of livestock keeping among the world's poor. It is estimated that about 70 percent of the world's 1.1. billion rural poor people who live on less than US$1 per day are at least partially dependent on livestock for their livelihoods (World Bank, 2007). Livestock production is the principal source of livelihood for about 120 million pastoralists worldwide (ILRI, 2002). Livestock provide draught power for more than 320 million hectares of farmland – one-quarter of the earth's total area under crop production. In total, it is estimated that the livestock sector employs 1.3 billion people and creates livelihoods for one billion of the world's poor (World Bank, 2007).

At the household level, particularly in developing countries, livestock – often of local breeds – perform many important functions including providing transport and draught power for crop production, and manure for fertilizer and fuel. They contribute significantly to social networking and cultural activities, and provide an essential means of savings and insurance. It is these multiple functions of livestock that make them particularly valuable assets for poor people.

However, such functions are difficult to assess in terms of commodity or economic values. Initial studies highlight that their contribution can be quite significant. For example, some studies try to quantify the value of financing and insurance functions to livestock keepers who are unable to access these services from other sources. The results indicate that these functions account for 81 percent of net benefits from meat goat production in southwestern Nigeria (Bosman et al., 1997), 23 percent in the case of cattle production in upland mixed farming systems in Indonesia (Ifar, 1996), and 11 percent in smallholder dairy goat production in the Eastern Highlands of Ethiopia (Ayalew et al., 2002).

These examples highlight that it is important to consider non-market values when comparing the value of different livestock production systems within the livestock sector because otherwise the value of small-scale livestock production and local breeds is easily underestimated. It is equally important to recognize that small-scale systems and local breeds are intrinsically linked to the livestock keepers behind these systems (pastoralists, crop–livestock farmers, and landless livestock keepers), and to the environments in which they operate.

2.2 Characteristics of smallholder farmers and pastoralists

Despite the recognized importance of small-scale livestock production, there is no internationally agreed definition of small-scale livestock keepers. Small-scale livestock production is often used

interchangeably with smallholder, subsistence and family farming, or with resource-poor, low-income, low external input, low-output or low-technology livestock keeping.

The World Bank (2003) classifies the rural poor into five categories: a) the landless; b) smallholders (farmers with up to two hectares of cropland); c) pastoralists (those who are not settled in any specific area and who derive most of their income from pastoral livestock); d) rural women (especially women-headed households); and e) ethnic minorities and indigenous populations.

Pastoralists have also been defined based on the contribution of livestock to agricultural income and the agro-ecological context in which they operate (FAO, 2007j). Another definition groups them according to their mobility ranging from entirely mobile "exclusive pastoralists" to semi-settled "agropastoralists" practising some agriculture (Blench, 1999). In reality, the systems often overlap. Settlement politics, economic development and changing environments further reduce the differences and move the balance more and more towards agropastoralism.

Recent findings indicate that smallholder farms constitute about 85 percent of all farms (IFPRI, 2005). However, a size-based definition of smallholders is of limited use, as it does not take into account many factors that have substantial implications for farm productivity and efficiency, such as the nature of the production system, the types of crops or livestock raised, regional and national differences, institutional and market arrangements, access to key social services such as health and education, and labour arrangements.

According to the definition accepted by the Working Group, small-scale livestock keepers include mixed crop–livestock farmers, pastoralists, and landless livestock keepers from both indigenous and non-indigenous societies. One way to define small-scale livestock keepers would be to describe them relative to the average livestock farm within a country, rather than by absolute herd size or land size. Pastoralists, however, can have quite large herds, because livestock is their main asset and they need a minimum number of livestock to resist drought cycles. ILRI (2008) used generic definitions for smallholder farmers, for example dairy farmers with fewer than six milking animals and/or less than 3 ha of land; pastoralists with fewer than ten mature cattle; farmers keeping fewer than 30 small ruminants or fewer than 200 poultry. Other important characteristics that might be considered in a definition of small-scale livestock keepers include their tendency to operate with limited resource endowments relative to other farmers in the sector, and the fact that, in general, small-scale livestock keepers have relatively low-levels of formal education and training. Small-scale livestock keepers, especially pastoralists, often also operate on communal rather than private land, or may be landless.

Small-scale livestock keeping is usually a family enterprise that practises subsistence production or a mix of subsistence and commercial production. The family is the major source of labour, and livestock production is often the principal source of income. Small-scale livestock keepers usually have limited access to input and output markets, and to services and credit. Most of their market interaction is within informal local markets, for which they produce local or traditional products. Small-scale livestock keepers routinely face high transaction costs in securing quality inputs and getting market recognition for quality outputs.

Small-scale livestock keepers tend not to purchase farm inputs. The majority of inputs come from within the farm as part of a closed nutrient cycle. Many small-scale livestock keepers operate at the lower-end of the production curve, where small additional inputs lead to substantial increases in productivity.

3 Contributions of smallholder farmers and pastoralists

3.1 Provision of products and services

Long overlooked, the provision of products and services by pastoralists and smallholders can be substantial. According to a study commissioned by the World Initiative for Sustainable Pastoralism (Rodriguez, 2008), pastoralism contributes about 8.5 percent of the gross domestic product in Uganda, 9 percent in Ethiopia, 10 percent in Mali, 20 percent in Kyrgyzstan, and 30 percent in Mongolia. Its contribution to the agricultural GDP of Sudan, Senegal and Niger is about 80 percent. In Ethiopia, milk produced by pastoralists makes up 65 percent of national production, not counting pastoralists' own consumption, estimated at 77 percent of the total milk production (Rodriguez, 2008). In most other African and many Asian countries, dairy production rests also mainly in the hands of small-scale keepers (Delgado et al., 1999; Rangnekar and Thorpe, 2002, Delgado et al., 2003).

Reports on the contribution of industrial production systems provide another indication of the importance of livestock products from smallholders and pastoralists. On a global scale, industrial systems now account for an estimated 67 percent of poultry meat production, 42 percent of pig meat production, 50 percent of egg production, 7 percent of beef and veal production, and 1 percent of sheep and goat meat production (FAO, 2007b p. 156). This means that the majority of small ruminant meat, and considerable shares of meat from monogastric species and milk are supplied by small-scale livestock keepers.

The merits of smallholder and pastoral production go far beyond the provision of food products, as they also contribute to the economy through the sale of live animals, hides, skins, wool, manure and transport services, and attracting tourism. Furthermore, they have means to use marginal areas sustainably for food production and they provide environmental services. Such merits are until now little captured in official statistics (Rodriguez, 2008) but will be of increasing importance in face of the threat of climate change. In fact, governments have started taking advantage of the various benefits that grazing can have on ecosystems by supporting herders to manage natural and cultural landscapes. The following sections provide details.

Sustainable use of marginal areas

Large, and possibly expanding, parts of the globe can be used for food production only by livestock that are adapted to local conditions. This includes the 41 percent of the earth's land surface that forms tropical and subtropical drylands, mountainous and high-altitude zones, as well as some very cold areas. In these ecozones grazing converts the local vegetation into food and energy that can sustain people. Without animals, huge stretches of the world would have remained uninhabitable.

To be able to utilize such inhospitable areas, which are often infested with diseases, pastoralists and smallholder producers have an array of strategies ranging from the development and use of hardy, well-adapted breeds (see section *Development and sustainable use of local breeds*) to sophisticated herd movements and grazing strategies (Box 1). Their livestock have thus become a means of extracting value from uncultivable land and generating food without competing for cereals (Hoffmann et al., 2008). This not only contributes considerably to food security in marginal areas but also provides products and services also to the wider society.

Box 1. Strategies used by smallholder livestock keepers and pastoralists to exploit marginal lands

To exploit inhospitable lands and use them in a sustainable way, small-scale livestock keepers and especially pastoralists have developed a number of strategies. Seasonal movements optimize the use of scarce vegetation. Limiting the duration an area is grazed to short periods and certain times of the year allows the vegetation to regrow and prevents overgrazing. Some plants may disappear under grazing pressure, while others need it to thrive (Rodridugez, 2008), and many tree seeds have to be eaten by animals before they will germinate (Bayer and Waters-Bayer, 1998).

Pastoral societies often have special decision-making structures to organize their herd movements and coordinate with other pastoral groups in their area (see, for example, Homann, 2005). But these traditional mechanisms are disturbed when social and agricultural development restricts herd movements (Hoffmann, 2004).

Another strategy to optimize land use is daily herd movement of the animals to take advantage of diverse grazing sites such as hedgerows, field borders, fallow fields and crop residues (Bayer, 1990). Grazing several species with different fodder preferences together is a further way to optimize the use of scarce fodder.

Herd movements and grazing strategies not only optimize the use of scarce resources, they also reduce disease challenges. Seasonal migrations avoid areas known to be unsafe due to infestation with disease and parasites; if possible, herders use these areas only at times when challenges are perceived to be lower. Examples include the movements of West African pastoralists to avoid tsetse-infested areas (Schillhorn van Veen, 1997) and movements of Saami herders to keep their reindeer away from flies (Anderson, 1996).

Restricting grazing at certain times of the day and avoid dew-ridden grass are an efficient way to reduce parasitic diseases because dew-ridden grasses can harbour the infective stages of parasites or their hosts (Schillhorn van Veen, 1979). Such strategies are reported for the Tzotzil Maya shepherds in southern Mexico (Perezgrovas, 1996) and Fulani herders in Nigeria (Bayer, 1990).

Continuous contact with prevailing diseases means that many local breeds and their management practices are uniquely adapted to local disease challenges including trypanosomosis, gastrointestinal parasitism, ticks and tick-borne diseases (McCorkle et al., 2001; Gibson, 2002) – one of the factors enabling their keepers to survive and produce in marginal environments.

Agro-ecosystem services

Grazing by livestock can create socially desirable landscapes and helps maintain biodiversity. Examples of landscapes shaped by livestock include much of the Near East region where sheep and goats were first domesticated about 10,000 years ago, and heathlands, calcareous grasslands, Mediterranean *maquis* and *garigue*, as well as subalpine dwarf shrub land in Europe.

Landscapes created through the co-evolution of livestock and vegetation often resemble wilderness to outsiders, but have actually been managed by indigenous and other traditional people over long time periods. Such systems sustain both domesticated and wild plants and animals whereby the spectrum from “cultivated” to “wild” biodiversity can be blurred. In fact, many societies do not make a clear distinction between “wild” and “domesticated” (Phillips and Stolton, 2008).

In other areas, livestock have continued what wild herbivores started millennia ago: the original Eurasian landscape was shaped by large herbivores such as aurochs, wild horses and wild boar, which created an open woodland habitat. The grasslands require periodic defoliation, so as not to

turn into scrub and eventually into woodland. This effect can not be achieved by mowing, but only by grazing. As these wild species have largely become extinct, low-intensity livestock keeping with traditional breeds replicates their effects and supports a rich wildlife.

Lack of grazing, on the other hand, can lead to the deterioration of landscapes and loss of biodiversity (Scholle et al., 2002) due to the invasion of bush species and the disappearance of the natural flora. For example, in Mediterranean countries, declining sheep numbers resulted in large areas of hills and mountains becoming covered by shrub vegetation with low biodiversity. The introduction of stall-feeding is another factor leading to the abandonment of grazing and the proliferation of shrubs. The accumulation of woody biomass increases risks such as fire and erosion and gives rise to environmental and economical losses (Osoro et al., 1999; Perrings and Walker 2003).

Modern farming with its machines and agrochemicals has added its share to the drastic decline of biodiversity (Finck et al., 2002), contrasting the positive effects grazing can have. Although the understanding of livestock's impact on the environment is only at its beginning, evidence is accumulating that effective grazing management can stimulate pasture growth and biodiversity, promote of ecosystem health and integrity, reduce invasive species, improve mulching, and contribute to mineral and water cycling. The following discussions highlight the benefits of grazing and how these benefits are used to manage and restore landscapes.

Grazing maintains a variety of habitats and creates highly diverse mosaic landscapes, thereby conserving biodiversity. Almost all research on this aspect of livestock keeping comes from Europe, where large-scale and low-intensity grazing is acknowledged as key to maintaining habitats that harbour rare animals and plants. One exception is a study of traditional land management by Borana pastoralists in southwest Ethiopia (Bassi and Tache, 2008).

A study of pasturing pigs, horses, and cattle in the Sava floodplain in Croatia highlights that biodiversity conservation results from a combination of factors: the animals disperse seeds through their dung; rooting by pigs creates microhabitats that allow several threatened plant species to germinate; and the depressions left in the soil by the pigs and by animals' hooves create tiny pools where amphibians can reproduce (Poschlod et al., 2002).

Grazing improves the water-holding capacity of grasslands by enhancing infiltration and reducing runoff (Sanderson et al. 2004 and Niamir-Fuller, 1999, cited in Rodriguez, 2008, p. 20). However, research on this is only at its beginning.

Controlling the growth of grass and undergrowth by grazing animals also prevents the spread of forest fires. Studies in the southern USA have shown that grazing reduces fire hazards by removing and breaking up potential fuel and by establishing trails through the forest (Campbell, 1954).

Migratory sheep each transport thousands of seeds from one area to another, thereby connecting different ecosystems. Experiments in Spain (Manzano and Malo, 2006) showed that seeds attached to the fleece of transhumant sheep were transported over long distances and that substantial numbers were dispersed up to several hundred kilometres. Livestock keepers may make conscious efforts to disperse the seeds of preferred plants. Pastoralists in Iran pack seeds in little bags and hang these around the neck of their sheep. During grazing the seeds drop out through little holes in the bags and are worked into to the ground by the sheep's hooves (Koocheki, 1992, cited in Bayer and Waters-Bayer, 1998 pp. 113–114). With changing climates, this promises to be an important way to enable plants to move into new habitats, and thereby preventing their extinction. A drawback is the distribution of unwanted species (Manzano and Malo, 2006).

The breeds kept by pastoralists and small-scale livestock keepers often help conserve wildlife, and frequently there is a history of co-evolution between wild species and local livestock. In the Kumbalgarh Wildlife Sanctuary in Rajasthan, India, for example, leopards and wolves (for which the sanctuary was established) prey almost exclusively on the sheep and goats pastured there

(Robbins and Changani, 2005). Such relationships between domestic and wild biodiversity have rarely been studied in detail. But evicting herders and their livestock from wildlife reserves may lead to an exodus of predators, or result in habitat changes that make it unattractive for wildlife. Examples from India are the withdrawal of Asia's last remaining lions from the Gir Forest National Park and Wildlife Sanctuary in Gujarat (Casimir, 2001) and the disappearance of Siberian cranes from the Bharatpur Bird Sanctuary in eastern Rajasthan (Lewis, 2003).

Finally, the dung of grazing animals is a valuable fertilizer for agricultural lands. Farmers have taken advantages of this benefit since ancient times. They often had formal or informal arrangements with herders from which both parties benefited (Box 2).

Box 2. Restoring and maintaining soil fertility through manure and nutrient recycling

There is a long tradition of farmer–herder arrangements under which farmers allow pastoralists to drive their herds over harvested fields and pastures so that the animals can feed on crop residues, and in exchange fertilize the fields with their manure (Hoffmann and Mohammed, 2004). Such arrangements are regulated through informal and formal agreements. An example for an informal agreement is the custom in Germany of putting a stick with a bundle straw in a field or pasture to signal to shepherds that the area is forbidden for grazing. Otherwise, pastures and harvested fields can be grazed during certain times of the year.

In the Zamfara Reserve in northwest Nigeria, the former in-kind exchanges between Fulbe pastoralists and Hausa farmers are increasingly replaced by monetarized ones: Fulani now have to pay for access to stubble grazing and crop residues, and farmers pay for manure (Hoffmann, 2004). Things are also changing in Europe: shrinking access to agricultural and common-property land and expanding infrastructure make it difficult for European pastoralists to continue their herd movements. On the other hand, some commercial dairy farmers have started returning to grazing to reduce their expenses on chemical fertilizers and to improve soil fertility through nutrient cycling (van't Hooft et al., 2008).

The improved understanding of the impact of grazing has been leading to growing recognition of the ecological value of the services that smallholder livestock keepers and pastoralists provide through their livestock management (see, for example, Rodriguez, 2008). Locally adapted breeds are seen as essential for conserving particular landscapes (Cole and Phillips, 2008). Tisdell (2003) points out that animals exposed to natural conditions provide a crucial and essential counterbalance to industrial systems which rely on environmentally sensitive high-yielding breeds that are selected mainly for production characteristics.

European Union policies now seek to use extensive livestock production systems for landscape and nature conservation, and conserve and strengthen them through two avenues: "contracts for sustainable development" between the state and individual farmers, and support for the marketing of typical animal products originating from defined breeds, locations and technologies (Kuit and van der Meulen 1999; Rook et al., 2004, see also section *Motivation to keep a breed*).

In Germany, the Federal Nature Conservation Agency supports grazing to reverse the effects of discontinued grazing. Examples include the use of goats to control blackberry growth; sheep to keep vegetation open and maintain nesting habitats for migratory birds; and sheep, cattle, and donkeys to re-establish sand-dune vegetation (Redecker et al., 2002). Grazing is also being tested in a commercial forest to make the area accessible for tree cutters and other equipment.

Given the increased fire risk experienced in some developed countries (e.g. the USA) following the discontinuation of grazing, the importance of livestock for the removal of shrubs and undergrowth will likely further grow.

3.2 Development and sustainable use of local breeds

In developing countries the human factor in breed creation has long been overlooked. Until recently, livestock breeds kept by rural communities were regarded as products of natural selection alone (Lanari *et al*., 2005) and thought to have developed mainly due to geographical isolation from each other. However, for centuries, the use and herding of livestock by specific ethnic groups and communities – combined with natural selection – has led to subdivision into many endogamous animal populations, resulting in separate and essentially closed gene pools (Köhler-Rollefson, 1997). Breeds named after ethnic groups (Box 3) are a vivid testimony of the human factor in the creation of these gene pools and the cultural link between individual ethnic or social groups and specific breeds (Köhler-Rollefson, 1993a, 1997, 2003; Rege, 2001).

Science has recently begun to acknowledge this link and take note of the ethnic groups and communities that are associated with individual breeds. Cockrill (FAO (1974, p. 51), for example, attributes *tedong bonga* buffaloes to the consistent breeding policy of the Toraja in Sulawesi. Studies in South Africa have elaborated the role of Zulu and Himba cultures, respectively, in the development of Nguni cattle (Poland et al., 2003) and Damara sheep (Du Toit, 2007). In India, a survey of poultry and small ruminant breeds in the state of Orissa links the breeds to specific tribal groups (Kornel et al., 2006; Mohapatra et al., 2006).

Another indication of the human involvement is the large share of breeds that drylands have contributed despite the few people (often pastoralists) living there (Hall and Ruane, 1993; Köhler-Rollefson, 2005). It is estimated that about a quarter of the world's documented breeds stem from drylands, including a high number of transboundary breeds (FAO, 2007b).

Box 3. Livestock breeds linked to specific ethnic groups

- Different pastoral groups of West African Fulani have developed the White Fulani and Red Bororo cattle and the Peulh sheep and goat, while Touareg developed Touareg sheep and goats.
- East African pastoralists created the Somali and Red Maasai sheep.
- Borana pastoralists of East Africa bred the Boran cattle, adapted to their three-day watering interval.
- Southern African small-scale farmers developed the Mashona and Nguni cattle.
- The best known livestock breeders in Rajasthan are the Raika or Rebari. They are a Hindu caste closely associated with the camel, but also have developed breeds such as Kankrej, Sanchore and Nari cattle, as well as Marwari sheep and Sirohi and Marwari goats.
- The Rath Muslims of northwestern Rajasthan developed the Rathi dairy cattle breed.
- In the Himalayas, the Gaddi pastoralists rear sheep and goat breeds named after them.
- A subtribe of the Golla, the Hallikars, shaped a well-known draft cattle breed of the same name.
- In South India, the Toda tribal community has collectively bred the Toda buffalo breed.
- The Navajo Churro sheep in the southwestern USA was bred by the Navajo Indians.

The following sections discuss the social and cultural factors that were crucial for the creation of breeds together with deliberate breeding decisions and management by livestock keeping communities. They illustrate the role of smallholder livestock keepers and pastoralists in breed

development and their intimate knowledge of their livestock and its relation to the natural environment.

Structuring animal genetic resources into breeds through social breeding mechanisms

The customs of livestock-keeping groups and communities that influence their livestock's gene pool are referred to as "social breeding mechanisms". These consolidate a livestock population by ensuring that animals are distributed within the community and remain a long-term asset over generations, but also create boundaries to genetic exchange with the livestock of other social groups. Social breeding mechanisms are important forces for forming and conserving breeds – resulting in genetically well circumscribed livestock populations and mirroring the rules of formal breeding associations.

One such mechanism is the prevention of the sale of female stock to anyone outside the community (e.g., Köhler-Rollefson, 1993a, Schäfer, 1998). Especially pastoralist societies often regard livestock as heritage from their ancestors, for which they act as temporary guardians and which they have to pass on to their children. Such unwritten community rules, often in the form of taboos, can be very strict, with punishments for non-compliance.

Another set of social rules determines the passing of animals from one generation to the next, regulating the presentation of animals as gifts at certain life-cycle events, such as birth, circumcision and puberty; and as dowry or bride wealth at weddings. They also regulate what happens to a herd when the owner dies. Among the East African Gabbra and Turkana, for example, camel herds are inherited by the son. Unmarried Turkana daughters receive an adult female camel (Hülsebusch and Kaufmann, 2002, p. 22).

Furthermore, pastoralists and other livestock keeping communities have sharing arrangements that facilitate access to breeding animals, the distribution and exchange of livestock, and the sharing of food and other livestock products. In many communities, the wealthier members have an obligation to share their livestock with their poorer relatives by giving long-term stock loans, sometimes over generations. They may allow the placement of female animals in their herd so that the females can be mated by a superior male. Other arrangements involve the loan of breeding males. Payments are often through the use of animal products and the sharing of offspring rather than money. Sharing brings prestige, furthers social relationships and reduces the risk of losing the whole herd if a disease or other calamity strikes. For the latter reasons, pastoralists may place some of their cattle with the herds of other herders far away from their own herd (Schwabe, 1978).

The set-up of sharing arrangements differs from society to society. *Vaata* in Andhra Pradesh, India, for example, regulates the sharing of kids from goats (ANTHRA and Girijana Deepika, 2003) while *mafisa* in Lesotho and western Zambia, entails placement of a family's cow in a herd with a superior bull. The cow returns home with its improved progeny after several years; in the meantime the host family can use the milk it produces (Beerling, 1986). If a Somali camel-breeding family does not have a breeding male of their own, they borrow one from kin, hire one from others, or drive their female camels as far as 200–500 km to have them served by a prominent sire (Hussein, 1993).

Some societies have institutionalized mechanisms to facilitate the access to male breeding animals and ensure optimal quality of the livestock. Such breeding institutions are frequently anchored at village level or may be supported by respected community members (Box 4). In West Africa and India, it was often the pastoralists who provided the function of supplying work animals to farmers and that had developed extensive knowledge of line-breeding (e.g., Habib, 1999; Joshi and Phillips, 1982, Mohammed, 2000).

Different from official breed societies, indigenous breeding institutions do not keep written records of sires and progenies. However, herders' mental record keeping of animals' pedigrees

can date back several generations and has parallels with herdbook societies (Adams and Kaufmann, 2003; Krätli, 2008; see also section *Indigenous knowledge about animal breeding and breeds*). In fact, the Arab principles of careful parent selection and maintaining pure lines that came to Britain with imported oriental horses in the seventeenth century substantially influenced breed development in Europe, culminating in the foundation of herd books and breeding societies in the nineteenth century (Berge, 1959).

Box 4. Traditional breeding institutions in India

- In Rajasthan, village-based institutions in the form of a communally owned bull (*godda*) and/or male buffalo (*padha*) exist. According to a survey conducted in 2000 in 50 villages, this institution continues to exist, in parallel to the government system of providing artificial insemination from exotic breeds. In most of the villages, community members jointly selected the animal, with each household contributing to its purchase costs. Some villages went to great lengths to obtain good quality bulls and buffaloes of superior genotypes, sending out scouting committees to distant villages that had a reputation for such animals. Each household shared the expense of the community bull's upkeep and of its keeper's salary (Anderson and Centonze, 2006).
- The famous Ongole breed from Ongole Taluka in Andhra Pradesh, southern India, developed through the practice of the "Brahmini" bull. When a well-to-do-man died, his family dedicated a good stud bull to the local deity. A special committee of experts was tasked with searching for a superior bull which became the property of the community (Nath, 1992).

Indigenous knowledge about animal breeding and breeds

With their long tradition of animal breeding and daily intimate interaction with their herds, livestock-keeping communities have accumulated detailed knowledge on their animals, their needs and their surroundings (e.g., FAO, 2009d+e; Martin *et al*., 2001).

Local classification systems can be very detailed (Galaty, 1989; Hussein, 1993; Kaufmann, 1998; Rege, 2001; Ayantunde et al., 2007; Krätli, 2008) – going beyond the scientific breed definition that commonly counts animals sharing the same external characteristics as one breed. Rendille and Gabbra in Kenya differentiate their camel breeds into four types, all of which differ in their adaptation and performance characteristics (Hülsebusch and Kaufmann, 2002). In Nigeria, poultry science recognized only one type of non-exotic chicken labelled "local", while Hausa and Fulani distinguished at least 15 types of local chicken based on productivity, colouring, feathering, body size and conformation, and ideological association with certain spirits (Ibrahim and Abdu, 1996).

Pastoralists especially know the qualities of animals in their herd; they may classify them first by status (sex, age, pregnant, lactating, castrated, etc.), then by colour and pattern, shape of the horns, or special characteristics. Frequently all animals in a herd are named and often all female animals of the same lineage are given the same name (Galaty, 1989).

Despite the absence of written records, pastoralists often memorize the ancestry of their animals in great detail and over several generations. Such mental pedigree records are known from the East African Maasai (Galaty, 1989), the WoDaaBe in Niger (Krätli, 2007, 2008), the Nuer of southern Sudan (Schwabe, 1978), and the Bodi of Ethiopia (Fukui, 1988). The WoDaaBe also remember the age of a cow when it first calved, and the age at which a sire was first used for breeding. In the case of heifers given out in loan contracts, they know the age at which the animal was loaned, how many calves it had borne and whether they were male or female (Krätli, 2008).

Banni buffalo breeders maintain that they remember the ancestry of their animals for 107 years. Raika camel breeders claim that they know the pedigree of their camels for seven generations (Köhler-Rollefson, 1993b).

The striving of Bedouin horse breeders for purity of their animals' blood reportedly bordered on fanaticism. They distinguished between pure-bred and ordinary camels and recognized a she-camel only then as a thoroughbred, when its female ancestors had been covered by a thoroughbred bull for at least four generations. Male thoroughbreds were recognized only in the ninth generations (Chaudhuri, 1990; Musil, 1928).

The knowledge on individual animals, their genetic relationship with the other animals in the herd and their history allows the herders to make considered breeding decisions and avoid inbreeding. The knowledge is also an extremely useful resource for breed documentation as well as breeding and conservation decisions (Perezgrovas et al., 1995) and can point to breeds and strains that would have otherwise escaped the attention of scientists who often find it difficult to determine whether animals belong to different breeds or represent ecotypes within a single breed (ILRI, 1996). The Malvi camel in India has been discovered based on information provided by Raika camel pastoralists (Köhler-Rollefson and Rathore, 1996; see Box 5 for further examples).

The "discovery" of new breeds requires detailed information that can only be obtained through participatory methods and close interaction with livestock keepers. As scientific breed documentation heavily relies on surveys and questionnaires, it can be expected that marginal areas still hold undiscovered treasures.

Box 5. Examples of locally distinguished breeds not (yet) recognized by science

- The Banni buffalo from Kutch in Gujarat is in the process of being officially recognized as a separate breed – the first new breed to be acknowledged since the official Indian breed classification was established in colonial times. While scientists presumed it was the same as the Murrah buffalo, ethno-historical information provided by Banni pastoralists clearly testifies that the breed came from Sindh in Pakistan and has evolved independently of the Murrah buffalo (Sahjeevan, 2008; unpublished report).
- Nari cattle are another breed in India that is phenotypically unique and fulfils all criteria to be recognized as a separate breed (LPPS, unpublished report).
- In Patagonia, Argentina, artisans pointed scientists to a sheep with a special type of wool. These sheep are locally known as Linca or Pampa, depending on the areas where they are kept. They have existed in the region since the late seventeenth century, and were bred by local communities long before the introduction of the Merino (Cardinaletti et al., 2008).

Breeding goals and objectives

Livestock keepers may not have a concept of the "ideal animal" such as exists in formal breeding societies (Adams and Kaufmann, 2003). They often keep breeds that can fulfil several of the multiple functions needed to survive and produce in difficult environments. Furthermore, they keep a mix of species, breeds and lineages with different functional traits and may structure their herds into matrilineal lineages to ensure the transmission of functionality across generations (Krätli, 2008). Functionality includes feeding competence, minimum stress interaction with other herd members and the herder (Krätli, 2008) and production traits (Hülsebusch und Kaufmann, 2002).

Reflecting the foregoing factors, the breeding goals of livestock breeding communities are multifaceted and comprise many criteria beyond high production of milk and meat. For small-scale livestock keepers, especially pastoralists, adaptive traits are usually more important than

productive traits, in view of the often the poor quality or seasonally low quantity of feed, high disease pressure, poor infrastructure and high costs of veterinary care and other inputs (FAO, 2003a; Steglich and Peters, 2003).

Breeding goals are also guided by aesthetic preferences, religious requirements and behavioural aspects, such as complacent nature, good mothering instincts, herdability, ability to walk long distances, and loyalty to the owner (Köhler-Rollefson, 2000a).

Breeding goals and selection criteria vary between societies and can be different for species and breeds, for male and female animals and perhaps even between types within a breed (Box 6). Within societies, different age and sex groups may have different breeding preferences. Among the Maasai of East Africa, the young men (*moran*) prefer sturdy and hardy animals that can walk long distances and withstand food and water shortage. The elder men (*landis*) who remain at home give preference to larger-framed and higher-producing animals. Women, on the other hand, who have to do a lot of the work connected with livestock keeping, favour animals that are docile, easy to milk, have good mothering instincts and provide surplus milk that is used for home consumption or can be sold in the market (Laswai et al., 2004).

Box 6. Examples of selection criteria of livestock keeping communities

- Beauty traits (colour patterns and horn length and shape) are major selection criteria for Ankole breeders in East Africa. Fertility and milk yield were more important for cows, whereas disease resistance and sire fertility were more important for bulls (Ndumu et al., 2006).
- Tano et al. (2003) interviewed subsistence livestock farmers, mixed-crop/livestock producers, and beef and milk livestock farmers in a tsetse-affected zone in Burkina Faso. It was discovered that all farmers prefer cattle that are not selective in the type of grass or the quality of water they consume. In bulls, traction ability, large body size, high fertility, disease resistance and rapid weight gain are considered positive. For cows, reproductive performance, milk yield and body size are important criteria, but this varies among production systems. Farmers valued traction more than pastoralists, who highly valued milk yield. Mixed-crop/livestock farmers are most interested in animal traction, are less interested in meat and milk offtake, and thus are less concerned about low reproductive performance. For pastoralists, low reproductive performance is of great concern because of its impact on herd size and productive capacity, and milk and beef often ranked highly. As in the case of bulls, large frame size in cows was preferred because it has an impact on the market value of the animals (Tano et al., 2003).
- Raika shepherds from India select their sheep according to a set of many criteria called *nauguna*: wool production, milk production, good pedigree (true to the breed), mothering abilities, height, good walking ability, fast growth rate, drought and famine resistance, beauty, high birth weight, ability to endure and withstand pain (Köhler-Rollefson and LIFE Network, 2007).
- For chickens, rural women in southwestern Iran select hatching eggs for medium size and weight, and laid by hens with good body formation, weight, feathers, colour, laying and growth rate, as well as good broodiness. Eggs laid in the morning are preferred. They continue to prefer traditional breeds, although the Ministry of Rural Development has distributed many highly productive laying breeds throughout rural areas (Shahvali et al., 2000).
- Goat herders in Patagonia mostly named two criteria for selecting Neuquén Criollo goats for breeding. Their main criteria seemed to be hair type and coat colour (Lanari et al., 2005).
- Agropastoralists of Usi, Peru, use different selection criteria for llamas and alpacas. For

llamas, size and strength are important, while for alpacas fibre is the main criterion (McCorkle, 1983).

Breeding management

Breeding management includes the practices and institutions that livestock keepers use to implement their decisions as to which animals are allowed to reproduce and which are not. It consists of selection of breeding animals, mating control, the removal of unwanted animals from the herd through culling or sale, and the decision on how many males are needed to cover all females (e.g. Hülsebusch and Kaufmann, 2002).

In traditional breeding, selecting male animals is more practical than selecting females, as one male can sire many offspring, whereas the number of offspring from a female is far more limited. Furthermore, herd sizes are often too small to mate only the best females, and as the milk from all females in a herd is needed, smallholders and pastoralists may also let inferior animals be mated (Mathias-Mundy and McCorkle, 1989).

Selection can focus on individual animals or on families. In Kenya, Rendille pastoralists select camels by family. For them the quality of characteristics of the ancestors and the "breeding line" of a new sire to be selected are more important than the characteristics of the individual young sire. Somali and to a lesser degree also Gabbra, on the other hand, consider the young sire's own characteristics and give less importance to those of his ancestors (individual or phenotypic selection). Family selection offers higher promise of success for characteristics with low heritability such as adaptation to drought or disease resistance, while individual selection has advantages in case of milk and growth which have slightly higher heritability values than adaptive traits (Hülsebusch and Kaufmann, 2002).

Some societies base selection on offspring testing. Camel breeders, including the Somali and the Indian Raika, mate new or young male animals only with a limited number of females to scrutinize the quality of the offspring. Only when the first crop conforms to their expectations will they use the male animal more widely (Elmi, 1989).

Animals with unwanted characteristics are commonly prevented from breeding. Some societies use very rigid mating control to obtain a certain bull/cow ratio or ensure special qualities. In the Marwar region of Rajasthan, communities enforced castration of all male animals not approved for reproduction. Male calves of the Nagauri cattle breed were castrated at the age of six months and only one bull was left for every 80 cows (Joshi and Phillips, 1982). Herders in Nigeria castrated hundreds of thousands of Sokoto Red Goats that did not have the red skin highly valued for the production of Morocco leather (Blench, 1999).

Mating control can be temporary or permanent. Temporary methods include fencing, the use of aprons and other devices to hinder mating, and manipulative practices such as tying the penis to the side (Mathias-Mundy and McCorkle, 1989). Castration is commonly a permanent method. Mauritanian Fulani, however, castrate their sheep and goats "temporarily" by lodging the animal's testes under a slit in the abdominal skin until mating time, when the testes are let down again (Ba, 1982).

In many societies, herders themselves castrate their animals, independently of veterinarians and government programmes (McCorkle et al., 2001). In India, castration is performed by a particular caste, the Satya, specialized in this service (Alstrom, 1999). With the exception of a report from China (Wagner, 1926), the available literature documents only the castration of male animals, using a large array of both open and bloodless forms, depending on the culture and species (McCorkle et al., 2001).

If castration is used for purposes other than mating control, it may lead to negative selection if the best sires are being castrated. Livestock owners often castrate animals destined for ploughing and pulling carts to ensure that they are docile. In some instances, so many males have been castrated or slaughtered that livestock owners find it difficult to find high quality males to cover their females. For example, the decreasing number and quality of swamp buffaloes was attributed to such factors (Chantalakhana, 1981) but in the absence of sociological studies from the period it is difficult to judge whether other factors also contributed to this change.

Other examples of castration for reasons beyond mating control are the practice of removing one testis from breeding bulls to make them more fertile. This is reported for the llamas of the Quechua in South America (McCorkle, 1983) and Karamoja cattle in northern Uganda. Furthermore, animals may be castrated for specific functions such as the bellwether male (the lead sheep in a flock) in the herds of sheep kept by Syrian Bedouins (FAO, 1985).

Animals that have unwanted characteristics or can no longer (re)produce may be sold or culled Reported reasons for removing females relate to fertility and reproductive problems and the ability to care for the offspring (Laswai et al., 2004). In some instances, discarded cows may be purchased by small breeders who use them for work, as in the case of Kangayam cattle in India (Joshi and Phillips, 1982).

If unwanted animals are not culled but are left in the herd and allowed to breed, herd composition will resemble that of a wild population, as the example of several cattle breeds in southern India shows (Vivekanandan and Paulraj, 2002).

Finally, pastoralists and smallholder livestock keepers are also known to experiment with breeds – to adapt their animals to local conditions, improve production, and perhaps also for curiosity. Upgrading of local poultry breeds has been observed all over the world; however, the need to maintain broodiness in the hens creates a limit for small-scale farmers (FAO, 2008; Besbes, 2008). Cross-breeds unfit for the local conditions are no longer pursued. Others are maintained if conditions allow, and further refined (Box 7). While cross-breeding has resulted in the development of valuable breeds, it may also reduce the number of purebreds in local herd so drastically that it can threaten the existence of local breeds, as in the case of Red Maasai sheep.

Box 7. Cross-breeding

- The Maasai deliberately introduce new germplasm into their herds by means of exchanges within the community and by experimenting with improved breeds such as the Boran and Mpwapwa cattle. However, it was observed that these improved genotypes suffered from high mortality, not being able to trek very long distances or cope with prolonged intervals between drinking (Laswai et al., 2004).
- Keteku cattle of Fulani pastoralists in Nigeria is a stabilized cross of Savannah Shorthorn (Muturu) and White Fulani (Bunaji), with some input from N'Dama Longhorn (Rege et al., 1994; Felius, 1995, cited from DAD-IS). Bunaji has a relatively high milk production for savannah breeds while N'Dama is trypanotolerant and adapted to rainforests. The resulting Keteku cattle can thrive under a wider range of drought and disease challenge (Schillhorn van Veen, cited in Martin et al., 2001).
- In the Gambia, cattle owners depend on the functional traits of the N'Dama breed and appreciate it as a multipurpose animal that is well integrated into their production system. Nevertheless, they conduct experiments by crossing it with the higher potential but trypano-sensitive Gobra breed, as long as the local agro-environment is favourable enough (Steglich, 2006).
- Most breeding programmes, aimed at improving the productivity of indigenous chickens, have used cross-breeding. This approach has provided significantly higher productivity, but

has resulted in a loss or dilution of the indigenous birds' morphological characters and instinct for broodiness. For example, the Sonali in Bangladesh was a high-yielding breed combination under semi-scavenging conditions. However, smallholders' acceptance declined when they discovered that they had no success in reproducing the breed. Similarly, when they received CARI cross-bred hens developed by the Central Animal Research Institute in India, Indian villagers complained about the dilution of morphological characters (Besbes, 2008).

- Pastoralists in Tibet have experimented with different ways of producing a species cross between cattle and yaks. The herders regard the offspring of cows crossed with yak bulls as less suitable for their harsh conditions than offspring stemming from cattle bulls mated to yak cows (Wu, 1997; 1998).

3.3 Conservation

Breed conservation and the preservation of option values

An important role of small-scale livestock keepers, especially pastoralists, is the preservation of option values (Pilling et al., 2008; Rodriguez, 2008) – values that derive "from the value given to safeguarding an asset for the option of using it at a future date. It is a kind of insurance value (given uncertainty about the future and risk aversion) against the occurrence of, for example, a new animal disease or drought and climate change" (FAO, 2007 p. 430). Pastoralists and smallholder livestock keepers keep animals with traits that may currently be of no commercial interest, but may be of huge value in changing environmental and economic scenarios. Such traits include "survival" characteristics such as the ability to fend for themselves and the ability to cope with diseases (see Box 8 for examples). The following factors and conscious strategies contribute to the maintenance of the traits.

Box 8. Traits furthering survival in harsh environments

Smallholder chickens often have to scavenge for their food rather than rely on daily handouts of concentrate. To survive under such conditions and to defend their chicks, local breeds need to be aggressive and energetic, and have good mothering ability. Examples are the Fayoumi chickens from Egypt, which can survive in harsh environments through their aggressive, high-energy behaviour (Meyer 1997), and Nigerian chicken breeds, which are known to fight off predators attacking their chicks (Ibrahim and Abdul, 1996; McCorkle et al., 2001).

Pastoralist livestock often retain the ability to defend themselves against predators. Nari cows, for example, defend their calves from leopards by forming a circle around the young animals and shielding them with their extremely long and pointed horns. Nari cattle owners even state that the cows will defend their owners in the same manner, if they perceive a threat to them (Köhler-Rollefson and LIFE Network, 2007).

Pastoralists and smallholder livestock keepers live and use their breeds mostly in the environments where the breeds originated. The continuous exposure to local conditions allows the breeds to maintain the adaptive traits that enable them to cope with the available fodder, the climate and specific environmental features such as stony ground, high altitudes and swampy land.

If removed from their original area for a number of generations, animals may lose the characteristics that allow them to survive in their in these environments. The North Ronaldsay

sheep of the Orkney Islands in Scotland, for example, are adapted to a diet of seaweed. If transferred to other environments, the animals lose this adaptation (Woolliams et al., 2008).

Some communities further the development of adaptive traits through purposive selection for such traits. The WoDaaBe herders in Niger select their animals for their "feeding competence", defined as the ability to select the best season-specific browse or graze and the ability to negotiate difficult terrain. The capacity to browse includes the ability to reach, choose, ingest and process the highly nutritious forage that their herders lead them to. Furthermore, the WoDaaBe select their animals for "social competence", i.e. minimum stress interaction with the other animals of the herd and with the herder (Krätli, 2008).

Other pastoralists keep their livestock in a state that is close to the wild. This exposes the animals to continued selection pressure, maintaining their phenotypes for adaptive traits and allowing them to adapt to changing conditions. Examples from India are camel breeders in the Thar Desert, Toda buffalo breeders in the Nilgiri Mountains and Pullikulum cattle breeders in Tamil Nadu.

As another strategy to improve adaptive traits, some groups of livestock keepers purposefully arrange for their female animals to be bred by wild males. This is known from the Mongolian Gobi Desert for camels, Sri Lanka and Vietnam for pigs, and Sri Lanka for poultry. In the Rann of Kutch in Gujarat, donkey owners deliberately provide opportunities for their female donkeys to be covered by male half-asses.

Livestock keepers are also known to undertake conscious efforts to adapt their animals to new environments and changing conditions (Martin et al., 2001). When introducing preferred breeds into new ecological zones, pastoralists may cross-breed their animals with males from local breeds to enhance their offspring's adaptation to local diseases and other conditions (Blench, 1999; McCorkle et al., 2001). Furthermore, herders may provide extra care to animals at risk (Blench, 1999) to help them cope with the challenges of the new environment. Some livestock keepers seem to adapt their animals to fodder known to be toxic to livestock through adding increasing amounts to the regular fodder (Mathias-Mundy et al., 1992). Other societies are known to train their animals to stay away from eating tempting but poisonous forages (McCorkle et al., 2001).

Finally, herders may take conscious efforts to bring their animals into contact with diseases by moving their herds near to infected herds and using local forms of vaccination (Mathias-Mundy and McCorkle, 1989). Both exposure and vaccination will cause mild forms of the diseases at convenient times, training the animals' immune systems and furthering their general hardiness.

Keeping the animals in their natural environment, purposively selecting for adaptive traits, exposing the animals to continued natural selection pressures and disease challenges, and adapting them to changing ecological conditions and new diseases that arise in their environment: all these factors and strategies help to conserve breeds and keep them "alive". This has the advantage that animals become adapted to the new challenges, but has the disadvantage that some of the "old" option values might be lost.

Reasons livestock keepers give up their breeds

In a recent global survey, FAO found that economic and market driven threats, inadequate livestock sector policies, poor conservation strategies, inadequate institutional capacities to manage breeds and loss of labour, are the five major threats eroding domestic animal diversity.[7] A detailed study on threats to breed survival in Europe include decrease in public funding, lack of political will to support rural communities, policies and legislation, including environmental schemes, disease, predators, urbanization, poor return on product, competition from other

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livestock, ageing of the farming population, lack of marketing support, inbreeding and loss of skills (Carson et al., 2008). These challenges also make it more and more difficult for livestock keepers to continue their livestock production, especially if they depend on natural resources for their livestock As a result, they may switch to other breeds or species, combine livestock keeping with other activities, or give their livestock up altogether.

The following sections discuss selected reasons livestock keepers give up their breeds. While the reasons are discussed one by one, one needs to keep in mind that usually a combination of several factors will be at work – as the case of the Muturu cattle in Nigeria illustrates (Blench, 1999, see Box 9).

Box 9. Replacement of Muturu cattle by zebu and cross-breeds

Muturu cattle are a small, trypanotolerant breed well adapted to the flora and the extremely high rainfall of southern Nigeria. Still very common in the 1960s, the breed has dramatically decreased since then, due to a number of factors:

- Children used to manage the animals; many of them now go to school.
- Muturu bulls used to be communally owned and protected by traditional religious sanctions. The spread of world religions has undermined such customs.
- New by-laws required herders to tether their animals and give them cut-and-carry feed. Along with increasing restrictions on herd movements and the availability of trypanocides (making it possible to keep other types of cattle), this offset the breed's comparative advantages and prestige.
- Cheap transportation made it possible to bring in zebu cattle from other areas.
- The introduction of the cash economy made it attractive for local people to specialize in other types of farming.

As a result, herders started switching to zebu or zebu x Muturu cross-breeds and employed Fulani graziers to take care of the animals. Source: Blench (1999).

For many decades, small-scale livestock keepers have been lured into adopting improved breeds and standardized production and breeding systems through a mix of pressure and one-sided information. The adoption of exotic breeds is often heavily subsidized, providing a competitive advantage over local breeds (Drucker et al., 2006). Efforts supporting and improving local breeds are rare.

Government programmes, extension personnel with formal training in animal science and private companies promote the adoption of high-performance breeds and management of animals according to scientific principles and intensive production systems (FAO, 2003b; FAO, 2007b; Köhler-Rollefson, 2003; Du Toit, 2007). Livestock development projects and programmes frequently introduce exotic breeds – by importing young animals, eggs, semen or fertilized embryos, or by encouraging cross-breeding. In many cases, promoters of exotic breeds fail to inform livestock keepers sufficiently of the special needs and drawbacks of these breeds.

Such efforts are not new, or confined to the developing world: in the southwestern USA, for example, the Navajo-Churro sheep population decreased due to government programmes. At the end of the nineteenth and beginning of the twentieth century, the Bureau of Indian Affairs promoted improved British rams. In the 1930s, thousands of sheep were annihilated by livestock reduction programmes (FAO, 2007c).

The impact of changing markets on livestock keepers' interest to continue keeping their breeds can work both for and against local breeds. Globalization and the growing connection between international and domestic markets impose many new requirements on livestock keepers. Although these markets are not identical, there are some common features. Increased domestic and long-distance trade requires standards and regulation to ensure safety and reduce transaction costs. Food control and certification systems must be of a high standard. In addition to the health and safety standards and regulations agreed by international bodies such as the World Organisation for Animal Health (OIE) and Codex Alimentarius, technical requirements may be imposed by retailers. These may include demands for particular meat cuts, carcass size and weight, leanness of meat, fat levels in milk, egg colour, or labelling with particular information or in specified languages.

Taken together, these requirements tend to marginalize small-scale keepers, and the local breeds they keep. However, it is difficult to predict how livestock keepers will react. Many scenarios are possible: they may switch to other species, to another local breed, or from local to high-yielding breeds or *vice versa*, start cross-breeding or give up livestock keeping altogether.

The slackening international demand for wool due to changing markets and consumer preferences, for example, has been making sheep rearing less profitable. Sheep rearers reportedly switched to other species, as the Jalauni sheep keepers in India who started keeping buffalo and cattle (Sahana et al., 2004), or shifted from wool to hair sheep and started crossbreeding. Examples for the latter are Raika sheep breeders in Rajasthan (Geerlings 2004; LPPS, 2003) and sheep breeders on the Deccan Plateau (ANTHRA, 2007).

Experience from former Soviet countries indicates that reduced demand for a specific product threatens breeds specialized on this product (FAO, 2007d) while a general deterioration of economic conditions can stimulate the use of local multipurpose breeds such as local fat-tailed sheep (which can graze better under the snow), Downy goats, and meat horses instead of cattle (Kerven and Lunch, 1998).

Rising demand for a mass product can have two differing effects, namely livestock keepers may stock up on local breeds or switch to high-yielding breeds. Operation Flood in India illustrates the first possibility as the increased supply of milk achieved over the last three decades was largely due to an increase in the number of buffaloes (Mathias and Mundy, 2005). Smallholders in Kenya, on the other hand, largely switched to high-yielding breeds to participate in the booming market for smallholder dairy products (Bebe et al., 2003).

Paradoxically, rising demand for products from a specific local breed can motivate livestock keepers to change their traditional breeds and management practices. The Iberian pig was traditionally kept under free-range conditions, but rising demand for its products has encouraged farmers to cross-breed their animals with Duroc pigs to improve the daily weight gain, feed conversion and carcass quality, and keep them in confinement rather than allowing them to forage (Daza et al., 2008).

Changes in the control and use of land, water and livestock commonly work against local breeds. A shift of livestock breeding from traditional societies into the hands of landowners with capital leads to the homogenization of once-distinct breeds. In Kenya's Central Highlands, the privatization and fencing of land in the 1950s and 1960s promoted the replacement of traditional livestock breeds with exotic dairy cattle (Rege, 2001). In Sudan, investors profited from a series of droughts which enabled them to accumulate large livestock holdings from different tribal groups. As a result, formerly distinct camel breeds merged into one generic type (Köhler-Rollefson, 1993b).

The expansion of cropping into former rangelands – often furthered by subsidies for power, fertilizer and high-yielding crops – means that livestock keepers have fewer areas to graze their animals. The result is lower production and major problems during drought, as well as conflicts with the farmers and other pastoralist groups. However, the areas now being farmed are often

unsuitable for cropping in low-rainfall years or when the groundwater level sinks due to overuse of water, leading to problems of poverty and food insecurity among the farmers as well as the pastoralists they have displaced.

National politics and policies have a major effect on the livelihood of livestock holders and the conservation of breeds. Due to the lack of recognition of the multiple contributions of small-scale livestock keepers and pastoralists, policies commonly further large-scale production, disadvantaging small-scale keepers and pastoralists. Settlement policies force pastoralists to give up nomadic lifestyles, with negative consequence for their breeds, environments and social relationships as the clash in approaches inevitably leads to mutual suspicion and conflict.

Projects and policies aiming to support small-scale and pastoral livestock keepers and conserve the environment can also have unintended adverse effects on livestock keepers. An example of this is the promotion of water holes in pastoral areas, which has induced pastoralists to reduce their movements, leading to overgrazing around the water holes (e.g. Homann, 2005). The ban of burning forced many yak herders in central Bhutan to give up yak keeping (FAO, 2007e) and restricted the grazing areas available to pastoralists in East Africa through the growth of bush (IIRR, 2004).

Regulations intended to protect consumers and prevent the spread of diseases put insuperable burdens on the small-scale livestock and pastoral keepers, making it difficult for them to continue using and conserving their breeds (FAO, 2005). Examples include measures to control epidemics through stamping out and zoning. Breeds threatened by such rigorous disease control measures and the prohibition of vaccination include the Chillingham cattle and British Lop pig in the United Kingdom (Roper, 2005) and Co ducks in Viet Nam (FAO, 2007f).

Control measures for highly pathogenic avian influenza have both direct and indirect impacts on poultry genetic resources. Direct impacts occur when local poultry breeds or even valuable stocks of pure breeds – in the case of the Faculty of Agriculture of the Cairo University – are culled in the wake of disease outbreaks (FAO, 2006b). Indirect impacts are caused by biosecurity measures and restructuring of the poultry sector which further marginalize smallholders and the local poultry breeds they keep. Examples include relocation of large scale-production and market units from densely populated poultry areas into more remote areas (e.g. Malaysia, Viet Nam), the closure or relocation of the live poultry ("wet") markets, collection points and small slaughter points and the subsequent exclusion of smallholders from the market chain (FAO, 2006c).

Other regulations that will push up production costs per animal and likely drive many small-scale livestock keepers and pastoralists out of business are the stringent record-keeping requirements that the European Union is planning to introduce for traceability.

Clearly, it is neither feasible nor advisable that breed conservation objectives should take precedence over the need to control serious epidemic and zoonotic diseases. Livelihood implications (positive and negative) particularly for the poor should, however, be given serious consideration. With better planning, much could be done to ensure that impacts on genetic diversity and traditional livelihoods are minimized. Smallholder farmers and pastoralists should be given a voice in designing disease management plans and campaigns.

And finally, socio-economic changes that are otherwise to be applauded may reduce the ability of livestock keepers to maintain their lifestyle and their breeds. The reasons presented earlier for the decline of the Muturu cattle (Box 9) shows that sending children to school can conflict with the need for labour to herd animals. School attendance not only competes for the children's time, but also tends to alienate children from their own culture. The temptations of modern life, broadcast by the media to the remotest corners of the globe, decrease the interest of young people in continuing their parents' lifestyles. Those who would like to continue do not see how they can make a living from livestock keeping, given all the adverse forces.

Other cultural changes such as the global trend towards commercialization affect breeds more directly. From being an integral part of a culture – to be preserved simply because they are part of

that culture – livestock breeds are coming to be regarded more as a source of income. For such reasons, Raika pastoralists in Rajasthan started selling their female camels and Tamberma agropastoralists in Togo are losing interest in their Somba cattle (FAO, 2007g).

Motivation to keep a breed

Livestock keepers may continue using and maintaining their breed for a number of reasons – mostly livelihoods. In some cases there may be a sense of custodianship (Box 10). More frequently, however, they (can) only continue if there are sufficient economic incentives.

Furthermore, the survival of many local breeds and their traits is bound to the survival of the production system and ecosystem in which their keepers live. The breeds fit a specific set of circumstances (climate, vegetation, parasites, diseases, management system, etc.), and fulfil certain functions (to provide food, labour, etc.). Their production relies on access to grazing land, feed and water sources. If those resources are removed – fenced off as private ranches, converted to cropland, overgrown by scrub, gazetted as nature reserves, or made inaccessible by political boundaries – then the ability of the breeds' keepers to maintain their breeds plummets.

Box 10. Communities' sense of custodianship conserves breeds

In some cases, traditional livestock keepers continue to keep their breeds, despite a lack of economic incentives. They feel a moral obligation, regard their animals as sacred, or believe their animals provide certain ritual functions that cannot be transferred to exotic animals. Examples of this abound in the literature:

- Alpaca herders in the Andes say that "in the same way as we nurture alpacas, they nurture us" or "the day the alpacas disappear, the world will disappear" (Vásquez, 1997).
- The trypanotolerant Muturu cattle in southern Nigeria are often kept in a semi-feral state and provide barely sufficient milk to nurture their calves. Nevertheless, traditional doctors take small amounts of milk for medical purposes. The animals are also necessary for the death rites of community members – corpses are rolled into hides from Muturu cattle, while the meat is consumed at the ceremonial feast (Rege et al., 1994).
- Although the lifestyle of Bahima pastoralists, who created the giant-horned Ankole cattle breed in Uganda, has changed dramatically over the last decades, they are still willing to keep these impressive animals (Wurzinger et al., 2008).
- In India, the Raika believe that they were made by God for the specific purpose of taking care of camels, and they feel responsible for the animals' welfare. This prevents them from selling their herds, although they no longer generate a profit and may even have become a burden.
- In the Lao People's Democratic Republic, indigenous chickens are important in traditional weddings in which bride and groom share an egg as symbol of love and solidarity (FAO, 2007i).

Economic incentives are of increasing importance for the survival of both breeds and healthy environments. Ways need to be found to enable small-scale and pastoral livestock keepers to continue managing their breeds in a way that conserves the genetics but improves their standard of living. Options include combining livestock keeping with ecotourism (e.g., Ghimire et al., 1998) or with efforts to address social and poverty-related issues (FAO, 2007h). Other possible approaches are ensuring access to markets, creation of new and niche markets, payments to livestock keepers for services, and subsidies for maintaining breeds.

Livestock keepers will invest in breeding animals for particular products (milk, meat, draught) only if markets for these are assured. Yet often such markets are far from certain. In many areas, security problems, corruption, quarantine restrictions, lack of roads and transport, inadequate communications infrastructure, and a lack of physical market facilities hamper trade and make regular supply of live animals and products difficult.

Relations in the marketing chain are typically weak: livestock keepers are often unorganized; they lack marketing associations; and they rely on traders who come to buy animals on an individual basis. There are also few market institutions in the livestock arena: animals are sold without being weighed; market information is scanty; quality grading is lacking; and there are few services such as extension and health services that might improve the quality of the marketed produce (Williams et al., 2003; KIT and IIRR, 2008). Overcoming these problems would make it easier and more profitable for livestock keepers to market their animals and the products and services they provide.

A promising avenue is to develop niche markets for specialty products from local breeds. Adding value through processing can raise the returns to livestock keepers and result in rising animal numbers. It is often the production system associated with the breeds, rather than the breed itself, that results in higher prices (CR AnGR Bulgaria, 2004). Not only the genetic characteristics of traditional breeds contribute to taste and structure of the meat, but also the vegetation consumed, the slow extensive production system, or special processing of meat or cheese (Kuit and van der Meulen, 1999; Rook et al., 2004).

In Brazil, spinning and weaving of naturally coloured wool of the Criollo Lanado sheep increased demand for the wool and as a consequence the number of herds (EMBRAPA, 2003). In Argentina, ponchos made from Linca wool can obtain prime prices (Cardinaletti et al., 2008). In India, designers created attractive items using black wool from the Deccani sheep; demand for these items is strong in Japan (Gopikrishna, 2008). In Rajasthan, Raika herders are exploring the possibility of marketing milk from their camel. Not traditionally sold, camel milk is proving a hit: it has anti-diabetic properties, and can be used to make tea, ice cream, sweets and other products, resulting in a steep rise in prices for female camels within a short time span and putting a stop to the sale of female camels for slaughter (Köhler-Rollefson, Rathore and Mathias, 2008).

An economic incentive of growing importance is payments for biodiversity and landscape maintenance. In Europe, it has become common for governments to pay livestock holders to herd their animals in certain areas so as to conserve the cultural landscape (see the section on *Agro-ecosystem services*). This has twin benefits: it conserves not only the landscape, but also the breed used to graze it. Because local breeds are well-adapted to local conditions, it makes sense to use these breeds, and not exotic ones. The payment for these services can make the difference between profit and loss for low-input production systems.

The European Union has also been supporting farmers to maintain breeds that are recognized as being endangered. Experience has shown that such payments can halt breed loss. But because the payments continued only as long as a breed's population was below a certain threshold size, they turned out to be a barrier to population growth. More recent European Union support aims to avoid this trap by promoting added values for rare breeds (Woolliams et al., 2008). But breeds with limited market potential may need financial and other support also in the future (e.g., Brito et al., 2005).

The provision of appropriate support services such as veterinary services, market infrastructure, transport, security and conflict resolution, communication, education and health services is another crucial input that livestock keepers need to continue using their breeds. Providing these services is difficult for governments because of low population densities and the inaccessibility of many rural areas.

It is often down-to-earth things that can help make services appropriate to smallholders. Examples are the employment of female extension agents for livestock mostly kept by women,

and the development of vaccines that do not require constant refrigeration, are easy to administer and are packaged in small batches so that they can be applied in difficult-to-reach areas by trained community vaccinators.

Services for pastoralists need to cater to a mobile lifestyle. Successful models already exist – mobile schools (IIRR, 2004; Pailwar and Mahajan, 2005) and clinics, training of paraveterinarians from among the pastoralist communities (Catley et al., 2002; IDL Group, 2003), and so on. More such initiatives are needed if pastoralism is to remain a viable lifestyle option for the Earth's vast rangelands, and if the breeds that pastoralists maintain are to survive.

Extension and animal health care services for small-scale keepers need to consider that smallholders may have limited and irregular access to cash, and little regular income. Under such conditions, it makes more sense to optimize costs and labour rather than to raise production (Tung 2005). This means proposed improvements of the livestock systems need to be low-cost, scale-independent and fit in with the local conditions – the simpler a technology and the easier it can be adapted, the higher is the probability that farmers will use the technology (Riise et al., 2005; Thomsen, 2005). For these reasons, and mortality being a major problem, farmers are often eager to have their animals vaccinated, but only against diseases they regard as a problem (e.g. Farooq et al., 2000). Priority-setting and participatory-epidemiology techniques can make valuable contributions to obtaining this kind of information.

In the developed world, numerous endangered breeds have been brought back from the brink of extinction by timely intervention and institutional support. Examples include the breeds "adopted" by NGOs such as Rare Breeds International, SAVE Foundation and national rare breed societies. The efforts and enthusiasm of a few dedicated breeders seem to be essential in the initial stages. In the long run, on the other hand, breed and breeders' associations are important tools to reach a critical mass and conserve the breed. It helps if a breed has commercial potential. In the USA, for example, the survival of Randall cattle is due to the efforts of a few individuals. When the number of animals and breeders increased, a breed association formed. This, and the potential of the breed for low-input dairy and beef production, stimulated demand for the breed and helped assure a market (Sponenberg et al., 2007).

Breed associations for local breeds are rare in the developing world. Few examples are reported. In India, a breeders association was founded to promote and conserve the Marwari horse through competitions (endurance riding) and awards for breeders (Rathore, 2008). In South Africa, the Nguni Breeders' Cattle Society (Scholtz and Ramsay, 2007) has helped to preserve Nguni cattle. Key to this success was the emphasis on making the breed competitive rather than striving for uniformity and breed standards. Furthermore, to involve emerging communal black farmers as stud breeders, the society developed a special recording scheme allowing registration of animals in the absence of written pedigree records (see Box 11). Another engaged South African association is the Damara Sheep Breeders' Society of South Africa (Du Toit, 2007).

Box 11. Establishing a herd book in the absence of written pedigree information: The Nguni Breeders' Cattle Society

The Nguni Breeders' Cattle Society was formed in 1986, triggered by the growing commercial interest in the breed's beef potential. While all the seed stock originated from communal breeders, these initially did not get a share of the benefits and had started cross-breeding their cattle with Brahman. To involve emerging black farmers as Nguni stud breeders, the association developed a special registration process to facilitate the registration of animals that had no written pedigree records. Phenotypically Nguni animals from the communities could enter the appendix of the stud book as "F1" animals which could be upgraded over two or three generations to "F4" animals that could enter the stud book proper. Farmers' mental pedigree records counted only insofar as they helped register animals as F2 rather than F1 – irrespective of the number of pedigree generations remembered by the farmers (Scholtz and Ramsay 2007). It is

too early to say whether the involvement of communal farmers as breeders has been successful.

Helping keepers of traditional breeds to raise awareness of the importance of local breeds and make their breeds known through information materials, exhibitions and other public-relations measures can motivate new keepers to "adopt" such breeds.

And perhaps most important, policies need to support pastoral and smallholder production and provide a level-playing field – for example, through supporting the integrity of common property, guaranteeing livestock keepers access to grazing land and water, and facilitating the provision of appropriate services and infrastructure to these keepers (e.g. Gupta, 1996). Livestock keepers themselves are in the best position to point out which regulations can help them to continue conserve threatened breeds.

Small-scale and pastoral keepers are rarely represented in national and international decision-making bodies and can voice their concerns only with the help of outsiders. But as they are the owners and keepers of the breeds to be conserved and holders of valuable knowledge about the breeds and their environment (FAO, 2009d+e), it is crucial to give them a voice in policy-making.

4 Ways and means to acknowledge the roles of small-scale livestock keepers

Small-scale livestock keepers maintain most of the worlds' animal genetic diversity for food and agriculture. Options for fully and effectively involving them in the implementation of specific Strategic Priorities of the *Global Plan of Action*, and ways and means to acknowledge contributions by smallholder farmers and pastoralists to food security and rural development, particularly in developing countries are considered below.

Strategic Priority Area 1: Characterization, inventory and monitoring of trends and associated risks

Pastoralists and smallholder farmers can provide valuable inputs to breed characterization and inventory. They are often aware of the existence of breeds that have not been identified in national inventories or through breed registration systems. Small-scale livestock keepers live closely with their livestock, and in general have an excellent understanding of their production environments and of breed characteristics, such as behaviour, hardiness and ability to cope with environmental and climatic stresses, production potential, management and feeding requirements, and disease resistance. They also know the specific traits of individual bloodlines. All this knowledge could greatly assist in advancing breed-development programmes and research on breed comparisons and comprehensive valuation of local breeds.

According to the *Global Plan of Action*, Governments agreed to "promote participatory approaches to characterization, inventory and monitoring of trends and associated risks that foster collaboration among all stakeholders, including livestock keepers" [8] and to "develop protocols for participatory monitoring of trends and associated risks, and characterization of local breeds managed by indigenous and local communities and livestock keepers." [9] As their daily existence depends on livestock, pastoralists and small-scale farmers can play a key role in monitoring, and quickly detect changes in breed use and population structure – thus contributing to early warning systems for animal genetic resources.[10].

[8] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 1 – Action 4.

[9] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 2 – Action 3.

[10] CGRFA/WG-AnGR-5/09/4.

Strategic Priority Area 2: Sustainable use and development

Small-scale livestock keepers can provide inputs to priority setting for breeding programmes and help select animals for breeding schemes. As they provide products from local breeds for local and niche markets, full participation of small-scale livestock keepers in determining appropriate breed development is needed in order to ensure that focus on access to these markets is not lost. It is also essential that breeding programmes address the challenges posed by the local production conditions. Small-scale livestock keepers are keenly aware of these challenges.

Strategies that combine traditional knowledge and modern science-based practices are needed to achieve the sustainable use and development of the multiple-purpose breeds that are essential to most small-scale livestock keepers. "However, a major obstacle to the further development of indigenous breeds is the lack of national strategies, programmes and institutional infrastructure to facilitate genetic and husbandry improvement programmes in low external input systems."[11] Therefore, according to the *Global Plan of Action,* "National institutions and research facilities are needed to make animal husbandry and animal health care services, facilities and techniques available to all livestock keepers"[12]. The relevant exchange, interaction and dialogue among indigenous and rural communities, scientists, government officials and other stakeholders should be promoted and enabled, in order to integrate traditional knowledge with scientific approaches.[13]

The *Global Plan of Action* further notes that "most countries lack comprehensive policies to support the maintenance and development of animal genetic resources held within their territories. Sustainable use policies should balance food-security goals and economic development with long-term sustainability and adaptation objectives. In addition, environmental and socio-economic changes, including demographic changes, climate change and desertification, require adaptive medium- and long-term policies and strategies for the management of animal genetic resources. These policies should also consider the contributions of livestock keepers ... to animal genetic diversity, respect the interests, rights and obligations of stakeholders, and take into account exchange, access, and the fair and equitable sharing of the benefits from animal genetic resources."[14]

There is an need to ensure that production systems which conserve biodiversity survive. Clearly, however, not all small-scale livestock production systems should be preserved in static form. Traditional livelihoods should not be destroyed, but new opportunities are urgenly needed. Conserving breeds and other types of biodiversity has to go hand in hand with securing and improving the livelihoods of rural people. Policies favouring diverse livestock production systems can, if carefully formulated and applied, also enhance poverty alleviation. Promoting niche market development for products derived from local breeds and adding value to their primary products offer important opportunities to promote these objectives.

Strategic Priorities 5 "Promote agro-ecosystems approaches to the management of animal genetic resources" and 6 "Support indigenous and local production systems and associated knowledge systems of importance to the maintenance and sustainable use of animal genetic resources" are of crucial importance to small-scale livestock keepers. Given the prerequisite that management decisions and policies on the sustainable use of animal genetic resources should be based on an understanding of their economic, social and cultural significance, human environments and livelihoods, and efforts to achieve food security and environmental objectives[15] the *Global Plan of Action* therefore calls for "[integration of] agro-ecosystem approaches in national agricultural

[11] *Global Plan of Action for Animal Genetic Resources,* paragraph 29.

[12] *Global Plan of Action for Animal Genetic Resources,* paragraph 30.

[13] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 6 – Action 3.

[14] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 3 – Rationale.

[15] *Global Plan of Action for Animal Genetic Resources*, Strategic Priority 5 – Rationale, Strategic Priority 6 – Rationale.

and environmental policies and programmes of relevance to animal genetic resources, where appropriate, particularly those directed towards pastoralist and rural smallholder communities, and fragile environments."[16] Support to indigenous and local livestock systems of importance to animal genetic resources "may include the provision of veterinary and extension services, delivery of microcredit for women in rural areas, appropriate access to natural resources and to the market, resolving land tenure issues, the recognition of cultural practices and values" [17] and promoting "the development of niche markets for products derived from indigenous and local species and breeds, and strengthen processes to add value to their primary products".[18]

Strategic Priority Area 3: Conservation

Because breeds are shaped by the environment and reflect community values and goals, conservation can best be achieved in these specific contexts. Sometimes, traditional livestock keepers may continue to keep their breeds out of a sense of moral obligation and because the animals are considered sacred or because they provide certain ritual functions that cannot easily be transferred to exotic animals. Economic incentives are, however, essential for ensuring breed survival *in situ*. The existence of livestock breeds with specific grazing habits and the ability to thrive in specific environments is also essential to achieve broader biodiversity conservation goals.

Given the enormous animal genetic diversity currently held by small-scale livestock keepers, ensuring their involvement in conservation measures is essential. Small-scale livestock keepers' role in conservation can be facilitated by various means. "The historic contribution of indigenous and local communities to animal genetic diversity, and the knowledge systems that manage these resources, needs to be recognized, and their continuity supported."[19] Small-scale livestock keepers should also be involved as active partners in the design and implementation of conservation programmes. According to the *Global Plan of Action,* governments, to aid conservation of animal genetic resources, may "provide and catalyse incentives for producers and consumers to support conservation of animal genetic resources at risk, as evaluated by individual countries, provided that such incentives are consistent with existing international agreements."[20]

Further means to acknowledge the important role of small-scale livestock keepers and to establish incentives for them to continue playing this role, include the creation of a register for their products which would allow the use of a specific label indicating that the products come from small-scale livestock production. Similar registers for traditional products have been introduced in a number of countries.

Further incentives for contributions by small-scale livestock keepers could include measures to support production systems, and payments for their breed conservation and ecosystem services, particularly where breeds are at significant risk of being lost or eroded. A number of countries have demonstrated that small-scale livestock keepers, often collaborating with government departments and non-governmental organizations, are successfully involved in conserving rare breeds.

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16 Global Plan of Action for Animal Genetic Resources, Strategic Priority 5 – Action 2.

17 Global Plan of Action for Animal Genetic Resources, Strategic Priority 6 – Action 2.

18 Global Plan of Action for Animal Genetic Resources, Strategic Priority 6 – Action 4.

19 Global Plan of Action for Animal Genetic Resources, Strategic Priority 6 – Rationale.

20 Global Plan of Action for Animal Genetic Resources, Strategic Priority 8 – Action 3.

Strategic Priority Area 4: Policies, institutions and capacity-building

The full and effective participation of small-scale livestock keepers including smallholder farmers and pastoralists, in strategic planning, policy development and research may also be highly beneficial in the implementation of the *Global Plan of Action* and in the preparation and implementation of National Strategies and Action Plans for Animal Genetic Resources. Implementing integrated approaches to food security, rural development, poverty alleviation and the sustainable use and conservation of biodiversity is difficult but potentially highly rewarding. As, in many cases, small-scale livestock keepers are the targets of food-security and rural-development programmes, and as they use areas important for the conservation of wild biodiversity, participatory integrated planning and policy development approaches that take local knowledge and traditions into account are indicated. Significant gains within current small-scale livestock production systems could be achieved through capacity-building and introduction of improved management practices. Capacity-building must take local conditions into account to ensure sustainability over the long term as efforts are made to enhance production and productivity.

Capacity-building and knowledge sharing among the world's small-scale livestock keepers should be encouraged. The *Global Plan of Action* recommends that governments "review the national educational needs of livestock keepers, while respecting traditional knowledge and indigenous practices."[21] Although they may lack experience in modern technologies, many small-scale livestock keepers have broad experience and understanding of managing livestock where the climate is harsh or other aspects of the production environment are limiting. Their knowledge may prove to be of great importance in rapidly changing climatic conditions. Significant gains in production and productivity in small-scale livestock production systems could be achieved through capacity-building and introducing improved management practices.

"There are both moral and practical imperatives to provide support to livestock keepers and breeders, who are the custodians of much the diversity of the world's animal genetic resources, particularly in developing countries, and who depend on them for their livelihoods. Their roles and needs cannot be ignored, if the *Global Plan of Action* is to succeed."[22]

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[21] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 13 – Action 4.

[22] *Global Plan of Action for Animal Genetic Resources,* Foreward.

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