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LIVESTOCK KEEPERS

Guardians of biodiversity

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At its Thirty-fourth Session, the FAO Conference 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 FAO Conference, therefore, requested the Commission on Genetic Resources for Food and Agriculture to address the issue.

This paper is based on a number of papers made available to the Commission on Genetic Resources for Food and Agriculture and its Intergovernmental Technical Working Group on Animal Genetic Resources for Food and Agriculture and other published literature, as well as field observations. It was prepared by Ilse Köhler-Rollefson with contributions from Evelyn Mathias and Irene Hoffmann, with support from other officers of the FAO Animal Genetic Resources Group: Paul Boettcher, Beate Scherf and Dafydd Pilling.

Summary

The world's livestock diversity comprises more than 7600 documented mammalian and avian breeds as well as an unknown number of not yet documented breeds. These breeds are largely the result of breeding activities by livestock keepers who have developed them without use of herd books or formal breeding societies. By maintaining their animals under exposure to natural selection, pastoralists and smallholder farmers play a crucial role in the sustainable use of adaptation and fitness traits. Breed diversity is especially high in peripheral and remote areas, notably drylands. Many breeds in Africa and Asia are named after ethnic groups; among these, pastoralist societies play an especially prominent role as creators and guardians of breeds, although farming societies have also produced specific breeds.

ECONOMIC ROLE OF THE LIVESTOCK SECTOR AND SIGNIFICANCE OF LIVESTOCK FOR LIVELIHOODS

Globally, the livestock sector accounts for over 40 percent of agricultural gross domestic product and livestock products provide almost 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.

About 70 percent of the world's more than 1 billion rural poor people that live on less than US$1.25 per day are at least partially dependent on livestock for their livelihoods. In smallholder and pastoral systems, livestock fulfil many functions in addition to producing meat, milk and eggs, including the provision of fertilizer, fuel, draught power and transport, a means of saving and investment, a buffer against crop failure, and diverse cultural and religious roles.

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 surface that consists of tropical and subtropical drylands, as well as mountainous and high-altitude zones and some very cold areas. Grazing animals convert the local vegetation in these ecozones into food that can sustain people. Pastoralists and smallholder farmers have developed an array of strategies for the sustainable use of these areas, including sophisticated herd movements and grazing strategies. Their livestock represent a means of extracting value from land that is not suitable for cropping, and generating food without competing for cereals. This not only contributes to food security in marginal areas but also provides products and services to wider society.

AGRO-ECOSYSTEM SERVICES

Traditional livestock production systems have endowed many landscapes with their typical characteristics. Examples of such landscapes 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*, and sub-alpine dwarf shrubland in Europe.

Agro-ecosystem services provided by livestock keepers and their breeds include the creation of mosaic landscapes and mini-habitats that sustain biodiversity, connecting ecosystems by transporting seeds, improving the water-holding capacity of grassland, reducing the risk of forest fires, restoring and maintaining soil fertility through manure and nutrient cycling and mimicking the grazing activities of large wild herbivores.

CREATORS AND GUARDIANS OF BREEDS

Social and cultural factors, together with deliberate breeding decisions and management by livestock keeping communities, have been crucial to the creation of breeds. Livestock keepers structure animal genetic resources into breeds through social breeding mechanisms that create more or less closed gene pools. Indigenous knowledge about animal breeding and breeds includes the ability to identify individual animals within large herds, keeping mental records of animal pedigrees, traditional classification systems, and the maintenance of traditional breeding institutions, such as village breeding bulls. Breeding goals and objectives are culture- and location-specific and selection is conducted through the use of (temporary) mating control, castration and the removal of unwanted animals. Many livestock keepers also undertake breeding experiments on their own initiative.

MAINTAINING OPTION VALUES

One important role played by livestock keepers, especially pastoralists, is the preservation of option values: they keep animals that have traits that may currently be of no commercial interest but which may be of huge value in the future if environmental and economic conditions change. Such traits include "survival" characteristics, such as the ability to fend for themselves and the ability to cope with diseases. The traits can be maintained by keeping the animals in their natural environments where they are exposed to natural selection. Continuous exposure to the local conditions allows the breeds to retain the adaptive characteristics that enable them to cope with the local feed, the local climate and other features of the local environment such as stony or swampy ground or high altitudes. If removed from their areas of origin, breeds may over time lose the characteristics that have enabled them to survive in these environments. Livestock keepers also undertake conscious efforts to adapt their animals to new environments and changing conditions. When introducing preferred breeds into new ecological zones, pastoralists may cross-breed their animals with males from breeds local to these environments in order to enhance their offspring's adaptation to local conditions.

REASONS WHY LIVESTOCK KEEPERS ABANDON THEIR BREEDS

A variety of factors can cause livestock keepers to stop keeping their traditional breeds or to abandon livestock keeping. These include changing market demands (for instance lack of demand for wool), one-sided information and pressure to adopt improved breeds and standardized production and breeding systems, loss of grazing grounds and access to water, animal health regulations and changing lifestyles.

MOTIVATION AND INCENTIVES TO CONTINUE KEEPING BREEDS

Pastoralists and smallholder farmers continue to keep their breeds wherever traditional production systems survive and where they have secure access to grazing and water. Among some livestock-keeping cultures, there is also a sense of custodianship that motivates people to hang on to their animals despite the lack of economic returns. Access to appropriate animal health and extension services, as well as to markets, payment for agro-ecosystem services and favourable policies are further means to encourage and enable livestock keepers to continue raising their breeds. As the owners and keepers of valuable breeds, smallholder farmers and pastoralists should be included in decision-making about research, development and conservation measures affecting their breeds and production environments.

Introduction

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 an ever narrower range of breeds and strains, 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 very 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.

There is an urgent 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 also 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.

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.

Despite numerous pressures, many small-scale livestock keepers continue to manage animal genetic resources in their ecosystems of origin and thereby conserve their adaptive traits and option values. The importance of their role in the use, development and conservation of livestock diversity is underlined by the fact that while about two-thirds of the breeds reported to the Domestic Animal Diversity Information System (www.fao.org/dad-is) are raised in developing countries, 60 percent of these countries have reported no structured breeding programmes in any of the five major livestock species (cattle, sheep, goats, pigs and chickens) (data from FAO, 2007a).

There are several international agreements and processes which seek to support this important role of small-scale livestock keepers.

The *Global Plan of Action* (FAO, 2007b) 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.

The *United Nations Permanent Forum on Indigenous Issues*, at its seventh session, requested FAO to give priority to Strategic Priority 6, and to further develop approaches to implementing it, including rights-based approaches and payment for services that support the custodianship of local breeds by indigenous peoples (UNPFII, 2008). 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.

The *United Nations 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.[1]

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 purpose of this booklet is to provide an overview of the role of small-scale livestock keepers in the sustainable management of animal genetic resources and provide suggestions on how this role could be strengthened for the benefit of livestock biodiversity and poverty alleviation.

[1] Conference of the Parties to the CBD Decision IX/1: *In-depth review of the programme of work on agricultural biodiversity* (available at http://www.cbd.int/decision/cop/?id=11644).

Background

IMPORTANCE OF THE LIVESTOCK SECTOR

Livestock products (meat, milk, eggs, fibres, hides, etc) account for over 40 percent of the value of world agricultural output, and they provide one-third of humanity's protein intake. Worldwide, the demand for livestock products is soaring because of population growth, growing incomes and changing food preferences. The global production of meat and milk is projected to roughly double during the first half of the twenty-first century. This trend, which is facilitated by global trade in livestock inputs and livestock products, has made livestock production the fastest-growing subsector of agriculture in many developing and transition countries (FAO, 2006a).

Raw economic figures do not capture the full significance of livestock production to economies and livelihoods around the world. It is important that sufficient consideration be given to the prevalence of livestock keeping among the world's poor. An estimated 70 percent of the world's more than 1 billion rural people living on less than US$1.25 a day (UN, 2009) are at least partially dependent on livestock for their livelihoods (LID, 1999). And for about 120 million pastoralists, livestock production is the principal source of livelihood (ILRI, 2002). Animals also provide draught power for more than 320 million hectares of farmland, equivalent to one-quarter of the earth's total area under crop production.

At the household level, particularly in developing countries, livestock perform many important functions including providing transport and draught power for crop production, and manure for fertilizer and fuel. They uphold social networks and cultural activities, and provide an essential means of savings and insurance. It is the ability to perform these multiple functions that make livestock particularly valuable assets for poor people. Local breeds tend to be well adapted to fulfilling these diverse roles.

Many of the functions that livestock perform are difficult to evaluate in economic terms, but some studies indicate that the contribution of non-market functions can be quite substantial. Studies that quantified the value of livestock's financing and insurance functions to households that are unable to access these services from other sources 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 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).

It is important to consider non-market values when comparing the value of different production systems within the livestock sector, because otherwise the value of small-scale livestock production and local breeds remains under-represented.

The contribution of livestock production to agricultural gross domestic product (GDP) is especially significant in countries where pastoral systems predominate. For example,

livestock production is reported to account for almost 90 percent of the agricultural GDP in Mongolia and for 80 percent in Sudan.

WHO ARE SMALL-SCALE LIVESTOCK KEEPERS?

There is no internationally agreed definition of small-scale livestock keepers. The term *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.

Smallholder farms constitute about 85 percent of all farms globally (IFPRI, 2005). A size-based definition of smallholders is, however, of limited use, as it does not take into account many factors that have important 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, labour arrangements and access to social services such as health and education.

According to FAO (2009a, b), small-scale livestock keepers include mixed crop–livestock farmers, pastoralists and landless livestock keepers. One option for defining small-scale livestock keepers might be relative to the average livestock keeper in their country rather than by the absolute size of their herds or land holdings. Pastoralists, however, can have quite large herds, because livestock is their main asset and they need a minimum number of animals to resist drought cycles. The International Livestock Research Institute has used generic definitions for smallholders, 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 producers 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 often keep their animals on communal rather than private land, or they may be landless.

Pastoralists can be distinguished from other livestock keepers on the basis of the contribution of livestock to their agricultural income and the agro-ecological context in which they operate (FAO, 2002). They can be grouped according to their mobility, ranging from entirely mobile "exclusive pastoralists" to semi-settled "agropastoralists" practising some agriculture (Blench, 1999). But in reality the systems often overlap. Settlement policies, economic development and changing environments further reduce the differences and move the balance towards agropastoralism

Importantly, 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 main source of income. These 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. They routinely face high transaction costs in securing quality inputs and getting market recognition for quality outputs.

PHOTO CREDIT: ELLEN GEERLINGS

Rural women in Bangladesh depend on dwarf goats for a regular income

Importantly, small-scale livestock keepers tend not to purchase production inputs. The majority of inputs come from within the farm or from local grazing land 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.

Economic and ecological roles of smallholder farmers and pastoralists

PROVISION OF PRODUCTS

Long overlooked, the provision of products and services by pastoralists and smallholders can be quite 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, which is estimated at 77 percent of total milk production (ibid.).

Smallholders and pastoralists not only provide food, but also hides, skins, wool, manure and transport services, and may attract tourism. Perhaps more important given the threat of climate change, they have means to use marginal areas sustainably for food production and they provide environmental services. Such contributions have been little captured in official statistics (ibid.).

PHOTO CREDIT: RAURI ALCOCK

Donkeys ploughing in South Africa

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 consist of tropical and subtropical drylands, mountainous and high-altitude zones, as well as some very cold areas. Grazing livestock are able to convert the local vegetation in these ecozones into food that can sustain people.

Locally adapted breeds used by small-scale livestock keepers allow people to live in some of the most inhospitable and marginal environments in the world. Across Africa, Asia, Latin America and the Near East more than 50 percent of local sheep and goat breeds, and almost all camelid and yak breeds, have been developed in, and are adapted to, drylands. The equivalent figures for local breeds of horse and cattle are around 30 percent; the figure for asses is more than 70 percent. In many species, breeds adapted to drylands also constitute a large proportion of transboundary breeds (those present in more than one country) – reflecting the particular importance of cross-border movement and exchange of breeding stocks in dryland breeds and dryland production systems (FAO, 2007c).

To be able to utilize such inhospitable areas, which are often seasonally infested with diseases, pastoralists and smallholder farmers have developed an array of strategies ranging from the use of hardy, well-adapted breeds to sophisticated herd movements and grazing strategies. Their livestock are thus 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 to the wider society. Seasonal movements optimize the use of scarce vegetation. Limiting the duration of grazing to short periods and certain times of the year allows vegetation to regrow and prevents overgrazing.

Pastoral societies often have special decision-making structures to organize their herd movements and to coordinate with neighbouring pastoral groups (see e.g. Homann, 2005). However, these traditional mechanisms are disturbed when social and agricultural development restricts herd movements (Hoffmann, 2004). Another strategy to optimize land use is daily 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 feeding 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 because of 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).

Long-term contact with prevailing diseases means that many local breeds and the management practices used by their keepers are uniquely adapted to local disease challenges (McCorkle *et al.*, 2001; Gibson, 2002).

HERDERS AND THE ENVIRONMENT: AGRO-ECOSYSTEM SERVICES

Many landscapes have been shaped by traditional livestock production systems and retain their special character only as long as livestock grazing is maintained. Among these are large parts 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 shrubland in Europe. Some plants may disappear under grazing pressure, while others need it to thrive (Rodriguez, 2008). Many tree seeds have to be eaten by animals before they will germinate (Bayer and Waters-Bayer, 1998).

Landscapes created through the co-evolution of livestock and vegetation often resemble wilderness to outsiders, although they have long been managed by indigenous and local people. In many long-inhabited and long-utilized landscapes, the distinction between "cultivated" and "wild" biodiversity can be blurred. In fact, many societies do not make a clear distinction between "wild" and "domesticated" (Phillips and Stolton, 2008). When traditional grazing systems, especially nomadic and transhumant ones disappear, there tend to be significant losses of biodiversity. One example is community-controlled grazing on "Allmende" (common land) in the Alps of southern Germany (Scholle *et al*., 2002).

In some areas, livestock have taken over the task of providing the ecological services once provided by wild herbivores: the Eurasian landscape was shaped by large herbivores such as aurochs, wild horses and wild boar, which created an open woodland habitat. Biologically diverse open woodlands can not be maintained by mowing, only by grazing. Low-intensity livestock keeping with traditional breeds replicates the effects of extinct herbivores and supports a rich wildlife.

Although understanding of livestock's impact on the environment is only beginning to be accumulated, it is clear that good grazing management has many positive effects – stimulating pasture growth and biodiversity, promoting ecosystem health and integrity, reducing invasive species, improving mulching, and promoting mineral and water cycling.

There is growing recognition of the ecological value of the services that smallholder farmers and pastoralists provide through their livestock management (Rodriguez, 2008). European Union policies now seek to use extensive livestock production systems for landscape and nature conservation purposes, and use two avenues to maintain and strengthen them: "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).

Creating mosaic landscapes and mini-habitats that sustain biodiversity

Grazing creates highly diverse mosaic landscapes. In Europe, widespread and low-intensity grazing is acknowledged as a key to maintaining many habitats that harbour rare animals and plants. In Ethiopia, traditional land management by Borana pastoralists has similar effects (Bassi and Tache, 2008). In the Sava floodplain in Croatia, grazing by pigs, horses, and cattle has a variety of positive effects on biodiversity: The animals disperse seeds through their dung; rooting by pigs creates mini-habitats that allow threatened plant spe-

cies 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). The positive effect that such systems have on biodiversity contrasts with that of many high external input farming systems which have, with their machines, agrochemicals and intensive sown pastures, led to drastic declines in biodiversity (Finck *et al*., 2002).

Conservation of wildlife

The animals kept by pastoralists and smallholder farmers are often important to wildlife conservation. Relationships between domestic and wild biodiversity have rarely been studied in detail. But evicting livestock from wildlife reserves may lead to an exodus of predators, or result in habitat changes that make it unattractive for wildlife. 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). In the Gir Forest National Park and Wildlife Sanctuary in neighbouring Gujarat, Asia's last remaining lions depend on livestock for part of their diet. Expelling pastoralists from the sanctuary has induced the lions to leave as well (Casimir, 2001). And in the Bharatpur Bird Sanctuary in eastern Rajasthan, a ban on grazing by buffaloes led to the disappearance of Siberian cranes, which need an open grazed environment for nesting (Lewis, 2003).

PHOTO CREDIT: ILSE KÖHLER-ROLLEFSON

The Chilika buffalo is important for people's livelihoods and as part of the Chilika lake ecosystem in Orissa, India

Connecting ecosystems by transporting seeds

Migratory sheep flocks provide a means by which plants can move from one ecosystem to another – each animal transports thousands of seeds. 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 from their points of origin. With changing climates, this promises to be an important way to enable plants to move into new habitats, and thereby to prevent their extinction. A drawback is the distribution of unwanted species (ibid.). Livestock keepers sometimes make conscious efforts to disperse the seeds of preferred plants. Pastoralists in the Islamic Republic of Iran pack seeds in little bags and hang these around the necks 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).

Improvement of water-holding capacity of grasslands

Well-managed grazing can also improve the water-holding capacity of grasslands by enhancing infiltration and reducing runoff (Niamir-Fuller, 1999; Sanderson *et al*., 2004). However, research on this is only beginning.

Managing landscapes and Reversing the effects of discontinued grazing

For various economic and political reasons and because of the increasing loss of agricultural land, livestock numbers on marginal lands have declined in several countries. Consequences for biodiversity are sometimes serious. In The former Yugoslav Republic of Macedonia, sheep numbers declined by 45 percent when subsidies for upland herding were eliminated; this led to an invasion by bush species and the disappearance of the natural flora. In other Mediterranean countries too, the abandonment of grazing has resulted in large areas of hills and mountains becoming covered by shrub vegetation with low biodiversity. This accumulation of woody biomass increases the risk of fires and erosion – with the accompanying environmental and economic costs (Osoro *et al*., 1999; Perrings and Walker 2003). In Germany and other European countries, the introduction of stall-feeding has changed the look of forests that used to be grazed by village livestock. In the absence of such use, blackberries and other shrubs have proliferated and prevent the rejuvenation of large forest trees.

Reintroducing grazing has become a well-established way of managing landscapes. In Germany, for example, it is supported by the Federal Nature Conservation Agency. 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 *at al*., 2002). It is at present also being tested in a commercial forest to make the area accessible for tree cutters and other equipment.

While grazing for landscape and conservation purposes does not always require the use of traditional breeds from the local area, it frequently offers significant opportunities for promoting sustainable use of livestock diversity (Cole and Phillips, 2008).

PHOTO CREDIT: KARL-HEINZ RAACH

Sheep flocks have become important for landscape and biodiversity conservation in Germany

Preventing forest fires

Grazing animals control the growth of grass and undergrowth and thereby prevent forest fires – a fact recognized by livestock keepers who operate in forested areas (Raika Biocultural Protocol, 2009). Some developed countries such as the United States of America (Campbell, 1954) have experienced increased fire risk following the discontinuation of grazing. There is likely to be an increase in the deliberate use of livestock to control vegetation.

Restoring and maintaining soil fertility through manure and nutrient recycling

In many countries, there are long traditions of farmer–herder arrangements in 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). These arrangements are becoming monetarized: in the Zamfara Reserve in northwest Nigeria, 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. Conversely, in some places commercial dairying has started to undergo a shift back towards grazing – taking advantage of the potential to improve nutrient cycling and reduce expenditure on chemical fertilizers (van't Hooft *et al*., 2008).

Creators and guardians of breeds

Social and cultural factors, together with deliberate breeding decisions and management by livestock keeping communities, have been crucial in the creation of breeds. Many breeds are associated with a particular ethnic group or community and this is often reflected in their names (Köhler-Rollefson, 1997). Breeds named after ethnic groups 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). See Box 1 for examples.

By contrast, in Europe, traditional breeds tend to be named after the geographic locations in which they were developed. Examples from the United Kingdom include Lincoln Red, North Devon, Sussex and Hereford cattle; Cheviot, Exmoor Horn and Hampshire Down sheep; Berkshire and Tamworth pigs; and Clydesdale and Suffolk horses.

SOCIAL BREEDING MECHANISMS

Social breeding mechanisms ensure that livestock is distributed within the community and remains a long-term asset over generations; such mechanisms also allow limits to be placed on genetic exchange with the livestock kept by other social groups. For example, some livestock keeping communities prevent the sale of female stock to anyone outside

BOX 1

Livestock breeds named after ethnic groups

- Different groups of West African Fulani developed the White Fulani and Red Bororo cattle, and Peulh sheep and goats; Touareg developed Touareg sheep and goats.
- East African pastoralists created Somali and Red Maasai sheep.
- Borana pastoralists of East Africa bred Boran cattle, adapted to their three-day watering interval.
- Southern African small-scale farmers developed Mashona and Nguni cattle.
- The Rath Muslims of northwestern Rajasthan developed the Rathi dairy cattle breed.
- In the Himalayas, the Gaddi pastoralists rear the sheep and goat breeds named after them.
- In southern India, the Toda tribal community has collectively bred the Toda buffalo breed.
- The Navajo Churro sheep of the southwestern United States of America was bred by the Navajo Indians.

the community (Köhler-Rollefson, 1993a, Schäfer, 1998). Pastoralist societies, in particular, often regard livestock as heritage passed down by their ancestors, for which they act as temporary guardians and which they have to pass on to their children. Unwritten community rules, often in the form of taboos, could be so strict that non-compliance was subject to punishment.

Another set of social rules determines how animals are passed from one generation to the next, regulating the presentation of animals as gifts at 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 Gabra and Turkana, for example, camel herds are inherited by the son. Unmarried Turkana daughters receive an adult female camel. Pastoralists and other livestock keeping communities also have sharing arrangements that facilitate access to breeding animals, the distribution of livestock and their products. Sharing strengthens 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 in the herds of other herders far away from their own herd (Schwabe, 1978).

In many communities, the wealthier members have an obligation to share their livestock with their poorer relatives by giving long-term stock loans, which sometimes extend over generations. They may allow the placement of female animals in their herd so that these animals 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, helps build alliances and reduces risk of total herd loss. The set-up of sharing arrangements differs from society to society (Box 2).

BOX 2

Traditional livestock-sharing arrangements

- *Vaata* is a traditional system of sharing and building assets among the Adivasi, a tribal group in Andhra Pradesh, India. The owner gives a six-month-old goat to another community member under the following arrangement: if the first-born kid is a male, the kid is sold and the profit is shared between owner and recipient. Female offspring are shared by giving the first-born kid to the owner and the second born kid to the beneficiary. The mother goat remains the property of the original owner, but when the animal becomes sick both parties are responsible (ANTHRA and Girijana Deepika, 2003).
- In Lesotho and western Zambia, *mafisa* entails placement of a family's cow in a herd where there is 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 may drive their female camels as far as 200–500 km to have them served by a prominent sire (Hussein, 1993).

INDIGENOUS KNOWLEDGE ABOUT ANIMAL BREEDING AND BREEDS

With their long tradition of animal breeding and daily interaction with their herds, livestock-keeping communities have accumulated detailed knowledge of their animals, their needs and their surroundings. Pastoralists, especially, are privy to important information that eludes scientists: they know the qualities and the family history of animals in their herd; they have traditional systems of population classification and are aware of the existence of breeds that have not been documented (Galaty, 1989; Kaufmann, 1998; Rege, 2001; Ayantunde *at al*., 2007; Krätli, 2008). This knowledge is an extremely useful resource for breed documentation as well as breeding and conservation decisions (Perezgrovas *et al*., 1995).

Pastoralists classify animals first by status (sex and age; and whether pregnant, lactating, castrated, etc.), then by colour and pattern, and the shape of the horns or other special characteristics. Frequently, all animals in a herd are named; all female animals of the same lineage are often given the same name (Galaty, 1989). Knowledge of the individual animals and their genetic relationship with the others in the herd allows the herders to make considered breeding decisions and avoid inbreeding.

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 concern of Arab Bedouin breeders for purity of their animals often bordered on

PHOTO CREDIT: SAVERIO KRÄTLI

WooDaaBe pastoralists herding Bororo cattle in Niger

fanaticism. They distinguished between pure-bred and ordinary camels and only recognized a she-camel as a thoroughbred if its female ancestors had been covered by a thoroughbred bull for at least four generations. Male thoroughbreds were recognized only in the ninth generation (Musil, 1928). The code of personal honour associated with horsemanship made it impossible for Bedouin owners to misrepresent the pedigree of their horses. The members of a Bedouin tribe who had lost pedigree horses in a raid were bound in honour to treat the enemy scouts as inviolable when they came to demand the breeding details of the captured animals (Chaudhuri, 1990).

Traditional mental record keeping of animals' pedigrees has parallels with herd-book societies. In fact, the Arab principles of careful parent selection and maintaining pure lines, which 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).

CLASSIFICATION OF BREEDS AND KNOWLEDGE ABOUT UNDOCUMENTED BREEDS

Local classification systems for livestock commonly differ from those used by modern science. Local classifications can be very detailed; for instance, Rendille and Gabbra pastoralists in Kenya differentiate their camel breeds into four types, each having different adaptation and performance characteristics (Hülsebusch and Kaufmann, 2002). In Nigeria, Hausa and Fulani distinguish 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).

PHOTO CREDIT: ILSE KÖHLER-ROLLEFSON.

Horse breeding is central to the culture of the inhabitants of the steppe in Turkmenistan

The information that pastoralists and smallholder farmers have on the history of their animals can point to breeds and strains that would otherwise escape the attention of scientists, who often find it difficult to determine whether animals belong to different breeds or represent ecotypes within a single breed. For example:

- The Malvi camel breed of Madhya Pradesh, India, was discovered based on information provided by Raika camel pastoralists (Köhler-Rollefson and Rathore, 1996).
- The Banni buffalo from Kutch in Gujarat, India, is in the process of being officially recognized as a separate breed – the first new breed to be acknowledged since 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 shows that the breed came from Sindh in Pakistan and has evolved independently of the Murrah buffalo (Sahjeevan, 2008).
- 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 area 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).

TRADITIONAL BREEDING INSTITUTIONS

Official breeding societies maintain breeds through a formal system of recording sires and progenies. Traditional societies have also developed breeding institutions that facilitate access to male breeding animals and aim to ensure the quality of their herds and flocks. Such breeding institutions are frequently anchored at village level and supported by respected community members. In West Africa and India, it was often pastoralists that supplied working animals to farmers and had extensive knowledge of line-breeding. Traditional breeding institutions from various parts of India are described in Box 3.

BREEDING GOALS AND OBJECTIVES

The breeding goals of livestock breeding communities are multifaceted and comprise many criteria beyond high production of milk and meat. Given that they often have to cope with poor quality feed or seasonal feed shortages, high disease pressures, poor infrastructure and high costs for veterinary care and other inputs, pastoralists especially are usually more concerned with adaptive traits than with productive traits (Steglich and Peters, 2003).

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

Pastoralists do not have the concept of an "ideal animal" such as exists in formal breeding societies (Adams and Kaufmann, 2003). Instead, they seek to maintain an optimal herd composed of different lineages representing certain functional traits (Krätli, 2008). Pastoralists structure their herds into matrilineal lineages to ensure the transmission of functionality across generations. Functionality includes feeding competence, minimum-stress interaction with other herd members and the herder (ibid.) and production traits (Hülsebusch and Kaufmann, 2002).

BOX 3

Traditional breeding institutions in India

- In Rajasthan, village-based breeding institutions include maintaining a communally owned bull and/or male buffalo. A survey conducted in 2000 in 50 villages revealed that this institution continued 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 the purchase costs. Some villages went to great lengths to obtain 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 its keeper's salary (Anderson and Centonze, 2006).
- The famous Ongole breed from Ongole Taluka in Andhra Pradesh, 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 given the task of searching for a superior bull, which became the property of the community (Nath, 1992).
- Around 80 percent of Kankrej cows are in the hands of the Rebaris and Bharwads, two tribes in northwestern India. Each breeder has a thorn paddock near his house, where cattle are kept at night. Breeders take great care in selecting and caring for male calves retained for breeding (Joshi and Phillips, 1982).
- In Gujarat, Gir cattle are bred largely by professional breeding groups such as Rabaris, Bharwads, Maldharis, Ahirs and Charans. These groups lead a nomadic life, moving their cattle from place to place in search of grazing (Joshi and Phillips, 1982).
- The Hallikar breed of southern Karnataka is bred by both professional breeders and cultivators. Each village has a few families who have been breeding the Hallikar for generations. These families maintain their own stud bulls and charge a small fee for service. It is said that certain families have become famous beyond their community and that cows may be taken up to 160 km to the bulls kept by such families (ibid.).

Different age- and sex groups within a livestock keeping society 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, who have to do a lot of the work involved in caring for the livestock, favour animals that are docile, easy to milk, have good mothering instincts and provide surplus milk that can be used for home consumption or sold in the market (Laswai *et al.*, 2004).

BOX 4

Examples of selection criteria

- Beauty traits (colour patterns and horn length and shape) are major selection criteria for Ankole breeders in East Africa. Fertility and milk yield are prioritized in cows, while disease resistance and sire fertility are prioritize in bulls (Ndumu *et al.*, 2006).
- In interviews with various categories of livestock keepers in a tsetse-affected zone in Burkina Faso, it was discovered that all livestock keepers prefer cattle that are not selective in the type of grass or the quality of water they consume (Tano *et al.*, 2003). In bulls, traction ability, large body size, high fertility, disease resistance and rapid weight gain are favoured. For cows, reproductive performance, milk yield and body size are important criteria, but this varies across the production systems. Pastoralists value milk yield highly. Mixed crop–livestock farmers are more interested in animal traction, less interested in meat and milk off-take, and therefore 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 production often ranked highly. As in the case of bulls, large frame size in cows was preferred because it increases the market value of the animals (ibid.).
- Raika shepherds in India select their sheep according to a set criteria called "*Naugu-na*": 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, and ability to endure and withstand pain (Köhler-Rollefson and LIFE-Network, 2007).
- Rural women in southwestern areas of the Islamic Republic of Iran select hatching eggs that are of 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. The women 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).
- Among goat herders in Patagonia, hair type and coat colour are the two most commonly mentioned criteria for selecting Neuquén Criollo goats for breeding (Lanari *et al*., 2005).
- Agropastoralists in 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).

Selection criteria, therefore, vary between societies, within societies, and between different species and breeds, between male and female animals, and perhaps even between types within a breed. Several examples of selection criteria are described in Box 4.

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 selecting breeding animals, mating control, the removal of unwanted animals from the herd through culling or sale, and the decision as to how many males are needed to cover all females (e.g. Hülsebusch and Kaufmann, 2002).

Selection of breeding animals

In traditional breeding, selecting male animals is more practical than selecting females, as one male can sire many offspring, while the number of offspring a female can produce is far more limited. Furthermore, given small herd sizes and the need to obtain milk from all females in a herd, it is often not feasible to mate only the superior female animals (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 the characteristics of the ancestors and the "breeding line" of a potential new sire are more important than the characteristics of the individual. Conversely, Somali, and to a lesser degree also Gabbra, consider the young sire's own characteristics and give less importance to those of his ancestors. Family selection offers better prospects for success in breeding for characteristics with low heritability, such as disease resistance or adaptation to drought, while individual selection has advantages when breeding for good milk production and growth which have slightly higher heritability values (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 with a limited number of females in order to scrutinize the quality of the offspring. Only if the first crop conforms to their expectations will they use the male animal more widely (Elmi, 1989).

PHOTO CREDIT: ILSE KÖHLER-ROLLEFSON

The Raika pastoralists are the custodians of the dromedary in Rajasthan, India

Mating control

Mating control is practised by pastoralists and smallholder farmers all over the world. Mating control can be temporary or long-term. The latter includes castration and the removal of potential breeders through culling or sale.

Some societies use very rigid mating control to obtain a specific bull/cow ratio and ensure selection for particular 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, with only one bull left for every 80 cows (Joshi and Phillips, 1982). It is reported that during a five-year period in the early twentieth century, herders in Nigeria castrated more than two-hundred thousand goats that did not have the red skin characteristic of the Red Sokoto breed, which is highly valued for the production of Morocco leather (Blench, 1999).

Methods for temporary mating control include fencing, the use of devices to hinder mating, and manipulative practices such as tying the penis to the side of the animal. Castration is widely practised among traditional livestock keepers, independently of veterinarians and government programmes. Animals with unwanted characteristics are removed by being sold or culled. The removal of both males and females is reported (e.g. Laswai *et al.*, 2004). If unwanted animals are left in the herd and allowed to breed, herd composition will come to resemble that of a wild population, as the examples of several cattle breeds in southern India show (Vivekanandan and Paulraj, 2002).

EXPERIMENTING WITH BREEDS

Pastoralists and smallholder farmers experiment with breeds and are often keen to introduce new blood into their herds. The Maasai, for example, deliberately introduce new germplasm into their herds by means of exchanges within the community and by experimenting with improved breeds such as Boran and Mpwapwa cattle. However, it has been observed that these improved genotypes suffer from high mortality rates; they are not able to trek very long distances or cope with prolonged intervals between drinking (Laswai *et al.*, 2004).

Keteku cattle kept by Fulani pastoralists in Nigeria are a stabilized cross of Savannah Shorthorn (Muturu) and White Fulani (Bunaji), with some input from N'Dama Longhorn (Rege *et al.*, 1994; Felius, 1995). The Bunaji has relatively high milk production for a savannah breed, while the N'Dama is trypanotolerant and adapted to rainforests. The resulting Keteku cattle can thrive under a wider range of drought and disease challenge (Martin *et al.*, 2001).

In the Gambia, cattle owners depend on the functional traits of the N'Dama and appreciate it as a multipurpose animal that is well integrated into their production system. Nevertheless, where the local agro-environment is favourable, they conduct experiments with crossing it with the higher potential, but trypanosensitive, Gobra (Steglich, 2006).

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 Ning, 1997; 1998).

PHOTO CREDIT: ANDREAS WILKES

The yak is important to the livelihoods of the inhabitants of the Tibetan plateau in China

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 breed, developed in Bangladesh as a high-yielding breed for use in under semi-scavenging conditions, lost popularity among smallholders when they discovered that they had no success in reproducing it. Similarly in India, when villagers received cross-bred hens from a research institute, they expressed concerns about the dilution of morphological characters (Besbes, 2008).

PHOTO CREDIT: ELLEN GEERLINGS

Indigenous chickens are important in the rural economy of Cambodia

Conservation

BREED CONSERVATION AND MAINTAINING OPTION VALUES

Pastoralists and smallholder farmers maintain animals with traits that may be of no current commercial interest, but potentially have huge value in changed environmental and economic circumstances. In other words, the livestock keepers maintain option values (Pilling *et al.*, 2008; Rodriguez, 2008). Such values may arise because the animals have "survival" characteristics, such as the ability to cope with particular diseases. If the diseases become more widespread or control methods become unsustainable the options values may be realized. Characteristics of this kind can be maintained by keeping the animals in their natural environments, where they are exposed to natural selection pressures. At the same time, the animals are exposed to changing ecological conditions and new diseases that arise in their environment. This has the advantage that animals become adapted to the new challenges, but has the disadvantage that some of the "old" option values may be lost.

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 include Fayoumi chickens from Egypt, whose aggressive high-energy behaviour allows them to survive in difficult conditions (Meyer, 1997), and Nigerian chicken breeds, which are known to fight off predators that try to attack 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 *et al.*, 2007).

Pastoralists and smallholder farmers live and use their breeds mostly in the environments where the breeds originated. 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 or swampy ground, or high altitudes.

If removed from their original environments for a number of generations, animals may lose the characteristics that allow them to survive. The North Ronaldsay sheep of the Orkney Islands in Scotland, for example, are adapted to a diet of seaweed. If animals are transferred to other environments, where the diet is different, natural selection eliminates rather than maintains the adaptation that makes the breed unique (Woolliams *et al.*, 2008).

FURTHERING ADAPTIVE TRAITS

Smallholder farmers and pastoralists are known to further the development of adaptive traits through purposive selection. WoDaaBe herders in Niger select their animals for their

PHOTO CREDIT: ILSE KÖHLER-ROLLEFSON

The Bactrian camels of the Gobi desert in Mongolia provide wool, transport, milk and meat

"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. The WoDaaBe also select their animals for "social competence", in order to minimize stress in interactions within the herd and with the herder (Krätli, 2008).

Other pastoralists keep their livestock in a state that is close to wild. This exposes the animals to continued selection pressure, maintaining their adaptive traits and allowing

BOX 5

Examples of breeding strategies that involve mating domestic animals with wild relatives

- In the Gobi Desert of Mongolia, camel breeders are pleased when their female animals are impregnated by wild camels.
- Farmers in rural areas of Sri Lanka are known to cross-breed domestic animals with wild species, such as the wild boar (*Sus scrofa*) and a species related to the red junglefowl (*Gallus lafayetti*), as a deliberate breeding strategy.
- There are indications that farmers in Viet Nam and Papua New Guinea purposefully cross-breed domestic and wild pig species.
- In the Rann of Kutch in Gujarat, India, donkey owners deliberately provide opportunities for their female donkeys to be covered by male half-asses.

them to adapt to changing conditions. Examples from India include camel breeders in the Thar Desert, Toda buffalo breeders in the Nilgiri Mountains and Pullikulum cattle breeders in Tamil Nadu.

Another strategy adopted by some groups of pastoralists to improve adaptive traits is to purposefully arrange for their female animals to be bred by wild males. Box 5 provides some examples.

ADAPTING BREEDS TO LOCAL CONDITIONS

Livestock keepers make 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 breeds local to the new environment in order to enhance their offspring's adaptation to local conditions (Blench, 1999; McCorkle *et al*., 2001; see also the section *Experimenting with breeds*). Herders may also provide extra care to animals at risk (Blench, 1999) to help them cope with the challenges of the new environment.

Why livestock keepers give up their breeds

A recent global survey (FAO 2009c) indicated 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 livestock genetic diversity. A detailed study of threats to breed survival in Europe concluded that important threats included decreases in public funding, lack of political will to support rural communities, inappropriate policies and legislation including environmental schemes, disease, predators, urbanization, poor return on product, competition from other livestock, ageing of the farming population, lack of marketing support, inbreeding in animal populations and loss of skills (Carson *et al.*, 2008). Livestock keepers, particularly those who depend on natural resources and common property to raise their animals, have to cope with many challenges, which are making it more and more difficult for them to continue production.

ONE-SIDED INFORMATION AND SUBSIDIES FAVOURING THE ADOPTION OF IMPROVED BREEDS AND STANDARDIZED PRODUCTION AND BREEDING SYSTEMS

Government programmes, extension personnel with formal training in animal science and private companies who want to increase their sales often promote the adoption of high-performance breeds and the management of animals according to principles drawn from experience in high external input production systems (FAO, 2007a; Köhler-Rollefson, 2003; Du Toit, 2007). The adoption of exotic breeds is often heavily subsidized, giving them a competitive advantage over local breeds (Drucker *et al.*, 2006). Livestock development projects and programmes frequently introduce or promote exotic breeds or their crosses. Few projects focus on supporting and improving local breeds. 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 United States of America, for example, the size of the Navajo-Churro sheep population decreased as a result of 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 (Bixby, 2007).

CHANGING MARKET DEMANDS

With globalization, international and domestic markets become connected. Although these markets are not uniform, there are some common features in their requirements and their impacts. 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 uniform batches and particular meat cuts, carcass sizes and weights, leanness of meat, fat levels in milk, egg colours, or labelling with particular information or in specified languages. Taken together, they tend to marginalize small-scale livestock keepers and the local breeds they keep.

As markets and consumer preferences change, the demand for certain products may decrease. The international demand for wool, for example, has dramatically slackened over the past decades, making sheep rearing less profitable. Sheep rearers may react to the change by switching to other species such as buffalo and cattle – as reported for Jalauni sheep keepers in India (Sahana *et al*., 2004) – or by shifting from wool to hair sheep.

Another option to cope with falling demand is cross-breeding the traditional breed with other production types and switching to other products. In Rajasthan, Raika sheep breeders adapted to the changing market conditions favouring meat rather than wool production by crossing their Marwari breed with faster-growing and higher milk-yielding breeds from neighbouring areas (Geerlings 2004; LPPS, 2003). For similar reasons, sheep breeders on the Deccan Plateau have been cross-breeding the Deccani wool sheep with Red Nellore rams – a hair breed (ANTHRA, 2007).

Experience from former Soviet countries indicates that reduced demand for a specific product threatens breeds specialized in the product, while a general deterioration of conditions can stimulate the use of local multipurpose breeds. Loss of inputs and markets caused by the break-up of the Soviet Union led people to return to more traditional breeds, such as local fat-tailed sheep (which can graze better under the snow) and Downy goats, and to keeping meat horses instead of cattle (Kerven and Lunch, 1998). Karakul sheep breeders in Uzbekistan, on the other hand, have not been able to cope with decollectivization and the collapse of the marketing system for pelts; they are rapidly abandoning the breed (Ibragimov *et al*., 2007).

Rising demand for a mass product can have two differing effects: namely livestock keepers may increase their stock of animals from local breeds or switch to high-yielding breeds from elsewhere. Operation Flood (a national dairy development programme initiated in India during the 1970s) illustrates the first possibility – the increased supply of milk achieved over the last three decades has largely been 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 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 daily weight gain, feed conversion and carcass quality, and to keep the animals in confinement rather than allowing them to forage (Daza *et al*., 2008).

PHOTO CREDIT: PHIL SPONENBERG

The Tennessee Fainting goat (United States of America) has a high meat to bone ratio and can be handled easily

CONTROL OF LAND, WATER AND LIVESTOCK

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 that enabled them to accumulate large livestock holdings from various 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 mechanized power, fertilizer and high-yielding crops – means that livestock keepers have fewer areas to graze their animals. In drylands, cropping usually expands in the slightly wetter areas, which pastoralists traditionally use for dry-season or emergency grazing. Cropping and fencing such areas deprive the pastoralists of important grazing resources, forcing them into drier, riskier areas. The result is lower production and major problems during drought, as well as conflicts with the farmers and other pastoralist groups. However, the newly farmed areas are often unsuitable for cropping in low-rainfall years or when the groundwater level sinks because of overuse, leading to poverty and food insecurity among the farmers as well as the pastoralists they have displaced.

POLICIES AND ANIMAL HEALTH REGULATIONS

National politics and policies have a major effect on the livelihood of livestock keepers and the conservation of breeds. Due to a lack of recognition of the multiple contributions of smallholder farmers and pastoralists, policies commonly further large-scale production, to the disadvantage of smallholders and pastoralists. Settlement policies force pastoralists to give up nomadic lifestyles, with negative consequence for their breeds and their environments.

Projects and policies aiming to support smallholder farmers and pastoralists 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). Yak breeders in Bhutan used to burn pastures to control scrub and promote palatable fodder plants. A prohibition of burning under the Bhutan Forest Act of 1969 forced many herders in central Bhutan to give up yak keeping (Gyamtsho, 2007). In East Africa, a ban on burning, and afforestation programmes with *Prosopis juliflora*, an unpalatable species, have encouraged the growth of bush and restricted the grazing areas available to pastoralists (IIRR, 2004).

Regulations intended to protect consumers and prevent the spread of diseases sometimes put insuperable burdens on smallholder farmers and pastoralists, making it difficult for them to continue using and maintaining their breeds (FAO, 2005). Examples include measures to control epidemics through stamping out and zoning (Carson *et al*., 2008). Breeds threatened by rigorous disease control measures have included Herdwick sheep and the British Lop pig, threatened by foot-and-mouth disease in the United Kingdom (Roper, 2005) and Co ducks threatened by highly pathogenic avian influenza in Viet Nam (Nguyen and Duc Trong, 2007).

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 institutional stocks (e.g. birds kept by the Faculty of Agriculture of the Cairo University) are culled because of disease outbreaks (FAO, 2006b). Indirect impacts are caused by biosecurity measures and poultry-sector restructuring introduced the wake of disease outbreaks, which have tended to marginalize smallholders and the local poultry breeds they keep. Examples include relocation of large scale-production and market units from areas with dense poultry populations into more remote areas (e.g. in Malaysia and Viet Nam); and the closure or relocation of live-poultry ("wet") markets, collection points and small slaughter points, with subsequent exclusion of smallholders from the market chain (FAO, 2006c).

Other regulations that push up production costs per animal and are likely to drive many smallholder farmers and pastoralists out of "business" include the stringent record-keeping requirements that the European Union is planning to introduce for traceability.

Clearly, it is not feasible or 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 livelihoods and genetic diversity are minimized. Smallholder farmers and pastoralists should be given a voice in designing disease management plans and campaigns.

PHOTO CREDIT: ELLEN GEERLINGS

Local black pigs are important for ritual purposes in Cameroon

CHANGING LIFESTYLES

Changes that are otherwise to be applauded may reduce the ability of livestock keepers to maintain their lifestyles and their breeds. 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 do so cannot see how they can make a living from livestock keeping, given all the adverse forces. The rural exodus in developing and developed countries reflects widespread neglect of integrated rural development.

Commercialization affects breeds more directly. From being an integral part of a culture –preserved simply because they are part of that culture – livestock breeds are coming to be regarded more as a source of income. The Raika pastoralists of Rajasthan used to refuse to sell their female camels, but declining grazing resources and high prices have induced them to send their female camels for slaughter. In Togo, West Africa, Tamberma agropastoralists traditionally keep the Somba breed mainly for ritual purposes and in small herds (up to ten) that can be protected inside their compounds. Animals of this breed are necessary for dowries and sacrifices to the ancestors. Traditionally, the Somba cattle also played a role in maintaining the spiritual balance of a family. Now the need for money to pay for education and medical care has changed attitudes towards cattle keeping and reduced interest in the breed (Bèdibètè *et al.,* 2007).

Motivation and incentives to keep a breed

Livestock keepers may continue using and maintaining their breeds for a number of reasons – mostly for livelihoods. In some cases there may be a sense of custodianship. More frequently, however, they (can) only continue if there are sufficient economic incentives. Furthermore, and perhaps most important, the survival of many local breeds is bound to the survival of the production systems and ecosystems in which their keepers live.

SURVIVAL OF TRADITIONAL PRODUCTION SYSTEMS AND ACCESS TO NATURAL RESOURCES

Livestock keepers have developed their breeds to fit a specific set of circumstances (climate, vegetation, parasites, diseases, management system, etc.), and to fulfil certain functions (to provide food, labour, etc.). Their livestock 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 these livestock keepers to maintain their breeds plummets.

So access to grazing land and natural resources and the survival of the traditional production system are key to the survival of many breeds. That does not mean preserving production systems without changes. Indeed, changes are necessary if livestock keepers are to make their way out of poverty. Ways need to be found to enable smallholder farmers and pastoralists to continue managing their breeds in a way that conserves the genetics but improves their standard of living. In Nepal, for example, Baruwal sheep and Sinhal goats depend on a traditional transhumant production system. Sheep in this mountainous area are used for carrying loads, so there may be opportunity for combining migratory sheep and goat raising with ecotourism (Ghimire *et al*., 1998). In Peru, stock raising communities have been able to combine the use and development of the Criollo sheep and other local livestock with efforts to address social and poverty-related issues (Flores *et al.,* 2007).

SENSE OF CUSTODIANSHIP

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 that the animals provide certain ritual functions that cannot be transferred to exotic animals. Examples 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 semiferal state

PHOTO CREDIT: MARIA WURZINGER

Ankole cattle are kept by Bahima pastoralist in Uganda

and provide barely sufficient milk to nurture their calves. Nevertheless, traditional doctors take small amounts of milk for medical purposes. The breed is also necessary for the death rites of community members – corpses are rolled into the hides and the meat is consumed at the ceremonial feast (Rege *et al*., 1994).

Although the lifestyle of the Bahima pastoralists, who created the giant-horned Ankole cattle breed in Uganda, has changed dramatically over recent 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 even when 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, at which bride and groom share an egg as symbol of love and solidarity (Bouaham *et al*., 2007).

ACCESS TO APPROPRIATE SERVICES

Livestock keepers need support services of various kinds: veterinary services, market infrastructure, transport, security and conflict resolution, communication, education and health services. 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 for pastoralists and smallholders. Examples include the employment of female extension workers to work in areas where livestock are 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 easily transported to difficult-to-reach areas and administered by trained community vaccinators.

Pastoralists' mobile lifestyle adds another problem for the provision of services for both humans and animals. It is a challenge for governments to design services that suit such conditions: many do not even try, but attempt instead to persuade pastoralists to settle. This clash in approaches inevitably leads to mutual suspicion and conflict. To support pastoralism, it would be better to design services that cater to a mobile lifestyle. Successful models already exist – mobile schools (IIRR, 2004; Pailwar and Mahajan, 2005) and clinics, training of paraveterinarians from among pastoralist communities (Catley *et al*., 2002; IDL Group, 2003) and so on. More such initiatives are needed if pastoralism is to remain a viable livelihood 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 and pastoralists 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 the probability that farmers will use it (Riise *et al*., 2005; Thomsen, 2005). For these reasons, and mortality being a major problem, livestock keepers 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.

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

PHOTO CREDIT: BEATE MILERSKI, GEH

Schwäbisch-Hällische pig has experienced a remarkable comeback in Germany, thanks to an active breeders' organization

INSTITUTIONAL SUPPORT

In the developed world, numerous endangered breeds have been brought back from the brink of extinction by timely intervention. Examples include the breeds "adopted" by non-governmental organizations 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, however, breed and breeders' associations are important tools for achieving the critical mass needed to conserve a breed. It helps if a breed has commercial potential. In the United States of America, for example, the survival of Randall cattle is the result of the efforts of a few individuals. When the number of animals and breeders increased, a breed association was formed. This, and the potential of the breed for low-input dairy and beef production, stimulated demand for the Randall and helped assure a market (Sponenberg *et al*., 2007).

Breed associations for local breeds are rare in developing countries. Few examples are reported, mainly from South Africa. There, the Nguni Breeders' Cattle Society (Scholtz and Ramsay, 2007) has helped to preserve the Nguni breed. Key to this success was an emphasis on making the breed competitive rather than striving for uniformity and breed standards. Furthermore, in order to involve emerging communal farmers as stud breeders, the society developed a special recording scheme allowing registration of animals in the absence of written pedigree records. Another engaged South African association is the Damara Sheep Breeders' Society of South Africa (Du Toit, 2007).

PHOTO CREDIT: ILSE KÖHLER-ROLLEFSON

The Damara sheep were originally developed by the Himba pastoralists, but are now popular with farmers in South Africa

ECONOMIC INCENTIVES

Economic incentives will be necessary to promote the survival of many endangered and declining local breeds. Livestock keepers are likely to engage in conservation only if their efforts are rewarded. These rewards may include ensuring access to markets, creation of new and niche markets, and payments to livestock keepers for services, including subsidies for maintaining breeds.

Access to markets

Livestock keepers will invest in breeding animals for particular products (milk, meat, draught) only if markets for these are assured. Yet such markets are often 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. There is also a lack of market institutions for livestock: 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.

Promoting niche markets

A promising avenue is to develop niche markets for specialty products from local breeds. 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 the taste and structure of the meat, but also the vegetation consumed, a slow extensive production system, or special processing (Kuit and van der Meulen, 1999; Rook *et al*., 2004).

In Brazil, the Criollo Lanado sheep produces naturally coloured wool for which the industry pays a very low price. But when peasants were trained in spinning and weaving this type of wool, demand for it increased, and consequently the number of flocks rose (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 camels. 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. LPPS, a local non-governmental organization, has persuaded the Indian Government to permit camel milk to be sold, opening the way to commercialization of this product (Köhler-Rollefson *et al*., 2008). Awareness of the business potential of camel milk resulted in a steep rise in the prices of female camels within a short time span and put a stop to the sale of these animals for slaughter.

Payment 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 rather than 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 showed that such payments can halt breed loss. But because 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). However, breeds with limited market potential may continue to need financial and other support in the future (e.g. Brito *et al.*, 2005).

SUPPORTIVE POLICIES

Policies need to provide a level-playing field for smallholder farmers and pastoralists: 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 what regulations and policies can help them to continue maintaining threatened breeds.

Smallholder farmers and pastoralists 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 guardians of the breeds to be conserved, it is crucial these livestock keepers be given a voice in policy-making.

PHOTO CREDIT: GUADALUPE RODRIGUEZ

Tzotzil sheperdesses in Mexico breed and take care of their black sheep breed

Improving small-scale livestock keepers' participation in the implementation of the *Global Plan of Action for Animal Genetic Resources*

This section presents options for fully and effectively involving Pastoralists and smallholder farmers in the implementation of specific Strategic Priorities of the *Global Plan of Action*, and ways and means to acknowledge the contributions of small-scale livestock keepers.

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"[2] 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."[3] 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 (FAO, 2009d).

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

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

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."[4] 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"[5]. 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.[6]

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."[7]

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[8] the *Global Plan of Action* therefore calls for

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4 *Global Plan of Action for Animal Genetic Resources,* paragraph 29.

5 *Global Plan of Action for Animal Genetic Resources,* paragraph 30.

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

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

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

"[integration of] agro-ecosystem approaches in national agricultural 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."[9] 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"[10] 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".[11]

STRATEGIC PRIORITY AREA 3: CONSERVATION

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."[12] 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."[13]

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.

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

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[9] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 5 – Action 2.
[10] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 6 – Action 2.
[11] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 6 – Action 4.
[12] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 6 – Rationale.
[13] *Global Plan of Action for Animal Genetic Resources,* Strategic Priority 8 – Action 3.

knowledge and indigenous practices."[14] 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."[15]

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

[15] *Global Plan of Action for Animal Genetic Resources,* Foreword.

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Smallholder farmers and pastoralists fulfill an invaluable yet undervalued role in conserving biodiversity. They act as guardians of locally adapted livestock breeds that can make use of even marginal environments under tough climatic conditions and therefore are a crucial resource for food security and possibly for adapting to climate change. But in addition, by sustaining animals on natural vegetation and as part of local ecosystems, these communities also make a significant contribution to the conservation of wild biodiversity and of cultural landscapes.

The *Global Plan of Action for Animal Genetic Resources* acknowledges and seeks to support this crucial contribution of smallholder farmers and pastoralists to keeping our planet healthy and diverse. The *United Nations Permanent Forum on Indigenous Issues* backs up this strategic approach and calls for it to be strengthened, while the *United Nations Convention on Biological Diversity* also commits its signatories to support *in situ* conservation by local and indigenous communities.

This publication provides a glimpse into the often intricate knowledge systems that pastoralists and smallholder farmers have developed for the management of their breeds in specific production systems. It also describes the multitude of threats and challenges these often marginalized communities have to cope with and suggests interventions that can sustain valuable human-animal-environment relationships and combine conservation of breeds and their ecosystems with poverty alleviation.

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