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CONTRIBUTIONS OF SMALLHOLDER FARMERS AND PASTORALISTS TO THE DEVELOPMENT, USE AND CONSERVATION OF ANIMAL GENETIC RESOURCES

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I. EXECUTIVE SUMMARY

1. This study provides detailed information on the role of smallholder livestock keepers and pastoralists in the development, use and conservation of breeds, and also provides an overview of their services to the wider society. Furthermore, it discusses the reasons why livestock keepers abandon their breeds and what motivates them to continue keeping them. The study is based on published literature, documents from the FAO Internet database and other Internet sites, as well as field observations by experts.

Cultural and geographic dimensions of breed diversity

2. The world's domestic animal diversity comprises some 7 616 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 farmers and pastoralists who have developed them without the use of herdbooks or formal breeding societies: the latter are a western phenomenon that postdates the eighteenth century, while distinct breeds were already known some five thousand years ago.

3. 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 custodians of breeds, although farming societies have also produced specific breeds. By contrast, in Europe, traditional breeds tend to be named after the geographic locations in which they were developed.

4. By maintaining animals under exposure to natural selection, pastoralists and small-scale livestock keepers play a crucial and essential role in the sustainable use of adaptation and fitness traits. They provide a counterbalance to industrial systems in which breeds are selected mostly for production characteristics and not exposed to natural environmental stressors.

Economic role of the livestock sector and significance of livestock for livelihoods

5. Globally, the livestock sector accounts for 40 percent of agricultural gross domestic product (GDP) and livestock products provide one-third of humanity's protein intake. The demand for livestock products is expanding due to growing populations and incomes, along with changing food preferences. The livestock sector employs 1.3 billion people and creates livelihoods for one billion of the world's poor.

6. About 70 percent of the world's 880 million rural poor people that live on less than US\$1 per day are at least partially dependent on livestock for their livelihoods. For more than 200 million smallholder farmers in Asia, Africa and Latin America, livestock such as cattle, buffalo, sheep, goats and poultry are the main source of income and for about 120 million pastoralists worldwide livestock production is the principal source of livelihoods. In smallholder and pastoral systems, livestock fulfil many functions going beyond the production of meat, milk and eggs, including the provision of fertilizer, fuel, draught power and transportation, representing a means of saving and investment as well as a buffer against crop failure, and playing an important cultural and religious role.

Role of livestock keepers in the development of breeds

7. Social and cultural factors together with deliberate breeding decisions and management by livestock keeping communities have been crucial for the creation of breeds. Unfortunately, in developing countries the human factor in breed creation has been overlooked – until recently, livestock breeds kept by rural communities were regarded as products of natural selection alone and thought to have developed mainly due to geographical isolation from each other. This perception did not account for the fact that livestock keepers structure animal genetic resources into breeds through social breeding mechanisms that create more or less closed gene pools. Such social mechanisms include the prevention of the sale of female animals to outsiders, passing on animals from one generation to the next and sharing animals within the kinship network.

8. 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 maintenance of traditional breeding institutions, such as village breeding bulls. Breeding goals and objectives are culture- and location-specific, and selection is executed through (temporary) mating control, castration, and removal of unwanted animals. Many livestock keepers also undertake breeding experiments on their own initiative.

Sustainable use of marginal areas

9. Large, and possibly expanding, parts of the globe can be used for food production only by livestock that are adapted to local conditions. This includes the 41 percent of the earth's land surface that forms tropical and subtropical drylands, as well as mountainous and high-altitude zones and some very cold areas. In these ecozones grazing converts the local vegetation into food and energy that can sustain people. Pastoralists and smallholder producers have developed an array of strategies for the sustainable use of these areas, such as sophisticated herd movements and grazing strategies. Their livestock represent a means of extracting value from uncultivable land and generating food without competing for cereals. This not only contributes considerably to food security in marginal areas but also provides products and services to the wider society.

Preservation of option-values

10. An important role of small-scale livestock keepers, especially pastoralists, is the preservation of option values: they keep animals with traits that may currently be of no commercial interest, but may be of huge value in changing environmental and economic scenarios. Such traits include "survival" characteristics, for instance the ability to fend for themselves and the ability to cope with diseases. The traits can be maintained through keeping the animals in their natural environment, exposing them to continued natural selection pressures and disease challenges.

11. The continuous exposure to local conditions allows the breeds to maintain the adaptive traits that enable them to cope with the available fodder, the climate and specific environmental features such as stony ground, high altitudes and swampy land. If removed from their original area, animals may lose the traits that have enabled them to survive in those environments. For instance, the North Ronaldsay sheep of the Orkney Islands in Scotland, have adapted to a diet of seaweed. If transferred to other environments, the animals lose this adaptation.

12. 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 local breeds to enhance their offspring's adaptation to local diseases and other conditions. Furthermore, herders may provide extra care to animals at risk to help them cope with the challenges of the new environment.

Agro-ecosystem services

13. 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*, as well as sub-alpine dwarf shrub lands in Europe.

14. Agro-ecosystem services provided by livestock keepers and their breeds include the creation of mosaic landscapes and mini-habitats that sustain biodiversity, the conservation of wildlife, connecting eco-systems by transporting seeds, improvement of the water holding capacity of grassland, prevention of forest fires, restoration and maintenance of soil fertility through manure and nutrient recycling and replicating the grazing behaviour of large wild herbivores.

Reasons why livestock keepers abandon their breeds

15. Many keepers of traditional breeds abandon keeping of their animals, due to a variety of factors, including one-sided information and pressure to adopt improved breeds and standardized

production and breeding systems, changing market demands (for instance lack of demand for wool), loss of grazing grounds and access to water, animal health regulations, and changing lifestyles.

Motivation and incentives to continue keeping breeds

16. Pastoralists and farmers continue to keep their breeds wherever traditional production systems survive and where they have secure access to grazing and water. Among some animal cultures, such as the Raika in India, there is also a sense of custodianship that motivates keepers 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 for niche products, payment for agro-ecosystem services and favourable policies are further incentives that encourage and enable livestock keepers to continue keeping their breeds. As the owners and keepers of valuable breeds, smallholder farmers and livestock keepers should be included in decisions about research and development and conservation measures for their breeds and environments.

II. INTRODUCTION

17. The world's plethora of livestock breeds are the product of both cultural and biological selection. By 2007 a total of 7 616 mammalian and avian breeds had been reported, 6 536 of which are classified as local (occurring only in one country) and 1 080 as transboundary (present in more than one country, FAO, 2007a). With the exception of a small number of composite breeds that were created, often by government breeding efforts, local breeds are the result of breeding activities by farmers and pastoralists. Even for the transboundary breeds, small-scale livestock keepers established the genetic foundation, although these may have been developed further through scientific breeding programmes.

18. The large majority of documented breeds were developed in the absence of herdbooks and breeding societies: the latter only date back to the late eighteenth century and are practically limited in their distribution to Northern countries (see section *Mental pedigree records and maintenance of pure bloodlines*). However, distinct breeds of livestock had already developed by the third millennium BC, according to pictorial and archival evidence from Mesopotamia (Steinkeller, 1995) and Egypt (Benecke, 1994). For China, a large number of pig breeds are documented for the Ming period between AD 1500 and 1644 (Tsang, 1996).

19. According to a study conducted in the early 1990s, breed diversity (measured as ratio of number of breeds per million people) is especially high in peripheral and remote areas (Hall and Ruane, 1993). Drylands are estimated to have contributed a quarter of the world's documented breeds, including a high number of transboundary breeds (FAO, 2007b). This observation can be correlated to the presence of pastoralist societies in these areas who have each developed individual breeds to fit their specific ecological and cultural requirements (Köhler-Rollefson, 2005).

20. The cultural link between individual ethnic or social groups and specific breeds is reflected in many breeds being named after ethnic groups (Köhler-Rollefson, 1993a, 1997, 2003; Rege, 2001). Examples from Africa, Asia and North America show that many ethnic groups have created a specific and phenotypically distinct breed (Box 1).

Box 1. Livestock breeds linked to specific ethnic groups

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

21. The link between breeds and ethnic groups has often remained obscure. One of the reasons for this is the limitation of breed documentation to phenotypical and production characteristics, without describing a breed's social and cultural contexts. However, more recently science has begun to take note of the ethnic groups and communities that are associated with individual breeds. In Southern Africa, recent studies have elaborated the role of Zulu and Himba cultures, respectively, in the development of Nguni cattle (Poland *et al.*, 2003) and Damara sheep (Du Toit, 2007). In India, a survey of poultry and small ruminant breeds in the state of Orissa links the breeds to specific tribal groups (Kornel *et al.*, 2006; Mohapatra *et al.*, 2006).

22. Pastoralists play an especially important role as creators and custodians of breeds (see Box 1 for examples). For India, the Royal Agriculture Commission noted in 1928 that "the best Indian breeds were the results of the efforts of the special castes of professional breeders who were nomadic and took cattle to graze over long distances" (Habib, 1999). This role of pastoralists in supplying farmers with good work animals dates back at least 1 000 years. According to Chaudhuri (2000), "Most nineteenth century observers were agreed that the cattle bred by peasants as part of the village economy failed to meet the standard of nomadic cattle and degenerated in size as well as in milk yield"... as no one took much care to separate the young bulls from the heifers. Wealthy farmers, who were anxious to improve their stock, sent some cows to be kept in the folds of the larger breed and obtained the use of good bulls."

23. Farming societies too have produced specific breeds. In Indonesia, examples of breeds associated with farming societies include Garut and Javanese Thin Tail sheep and the Kacang goats of Sundanese and Javanese farmers, Bali and Banteng cattle of rice farmers in Bali and Madura, and the spotted buffalo or *tedong bonga* of the Toraja in Sulawesi. FAO (1974, p. 51) describes these buffaloes as "magnificent animals by any standard" and considers it as "unusual that in such a remote area it should be demonstrated so effectively that an excellent meat type animal, bearing in many respects a close resemblance to the conformation of the Hereford, can be the result of a consistent breeding policy." However, in many developing countries far fewer cases and details of breed formation are documented for farmers than for pastoralists.

24. In countries where ethnic affiliation is less pronounced, the situation is different. Here, heterogeneous landscapes led to the development of adapted breeds also in mixed farming systems,

especially after the description and development of pedigree herds and flocks with particular qualities, specially adapted to local circumstances in the eighteenth and nineteenth centuries. The place names associated with many traditional breeds are testament to their local evolution. For instance, in the United Kingdom, cattle breed names such as Lincoln Red, North Devon, South Devon, Sussex and traditional Hereford, and sheep breeds including Cheviot, Cotswold Sheep or Cotswold Lion, the Dorset Horn and Poll Dorset, Exmoor Horn, Hampshire Down, Portland, Southdown, Wiltshire Horn, Whiteface Dartmoor and Greyface Dartmoor reflect their association with particular places. Such breeds are essential for conserving particular landscapes some of which are designated as IUCN Protected Landscapes (Cole and Phillips, 2008).

25. With respect to global animal genetic resource management, livestock keepers that maintain animals exposed to natural conditions provide a crucial and essential counterbalance to industrial systems which rely on environmentally sensitive high-yielding breeds that are selected mainly for production characteristics. “From a long-term point of view it is possible that concentration on high-yielding environmentally sensitive breeds will create a serious problem... It is possible that farmers will lose their ability to manipulate natural environmental conditions. If all environmentally tolerant breeds are lost in the interim, the level of livestock production could collapse” (Tisdell, 2003).

26. The important role of small-scale livestock keepers and pastoralists as developers and custodians of livestock biodiversity is recognized by the *Global Plan of Action for Animal Genetic Resources*. Its Strategic Priority 5 promotes agro-ecosystems approaches to the management of animal genetic resources, while its Strategic Priority 6 seeks to support indigenous and local production systems and associated knowledge systems of importance to the maintenance and sustainable use of animal genetic resources.

27. This study provides detailed information to the Intergovernmental Technical Working Group on Genetic Resources for Food and Agriculture on the role of smallholder livestock keepers and pastoralists in breed development, use and conservation and their services to the wider society. It also discusses the reasons why stakeholders decide to give up their breeds and what motivates them to continue keeping them. The study is based on published literature, documents from the FAO Internet database and other Internet sites, as well as field observations by experts.

III. THE LIVESTOCK SECTOR

28. Globally, the livestock sector accounts for 40 percent of agricultural gross domestic product (GDP) and livestock products provide one-third of humanity’s protein intake. The demand for livestock products is expanding due to growing populations and incomes, along with changing food preferences. Global production of meat is projected to more than double from 229 million tonnes in 1999/2001 to 465 million tonnes in 2050, and that of milk to grow from 580 to 1 043 million tonnes. Livestock development is the fastest growing subsector of agriculture in many developing and transition countries (FAO, 2006a), facilitated by the globalization of trade in both livestock inputs and livestock products.

29. The livestock sector employs 1.3 billion people and creates livelihoods for one billion of the world’s poor. About 70 percent of the world’s 880 million rural poor people that live on less than US\$1 per day are at least partially dependent on livestock for their livelihoods (World Bank, 2007). For more than 200 million smallholder farmers in Asia, Africa and Latin America, livestock such as cattle, buffalo, sheep, goats and poultry are the main source of income, and for about 120 million pastoralists worldwide livestock production is the principal source of livelihoods (Thornton *et al.*, 2002). In smallholder and pastoral systems, livestock fulfil many functions going beyond the production of meat, milk and eggs (Box 2).

Box 2. Functions of livestock in smallholder and pastoral systems

In smallholder and pastoral systems, animals fulfil many functions (FAO, 2007b).

- They produce **food**: meat, milk, eggs, blood and other products.
- They produce **fibre and hides**, as well as bones and feathers.
- Their dung is used as **fertilizer and fuel**.
- They are sold for **cash income**: for slaughter or as fattening or breeding stock, or produce a regular cash income through sale of milk, eggs, wool, and other products.
- They provide **draught power and transportation** for their owners, or are hired out to neighbours.
- They act as a self-replicating **asset** – one of the few ways to invest money in areas without banks.
- They act as a **buffer against crop failure** and other risks – a function that is particularly important in areas subject to drought or crop pests.
- They have important in **cultural and religious functions**.

To meet their many needs, smallholder livestock keepers and pastoralists commonly keep a mix of species and breeds which are used and valued for more than one function. For example, chickens produce eggs, fertilizer and chicks which can be sold, as well as meat for special occasions. Large animals such as camels, cattle and yaks yield milk, dung, transport and draught services. Food is but one of many products, and may not be the reason a breed is kept; in some instances, it does not play a role at all: horses and donkeys are often kept for transport rather than slaughter, and fighting cocks are kept for entertainment.

Some breeds may be kept for a specific purpose – examples are breeds used for ceremonies (such as the llama for the Inca, Brotherstone, 1989). But such specialized breeds can nevertheless fulfil more than their main function: Ceremonial animals can be an important source of protein. The spotted buffaloes of Sulawesi are slaughtered during funerals and their meat is distributed to guests, sometimes feeding a large portion of the community.

The importance of livestock's role in the provision of financing and insurance is frequently overlooked. Several attempts have been made to quantify the value of financing and insurance functions to livestock keepers who are unable to access these services from other sources and include them in calculations of the net benefits of livestock production. For example, studies have indicated that these functions account for 81 percent of net benefits from meat goat production in southwestern Nigeria (Bosman *et al.*, 1997), 23 percent in the case of cattle production in upland mixed farming systems in Indonesia (Ifar, 1996), and 11 percent in smallholder dairy goat production in the Eastern Highlands of Ethiopia (Ayalew *et al.*, 2002).

IV. CHARACTERISTICS OF SMALLHOLDER FARMERS AND PASTORALISTS

30. Despite the recognized importance of smallholder and pastoral livestock production for the livelihoods of numerous poor people, there are no internationally agreed definitions of pastoralists (Box 3) and smallholder farmers (see below). Smallholder production is often used interchangeably with small-scale, subsistence and family farming, resource-poor, low-income, low external input, low-output or low-technology livestock farming. Furthermore, some recent definitions include pastoralists among smallholder farmers.

31. According to IFPRI (2005), smallholder farms constitute about 85 percent of all farms. The World Bank, in its Rural Strategy, classifies the rural poor into five categories: a) the landless; b) smallholders (farmers with up to two hectares of cropland); c) pastoralists (those who are not settled in any specific area and who derive most of their income from pastoral livestock); d) rural women (especially women-headed households); and e) ethnic minorities and indigenous populations (World Bank, 2003). ILRI (personal communication 2008) uses generic definitions for smallholder farmers, for example dairy farmers with fewer than 6 milking animals and/or less than 3 ha of land; pastoralists with fewer than 10 mature cattle; farmers keeping fewer than 30 small ruminants or fewer than 200 poultry.

32. A size-based definition of smallholders, however, is of limited use, as it does not take into account many important factors that have substantial implications for farm productivity and efficiency, such as the nature of the production system, the types of crops or livestock used, regional and national differences, institutional and market arrangements available to farmers, access to key social services such as health and education, or labour arrangements.

33. For the purpose of this paper, smallholder farmers and pastoralists are grouped together with landless livestock keepers as “small-scale livestock keepers”. One way to define small-scale livestock keepers would be to describe them relative to the average livestock farm within a country, rather than by absolute herd size or land size.

34. Other important characteristics that might be used to define small-scale livestock keepers include their tendency to operate with limited resource endowments relative to other farmers in the sector, and the fact that in general, small-scale livestock keepers have relatively low-levels of formal education and training. Small-scale livestock keepers, especially pastoralists, often also operate on communal rather than private land; or they may be landless.

35. 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 the workforce, and livestock production is often the principal source of income. They usually have limited access to input and output markets, and to services and credit. Most of their market interaction is within informal local markets, for which they produce local or traditional products. Small-scale livestock keepers routinely face high transaction costs in securing quality inputs and getting market recognition for quality outputs.

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

Box 3. Definitions of pastoralists

Pastoralists have been defined based on the contribution of livestock to agricultural income and the agro-ecological context in which they operate (FAO, 2007j). Another definition groups them according to their mobility ranging from entirely mobile “exclusive pastoralists” to semi-settled “agropastoralists”. “Exclusive pastoralists” are livestock producers who have no permanent settlements, grow no crops and depend on the sales of animals and livestock products to buy grain. Some communities migrate over long distances, commonly along set routes where they may have standing agreements with farmers to make use of their crop residues. Other pastoral groups may move their herds only short distances between wet and dry season pastures. “Transhumant pastoralists” have a permanent homestead, grow some crops mostly for home use, and may move only parts of their herds in search of grazing. “Agropastoralists” are semi-settled, hold land-rights and grow their own staple crops and sometimes crops for sale (Blench, 1999).

The herds of agropastoralists are often smaller than the herds kept in other pastoral systems (Blench, 1999) which can be quite large, because livestock is the main asset in these systems and the pastoralists need a minimum number of livestock to resist drought cycles (FAO, 2007j). In reality, the systems often overlap. Settlement politics, economic development and changing environments further reduce the differences and move the balance more and more towards agropastoralism.

V. ROLE OF LIVESTOCK KEEPERS IN BREED DEVELOPMENT

37. In developing countries the human factor in breed creation has long been overlooked. Until recently, livestock breeds kept by rural communities were regarded as products of natural selection alone (Lanari *et al.*, 2005) and thought to have developed mainly due to geographical isolation from each other. However, combined with natural selection, the use and herding of livestock by specific ethnic groups and communities has led to subdivision into many endogamous animal populations, resulting in separate and essentially closed gene pools (Köhler-Rollefson, 1997).

38. The following sections discuss the social and cultural factors that were crucial for the creation of breeds together with deliberate breeding decisions and management by livestock keeping

with respect to other species. Fulani cattle pastoralists rarely sell fertile heifers; females found on the market are usually old and have fertility problems (Schaefer, 1998). The Raika pastoral community in Rajasthan issued caste regulations against the sale of female sheep outside the community, punishing perpetrators with outcasting.

Rules for passing on animals to the next generation

41. Traditional communities often have fixed rules for presenting animals as gifts at certain life-cycle events, such as birth, circumcision and puberty; and as dowry or bride wealth at weddings. They also regulate what happens to a herd when the owner dies. Among the East African Gabra and Turkana, for example, camel herds are inherited by the son. Unmarried Turkana daughters receive an adult female camel (Hülsebusch and Kaufmann, 2002, p. 22).

Sharing mechanisms

42. Sharing arrangements are common among all pastoralist groups and are also known from settled and tribal communities. They facilitate access to breeding animals, the distribution and exchange of livestock, and the sharing of food and other livestock products; sharing also furthers social relationships and reduces the risk of losing the whole herd if a disease or other calamity strikes. For the latter reasons, pastoralists may place some of their cattle with the herds of other herders far away from their own herd (Schwabe, 1978). The set-up of sharing arrangements differs from society to society (Box 4).

Box 4. Livestock sharing mechanisms

In many communities, the wealthier members have an obligation to share their livestock with their poorer relatives by giving long-term stock loans, sometimes over generations. They may allow the placement of female animals in their herd so that the females can be mated by a superior male. Other arrangements involve the loan of breeding males. Payments are often through the use of animal products and the sharing of offspring rather than money. Furthermore, sharing brings prestige, helps build alliances and reduces risk of total herd loss. The following examples illustrate some of the foregoing points.

- *Vaata* is a traditional system of sharing and building assets among the Adivasi, a tribal group in Andhra Pradesh, India. The owner gives a 6-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 with a superior bull. The cow returns home with its improved progeny after several years; in the meantime the host family can use the milk it produces (Beerling, 1986).
- If a Somali camel-breeding family does not have a breeding male of their own, they borrow one from kin, hire one from others, or drive their female camels as far as 200–500 km to have them served by a prominent sire (Hussein, 1993).

Indigenous knowledge about animal breeding and breeds

43. With their long tradition of animal breeding and daily intimate interaction with their herds, livestock-keeping communities have accumulated detailed knowledge on their animals, their needs and their surroundings. 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 (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).

Identification of individual animals

44. Pastoralists have well-honed skills in classifying and identifying animals that look very similar or are undistinguishable to outsiders (Galaty, 1989). In order to make considered breeding decisions and avoid inbreeding, they must know each individual animal in their herd and its genetic relationship with all the other animals. For this purpose they first classify animals by status (sex, age, pregnant, lactating, castrated, etc.), then by colour and pattern, shape of the horns, or special characteristics. Frequently all animals in a herd are named and often all female animals of the same lineage are given the same name.

Mental pedigree records and maintenance of pure bloodlines

45. With rare exceptions (e.g. Rathore, 2008), official breed societies did not spring up in developing countries. However, despite the absence of written records, pastoralists often memorize the ancestry of their animals in great detail and over several generations. Such mental record keeping of animals' pedigrees has parallels with herdbook societies (Adams and Kaufmann, 2003; Krätli, 2008). In fact, the Arab principles of careful parent selection and maintaining pure lines that came to Britain with imported oriental horses in the seventeenth century substantially influenced breed development in Europe, culminating in the foundation of herd books and breeding societies in the nineteenth century (Berge, 1959). The examples in Box 5 illustrate the importance that pastoral societies place on pedigree records.

Box 5. Mental pedigree records by pastoral societies

- East African Maasai conceive their cattle herds as being composed of “houses” or matrilineages: all animals descended from one particular cow are grouped together and given the same name (Galaty, 1989). The WoDaaBe in Niger have a similarly intricate system (Krätli, 2007, 2008). Other examples include the Nuer of southern Sudan (Schwabe, 1978), and the Bodi of Ethiopia (Fukui, 1988) who can both trace back their cattle's pedigrees over several generations.
- WoDaaBe herders in Niger remember the genealogy of each animal born in their herd over a 20-year period, including the name of the sire, the sire's owner and the season of fertilization. They 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).
- Bedouin horse breeders had a reputation for maintaining the purity of their animals' blood, which bordered on fanaticism. The code of personal honour associated with horsemanship made it impossible for the 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).
- Bedouins distinguished between pure-bred and ordinary camels: “If a well-shaped female of the common sort is covered by a thoroughbred bull and the same is done with her female descendants, then a she-camel sprung from this line is recognized as a thoroughbred in the fifth, the male in the ninth generation” (Musil, 1928).
- 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).

Classification of breeds and knowledge about undocumented breeds

46. Local classifications of livestock commonly differ from the classification system used by modern science. Many of the pastoral systems are very detailed – going beyond the scientific breed definition that counts animals sharing the same external characteristics as one breed. Rendille and Gabbra in Kenya differentiate their camel breeds into four types, all of which differ in their adaptation and performance characteristics (Hülsebusch and Kaufmann, 2002).

47. Pastoralists and smallholders not only develop their own breed classifications (Hussein, 1993), but are often also aware of breeds or strains that have escaped the attention of scientists (Box 6). The Malvi camel in India, for example, has been discovered based on information provided by Raika camel pastoralists (Köhler-Rollefson and Rathore, 1996). In Nigeria, poultry science recognized only one type of non-exotic chicken labelled “local”, while Hausa and Fulani distinguished at least 15 types of local chicken based on productivity, colouring, feathering, body size and conformation, and ideological association with certain spirits (Ibrahim and Abdu, 1996).

48. Because of a lack of information and no categorical definition of “breed”, animal genetic resource specialists often find it difficult to determine whether animals belong to different breeds or represent ecotypes within a single breed (ILRI, 1996). In such cases, pastoralists often can provide useful information, as they know which animals are theirs, how long they have been associated with them, and whether animals have come in from the outside (see case of Banni buffalo in Box 6).

Box 6. Examples of locally distinguished breeds not (yet) recognized by science

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

Traditional breeding institutions

49. Official breeding societies maintain breeds through a formal system of records of sires and progenies. But traditional societies have also developed breeding institutions aimed at facilitating access to male breeding animals and ensuring the optimal quality of the livestock. Such breeding institutions are frequently anchored at village level or may be supported by respected community members. In West Africa or India, it was often the pastoralists that provided the function of supplying work animals to farmers and that had developed extensive knowledge of line-breeding. Box 7 provides examples of breeding institutions from India.

Box 7. Traditional breeding institutions in India

- In Rajasthan, village-based institutions in the form of a communally owned bull (godda) and/or male buffalo (padha) exist. 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 its purchase costs. Some villages went to great lengths to obtain good quality bulls and buffaloes of superior genotypes, sending out scouting committees to distant villages that had a reputation for such animals. Each household shared the expense of the community bull's upkeep and of its keeper's salary (Anderson and Centonze, 2006).
- The famous Ongole breed from Ongole Taluka in Andhra Pradesh, southern India, developed through the practice of the "Brahmini" bull. When a well-to-do man died, his family dedicated a good stud bull to the local deity. A special committee of experts was tasked with searching for a superior bull which became the property of the community (Nath, 1992).
- Practically 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).
- Gir cattle are bred largely by professional breeding groups such as Rabaris, Bharwads, Maldharis, Ahirs and Charans. These lead a nomadic life, moving their cattle from place to place in search of grazing (Joshi and Phillips, 1982).
- The Hallikar breed is bred by both professional breeders and cultivators. Each village has a few families who have been breeding the Hallikar type of cattle 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 cows may be taken 110–160 km to the bulls kept by such persons (Joshi and Phillips, 1982).

Breeding goals and objectives

50. Livestock keepers may not have a concept of the ideal animal as they realize that no one animal can fulfil the multiple functions needed to survive and produce in difficult environments. Keeping a mix of species and breeds helps to meet the different needs. Furthermore, individual breeds often fulfil multiple functions and may even further segregate into types or lineages with differing qualities (Hülsebusch and Kaufmann, 2002; Krätli, 2008, see also Boxes 2 and 8 and the section *Identification of individual animals*).

Box 8. Strategies influencing herd management and composition

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 a herd that is 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 (Krätli, 2008) and production traits (Hülsebusch und Kaufmann, 2002).

51. Reflecting the foregoing factors, the breeding goals of livestock breeding communities are multifaceted and comprise many criteria beyond high production of milk and meat. For small-scale livestock keepers, especially pastoralists, adaptive traits are usually more important than productive traits, in view of the often the poor quality or seasonally low quantity of feed, high disease pressure,

poor infrastructure and high costs of veterinary care and other inputs (FAO, 2003a; Steglich and Peters, 2003).

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

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

54. As a result, selection criteria vary between societies and within societies, and among the different species and breeds, between male and female animals and perhaps even between types within a breed (Box 9).

Box 9. Examples of selection criteria of livestock keeping communities

- Beauty traits (colour patterns and horn length and shape) are major selection criteria for Ankole breeders in East Africa. Fertility and milk yield were more important for cows, whereas disease resistance and sire fertility were more important for bulls (Ndumu *et al.*, 2006).
- Tano *et al.* (2003) interviewed subsistence livestock farmers, mixed-crop/livestock producers, and beef and milk livestock farmers in a tsetse-affected zone in Burkina Faso. It was discovered that all farmers prefer cattle that are not selective in the type of grass or the quality of water they consume. In bulls, traction ability, large body size, high fertility, disease resistance and rapid weight gain are considered positive. For cows, reproductive performance, milk yield and body size are important criteria, but this varies among production systems. Farmers valued traction more than pastoralists, who highly valued milk yield. Mixed-crop/livestock farmers are most interested in animal traction, less interested in meat and milk offtake, and thus are less concerned about low reproductive performance. For pastoralists, low reproductive performance is of great concern because of its impact on herd size and productive capacity, and milk and beef often ranked highly. As in the case of bulls, large frame size in cows was preferred because it has an impact on the market value of the animals (Tano *et al.*, 2003).
- Raika shepherds from India select their sheep according to a set of nine criteria called “*Nauguna*”: wool production, milk production, good pedigree (true to the breed), mothering abilities, height, good walking ability, fast growth rate, drought and famine resistance, beauty, high birth weight, ability to endure and withstand pain (Köhler-Rollefson and LIFE-Network, 2007).
- For chickens, rural women in southwestern areas of the Islamic Republic of Iran select hatching eggs for medium size and weight, and laid by hens with good body formation, weight, feathers, colour, laying and growth rate, as well as good broodiness. Eggs laid in the morning are preferred. They continue to prefer traditional breeds, although the Ministry of Rural Development has distributed many highly productive laying breeds throughout rural areas (Shahvali *et al.*, 2000).
- Goat herders in Patagonia mostly named two criteria for selecting Neuquén Criollo goats for breeding. Their main criteria seemed to be hair type and coat colour (Lanari *et al.*, 2005).
- Agropastoralists of Usi, Peru, use different selection criteria for llamas and alpacas. For llamas, size and strength are important, while for alpacas fibre is the main criterion (McCorkle, 1983).

Breeding management

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

Selection of breeding animals

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

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

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

Mating control

59. Mating control is widely practised all over the globe by both pastoralists and small-scale farmers. Mating control can be temporary or long-term. The latter includes castration and the removal of potential breeders through culling or sale.

60. Some societies use very rigid mating control to obtain a certain 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 and only one bull was left for every 80 cows (Joshi and Phillips, 1982). Herders in Nigeria castrated hundreds of thousands of Sokoto Red Goats that did not have the red skin highly valued for the production of Morocco leather, much in demand in Europe since medieval times and used for binding Korans. This way they ensured that only males with red skin could mate (Blench, 1999).

61. 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. Here are some examples of practices for temporary mating control:

- keeping a community-owned bull to which cows are brought when in heat (see also the section *Traditional breeding institutions*);
- keeping a ram with the flock, but preventing it from mating at specific times of the year by tying an apron in front of the genitals. This is a very common method used in many countries for small

ruminants. The apron is removed at certain times of the year so that lambs are only born when fodder is available (Mathias-Mundy and McCorkle, 1989).

- Mauritanian Fulani use a "temporary" castration method for sheep and goats. They lodged the animal's testes under a slit in the abdominal skin until mating time, when the testes are let down again (Ba, 1982).

62. **Castration** is widely practised among traditional livestock keepers, independently of veterinarians and government programmes. It is perhaps the most common form of traditional surgery (McCorkle *et al.*, 2001). In India, castration is performed by a particular caste, the Satya, specialized in this service (Alstrom, 1999). But in many societies, herders themselves castrate their animals.

63. With the exception of a report from China (Wagner, 1926), the available literature documents only the castration of male animals, using a large array of both open and bloodless forms, depending on the culture and species. Methods include removal of the testes, severing the spermatic cord, often by biting through the cord or crushing it with some instrument. Another common method is tying off or banding the testes until they wither from lack of blood flow (McCorkle *et al.*, 2001).

64. Castration is not only a tool for mating control. Livestock owners often castrate animals destined for ploughing and pulling carts to ensure that they are docile. This restricts the pool of male animals available for breeding, or may lead to negative selection if the best sires are being castrated. In some instances, so many males have been castrated or slaughtered that livestock owners find it difficult to find high quality males to cover their females. For example, the decreasing number and quality of swamp buffaloes was attributed to such factors (Chantalakhana, 1981) but in the absence of sociological studies from the period it is difficult to judge whether other factors also contributed to this change.

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

66. Animals with unwanted characteristics are **removed** by being either sold or culled. The removal of both males and females is reported (e.g. Laswai *et al.*, 2004). Reported reasons for removing females relate to fertility and reproductive problems and the ability to care for the offspring:

- The Maasai in the south of Simanjiro district in the United Republic of Tanzania cull female animals with long calving intervals, poor fertility and poor mothering abilities, low milk yield, blocked teats or bad temper (Laswai *et al.*, 2004).
- Large breeders of Kangayam cattle in India take care that cows that are not regular breeders are disposed of. Such discarded cows are usually purchased by small breeders who use them for work (Joshi and Phillips, 1982).

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

Experimenting with breeds

68. Pastoralists and smallholder livestock keepers are known to experiment with breeds – to adapt their animals to local conditions, improve production, and perhaps also for curiosity. Upgrading of local poultry breeds has been observed all over the world; however, the need to maintain broodiness in the hens creates a limit for small-scale farmers (FAO, 2008; Besbes, 2008). Cross-breeds unfit for the local conditions are no longer pursued. Others are maintained if conditions allow, and further refined (Box 10).

Box 10. Cross-breeding

- The Maasai deliberately introduce new germplasm into their herds by means of exchanges within the community and by experimenting with improved breeds such as the Boran and Mpwapwa cattle. However, it was observed that these improved genotypes suffered from high mortality, not being able to trek very long distances or cope with prolonged intervals between drinking (Laswai *et al.*, 2004).
- In the Gambia, cattle owners depend on the functional traits of the N'Dama breed and appreciate it as a multipurpose animal that is well integrated into their production system. Nevertheless, they conduct experiments with crossing it with the higher potential Gobra breed, as long as the local agro-environment is favourable enough (Steglich, 2006).
- Keteku cattle of Fulani pastoralists in Nigeria is a stabilized cross of Savannah Shorthorn (Muturu) and White Fulani (Bunaji), with some input from N'Dama Longhorn (Rege *et al.*, 1994; Feliuss, 1995, cited from DAD-IS). Bunaji has a relatively high milk production for savannah breeds while N'Dama is trypanotolerant and adapted to rainforests. The resulting Keteku cattle can thrive under a wider range of drought and disease challenge (Schillhorn van Veen, cited in Martin *et al.*, 2001).
- Most breeding programmes, aimed at improving the productivity of indigenous chickens, have used cross-breeding. This approach has provided significantly higher productivity, but has resulted in a loss or dilution of the indigenous birds' morphological characters and instinct for broodiness. For example, the Sonali in Bangladesh was a high-yielding breed combination under semi-scavenging conditions. However, smallholders' acceptance declined when they discovered that they had no success in reproducing the breed. Similarly, when they received CARI cross-bred hens, Indian villagers complained about the dilution of morphological characters (Besbes, 2008).
- Pastoralists in Tibet have experimented with different ways of producing a species cross between cattle and yaks. The herders regard the offspring of cows crossed with yak bulls as less suitable for their harsh conditions than offspring stemming from cattle bulls mated to yak cows (Wu, 1997; 1998).

VI. PROVISION OF PRODUCTS AND SERVICES THROUGH SUSTAINABLE USE OF MARGINAL AREAS

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

70. To be able to utilize such inhospitable areas, which are often infested with diseases, pastoralists and smallholder producers have developed an array of strategies ranging from the use of hardy, well-adapted breeds to sophisticated herd movements and grazing strategies (Box 11). Their livestock have thus become a means of extracting value from uncultivable land and generating food without competing for cereals (Hoffmann *et al.*, 2008). This not only contributes considerably to food security in marginal areas but also provides products and services also to the wider society.

71. Long overlooked, this contribution by pastoralists and smallholders to national economies 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, and 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 the total milk production (Rodriguez, 2008).

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

Box 11. Strategies used by smallholder livestock keepers and pastoralists to exploit marginal lands

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

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

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

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

Another measure to reduce animal disease problems is restricting grazing at certain times of the day. Tzotzil Maya shepherds in southern Mexico (Perezgrovas, 1996) avoid grazing their animals in the early morning when forage is still dew-laden, as they have observed that their animals then may become infected with liver fluke. Also Fulani herders in Nigeria avoid dew-ridden grass (Bayer, 1990). Herders may do so even if they do not know of the organisms that cause the health problems. Such strategies can nevertheless be an efficient way to reduce parasitic diseases because dew-ridden grasses can harbour the infective stages of parasites or their hosts (Schillhorn van Veen, 1979).

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

73. In addition to the provision of food products, pastoralists and smallholder livestock keepers also contribute to the economy through the sale of live animals, hides, skins, wool, manure and transport services. Livestock also provides draught power for more than 320 million ha, a quarter of the earth's total arable land, and livestock manure contributes to agricultural productivity. Other

values supplied by small-scale livestock keepers and pastoralists include contributions to tourism and environmental services (see the section *Agro-ecosystem services*), until now little captured in official statistics (Rodriguez, 2008).

VII. BREED CONSERVATION AND THE PRESERVATION OF OPTION VALUES

74. An important role of small-scale livestock keepers, especially pastoralists, is the preservation of **option values**¹ (Pilling *et al.*, 2008; Rodriguez, 2008): they keep animals with traits that may currently be of no commercial interest, but may be of huge value in changing environmental and economic scenarios. Such traits include “survival” characteristics such as the ability to fend for themselves and the ability to cope with diseases (see Box 12 for examples). The traits can be maintained through keeping the animals in their natural environment, exposing them to continued natural selection pressures and disease challenges. At the same time, animals are also 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 might be lost. The sections below provide details.

Box 12. Traits furthering survival in harsh environments

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

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

Maintaining animals in their natural environment

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

76. If removed from their original area, animals may lose the traits that allow them to survive in their in these environments. The North Ronaldsay sheep of the Orkney Islands in Scotland, for example, are adapted to a diet of seaweed. If transferred to other environments, the animals lose this adaptation (Woolliams *et al.*, 2008).

¹ Option values derive “from the value given to safeguarding an asset for the option of using it at a future date. It is a kind of insurance value (given uncertainty about the future and risk aversion) against the occurrence of, for example, a new animal disease or drought/climate change” (FAO, 2007 p. 430).

Furthering adaptive traits

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

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

79. As another strategy to improve adaptive traits, some groups of livestock keepers purposefully arrange for their female animals to be bred by wild males.

- 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 and wild species as a breeding strategy, for example the wild boar (*Sus scrofa*) and a species related to the red junglefowl (*Gallus lafayetti*).
- There are indications that farmers in Viet Nam cross-breed domestic and wild pig species as a breeding strategy.
- In the Rann of Kutch in Gujarat, donkey owners deliberately provide opportunities for their female donkeys to be covered by male half-asses.

Adapting breeds to local conditions

80. Livestock keepers undertake conscious efforts to adapt their animals to new environments and changing conditions (Martin *et al.*, 2001). When introducing preferred breeds into new ecological zones, pastoralists may cross-breed their animals with males from local breeds to enhance their offspring’s adaptation to local diseases and other conditions (Blench, 1999; McCorkle *et al.*, 2001; see also the section *Experimenting with breeds*). Furthermore, herders may provide extra care to animals at risk (Blench, 1999) to help them cope with the challenges of the new environment.

81. Livestock keepers are also reported to adapt their animals to fodder known to be toxic to livestock through adding increasing amounts to the regular fodder. In West Java, Indonesia, farmers in Nagrak village, for example, developed a diet for their sheep that includes fresh cassava leaves and peelings. The farmers know that these are poisonous to their sheep. However, they say that toxicity is reduced if the cassava products are given together with or after grass. As cassava peels were widely available and their sheep were in excellent and much better condition than animals in neighbouring villages, the farmers accepted that they would lose a sheep every now and then due to cassava poisoning (Mathias-Mundy *et al.*, 1992). Other societies are known to train their animals to stay away from eating tempting but poisonous forages (McCorkle *et al.*, 2001).

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

VIII. AGRO-ECOSYSTEM SERVICES

83. 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*, as well as subalpine dwarf shrub land in Europe.

84. Landscapes created through the co-evolution of livestock and vegetation often resemble wilderness to outsiders, but have actually been managed by indigenous and other traditional people over long time periods. Such land management systems sustain not only their respective varieties of domesticated plants and animals, but also many wildlife species. In many long-inhabited and long-utilized landscapes, there is a spectrum from “cultivated” to “wild” biodiversity, with occasionally some blurring between the two. In fact, many societies do not make a clear distinction between “wild” and “domesticated” (Phillips and Stolton, 2008). The demise of traditional grazing systems, especially nomadic and transhumant ones such as the community-controlled grazing on “Allmende” (common land) in the Alps of southern Germany, would result in the loss of a significant amount of biodiversity (Scholle *et al.*, 2002).

85. In other areas, livestock have continued what wild herbivores started millennia ago: the original Eurasian landscape was shaped by large herbivores such as aurochs, wild horses and wild boar, which created an open woodland habitat. The grasslands require periodic defoliation, so as not to turn into scrub and eventually into woodland. This effect can not be achieved by mowing, but only by grazing. As these wild species have largely become extinct, low-intensity livestock keeping with traditional breeds replicates their effects and supports a rich wildlife.

86. Although the understanding of livestock’s impact on the environment is only at its beginning, evidence is accumulating that effective grazing management can have many positive effects, including stimulation of pasture growth and biodiversity, promotion of ecosystem health and integrity, reduction of invasive species, improvement of mulching, and mineral and water cycling.

87. This has been leading to growing recognition of the ecological value of the services that smallholder livestock keepers and pastoralists provide through their livestock management (see, for example, Rodriguez, 2008).

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

89. The following sections summarize the ecological benefits of extensive livestock production systems.

Creating mosaic landscapes and minihabitats that sustain biodiversity

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

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

92. The positive impact on biodiversity of such systems contrasts with modern farming that has with its machines and agrochemicals led to a drastic decline of biodiversity (Finck *et al.*, 2002).

Conservation of wildlife

93. The breeds kept by pastoralists and small-scale livestock keepers often help conserve wildlife, and frequently there is a history of co-evolution between wild species and local livestock. Such 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 also to leave (Casimir, 2001). And in the Bharatpur Bird Sanctuary in eastern Rajasthan, a ban on grazing by buffaloes led to the disappearance of Siberian cranes that need an open grazed environment for nesting (Lewis, 2003).

Connecting ecosystems by transporting seeds

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

Improvement of water-holding capacity of grasslands

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

Reversing the effects of discontinued grazing and managing landscapes

96. Due to various economic and political reasons and due to the increasing loss of agricultural land, livestock numbers on marginal lands and overall breed diversity have declined in several countries. For instance, in the former Yugoslav Republic of Macedonia, sheep numbers have declined by 45 percent since the abandoning of subsidies for upland herding. This leads to an invasion by bush species and the disappearance of the natural flora. Abandonment of grazing has also in other Mediterranean countries resulted in large areas of hills and mountains becoming covered by shrub vegetation with low biodiversity. This accumulation of woody biomass increases risks such as fire and erosion and gives rise to environmental and economical losses (Osoro *et al.*, 1999; Perring 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, shrubs such as blackberries have proliferated and prevent the rejuvenation of large forest trees.

97. Reintroducing grazing has become a well-established way of managing cultural and natural 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.

Preventing forest fires

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

99. Given the increased fire risk experienced in some developed countries (e.g. the United States of America) following the discontinuation of grazing, the use of livestock for the removal of shrubs and undergrowth will likely gain importance.

Restoring and maintaining soil fertility through manure and nutrient recycling

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

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

IX. REASONS LIVESTOCK KEEPERS GIVE UP THEIR BREEDS

102. Livestock keepers, particularly those who depend on natural resources for their livestock, have to cope with many challenges, making it more and more difficult for them to continue their livestock production. As a result, they may switch to other breeds or species, combine livestock keeping with other activities, or give their livestock up altogether.

103. According to the Heritage Sheep project implemented in five European countries (Carson, 2008), threats to breed survival include decrease in public funding, lack of political will to support rural communities, policies and legislation, including environmental schemes, disease, predators, urbanization, poor return on product, competition from other livestock, ageing of the farming population, lack of marketing support, inbreeding and loss of skills.

104. The following sections discuss selected reasons livestock keepers give up their breeds. While the reasons are discussed one by one, one needs to keep in mind that usually a combination of several factors will be at work – as the case of the Muturu cattle in Nigeria illustrates (Blench, 1999, see Box 13).

Box 13. Replacement of Muturu cattle by zebu and cross-breeds

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

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

Source: Blench (1999).

Pressure and one-sided information to adopt improved breeds and standardized production and breeding systems

105. Government programmes, extension personnel with formal training in animal science and private companies promote the adoption of high-performance breeds and management of animals according to scientific principles and intensive production systems (FAO., 2003b; FAO, 2007b; Köhler-Rollefson, 2003; Du Toit, 2007).

106. Furthermore, the adoption of exotic breeds is often heavily subsidized, providing a competitive advantage over local breeds (Drucker *et al.*, 2006). Livestock development projects and programmes frequently introduce exotic breeds – by importing young animals, eggs, semen or fertilized embryos, or by encouraging cross-breeding. 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.

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

Changing market demands

108. With globalization, international and domestic markets can become connected. Although these markets are not identical, 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 particular meat cuts, carcass size and weight,

leanness of meat, fat levels in milk, egg colour, or labelling with particular information or in specified languages. Taken together, they tend to marginalize smallholders, and the local breeds they keep.

109. 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 shifting from wool to hair sheep.

110. 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).

111. Experience from former Soviet countries indicates that reduced demand for a specific product threatens breeds specialized on this product while a general deterioration of conditions can stimulate the use of local multipurpose breeds. Loss of inputs and markets due to the break-up of the former Soviet Union led people to return to more traditional breeds, such as local fat-tailed sheep (which can graze better under the snow), Downy goats, and meat horses instead of cattle (Kerven and Lunch, 1998). 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 (FAO, 2007d).

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

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

Control of land, water and livestock

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

115. The expansion of cropping into former rangelands – often furthered by subsidies for power, fertilizer and high-yielding crops – means that livestock keepers have fewer areas to graze their animals. 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 areas now being farmed are often unsuitable for cropping in low-rainfall years or when the groundwater level sinks due to overuse of water, leading to problems of poverty and food insecurity among the farmers as well as the pastoralists they have displaced.

Policies and animal health regulations

116. National politics and policies have a major effect on the livelihood of livestock holders and the conservation of breeds. Due to the lack of recognition of the contribution of small-scale livestock keepers and pastoralists, policies commonly further large-scale production, disadvantaging small-scale keepers and pastoralists. Settlement policies force pastoralists to give up nomadic lifestyles, with negative consequence for their breeds and environments.

117. Projects and policies aiming to support small-scale and pastoral livestock keepers and conserve the environment can also have unintended adverse effects on livestock keepers. An example of this is the promotion of water holes in pastoral areas, which has induced pastoralists to reduce their movements, leading to overgrazing around the water holes (e.g. Homann, 2005). 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 (FAO, 2007e). 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).

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

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

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

Changing lifestyles

121. Changes that are otherwise to be applauded may reduce the ability of livestock keepers to maintain their lifestyle and their breeds. The reasons presented earlier for the decline of the Muturu cattle (Box 13) shows that sending children to school can conflict with the need for labour to herd animals. School attendance not only competes for the children’s time, but also tends to alienate children from their own culture. The temptations of modern life, broadcast by the media to the remotest corners of the globe, decrease the interest of young people in continuing their parents’ lifestyles. Those who would like to continue do not see how they can make a living from livestock keeping, given all the adverse forces.

122. Commercialization affects breeds more directly. From being an integral part of a culture – to be preserved simply because they are part of that culture – livestock breeds are coming to be regarded more as a source of income. The Raika pastoralists of Rajasthan used to refuse to sell their female camels, but declining amounts of grazing and high prices have induced them to send their female camels for slaughter. In Togo, West Africa, the Tamberma agropastoralists traditionally keep the

Somba breed mainly for ritual purposes and in small numbers (up to ten), so that they can be protected inside their compounds. Animals of this breed are necessary for dowries and sacrifices to the ancestors. The Somba cattle also played a role in maintaining the spiritual balance of a family. But now the need for money to pay for education and medical care has changed the attitude towards cattle keeping and reduced interest in this breed (FAO, 2007g).

X. MOTIVATION TO KEEP A BREED

123. Livestock keepers may continue using and maintaining their breed for a number of reasons – mostly livelihoods. In some cases there may be a sense of custodianship. 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 system and ecosystem in which their keepers live.

Survival of traditional production system and access to natural resources

124. 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.

125. So access to grazing land and natural resources and the survival of the traditional production system are key to the survival of the breed. That does not mean preserving it without changes. Indeed, changes are necessary if livestock keepers are to make their way out of poverty. Ways need to be found to enable small-scale and pastoral livestock keepers to continue managing their breeds in a way that conserves the genetics but improves their standard of living. In Nepal, for example, Barawal 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 (FAO, 2007h).

Sense of custodianship

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

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

- In the Lao People's Democratic Republic, indigenous chickens are important in traditional weddings in which bride and groom share an egg as symbol of love and solidarity (FAO, 2007i).

Access to appropriate services

127. 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.

128. It is often down-to-earth things that can help make services appropriate to smallholders. Examples are the employment of female extensionists for livestock mostly kept by women, and the development of vaccines that do not require constant refrigeration, are easy to administer and are packaged in small batches so that they can be applied in difficult-to-reach areas by trained community vaccinators.

129. Pastoralists' mobile lifestyle adds another problem for services provision for humans and animals. It is a challenge for governments to design services that suit such conditions: many do not even try, but instead attempt 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 the pastoralist communities (Catley *et al.*, 2002; The IDL Group, 2003), and so on. More such initiatives are needed if pastoralism is to remain a viable lifestyle option for the Earth's vast rangelands, and if the breeds that pastoralists maintain are to survive.

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

131. Helping keepers of traditional breeds to raise awareness of the importance of local breeds and make their breeds known through information materials, exhibitions and other public-relations measures can motivate new keepers to “adopt” such breeds (see also the following section on *Institutional support*).

Institutional support

132. 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 NGOs such as Rare Breeds International, SAVE Foundation and national rare breed societies. The efforts and enthusiasm of a few dedicated breeders seem to be essential in the initial stages. In the long run, on the other hand, breed and breeders' associations are important tools to reach a critical mass and conserve the breed. It helps if a breed has commercial potential. In the United States of America, for example, the survival of Randall cattle is due to the efforts of a few individuals. When the number of animals and breeders increased, a breed association formed. This, and the potential of the breed for low-input dairy and beef production, stimulated demand for the breed and helped assure a market (Sponenberg *et al.*, 2007).

133. Breed associations for local breeds are rare in the developing world. Few examples are reported and mainly from South Africa. There, the Nguni Breeders' Cattle Society (Scholtz and

Ramsay, 2007) has helped to preserve Nguni cattle. Key to this success was the emphasis on making the breed competitive rather than striving for uniformity and breed standards. Furthermore, to involve emerging communal black farmers as stud breeders, the society developed a special recording scheme allowing registration of animals in the absence of written pedigree records (see Box 14). Another engaged South African association is the Damara Sheep Breeders' Society of South Africa (Du Toit, 2007).

Box 14. Establishing a herd book in the absence of written pedigree information: the Nguni Breeders' Cattle Society

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

Economic incentives

134. 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, payments to livestock keepers for services, and subsidies for maintaining breeds.

Access to markets

135. Livestock keepers will invest in breeding animals for particular products (milk, meat, draught) only if markets for these are assured. Yet often such markets are far from certain. In many areas, security problems, corruption, quarantine restrictions, lack of roads and transport, inadequate communications infrastructure, and a lack of physical market facilities hamper trade and make regular supply of live animals and products difficult. Relations in the marketing chain are typically weak: livestock keepers are often unorganized; they lack marketing associations; and they rely on traders who come to buy animals on an individual basis. There are also few market institutions in the livestock arena: animals are sold without being weighed; market information is scanty; quality grading is lacking; and there are few services such as extension and health services that might improve the quality of the marketed produce (Williams *et al.*, 2003; KIT and IIRR 2008). Overcoming these problems would make it easier and more profitable for livestock keepers to market their animals and the products and services they provide.

Promoting niche markets

136. 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 taste and structure of the meat, but also the vegetation consumed, the slow extensive production system, or special processing of meat or cheese (Kuit and van der Meulen, 1999; Rook *et al.*, 2004).

137. 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 herds 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 NGO, has persuaded the Indian government to permit camel milk to be sold, opening the way to commercialization of this product (Köhler-Rollefson, Rathore and Mathias, 2008). Awareness about the business potential of camel milk resulted in a steep rise in prices for female camels within a short time span and put a stop to the sale of female camels for slaughter.

Payment for biodiversity and landscape maintenance

138. 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 breed, and not exotic ones. The payment for these services can make the difference for low-input production systems.

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

Supportive policies

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

141. Until now small-scale and pastoral keepers are rarely represented in national and international decision making bodies and can voice their concerns only with the help of outsiders. But as they are the owners and keepers of the breeds to be conserved, it is crucial to give them a voice in policy-making.

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