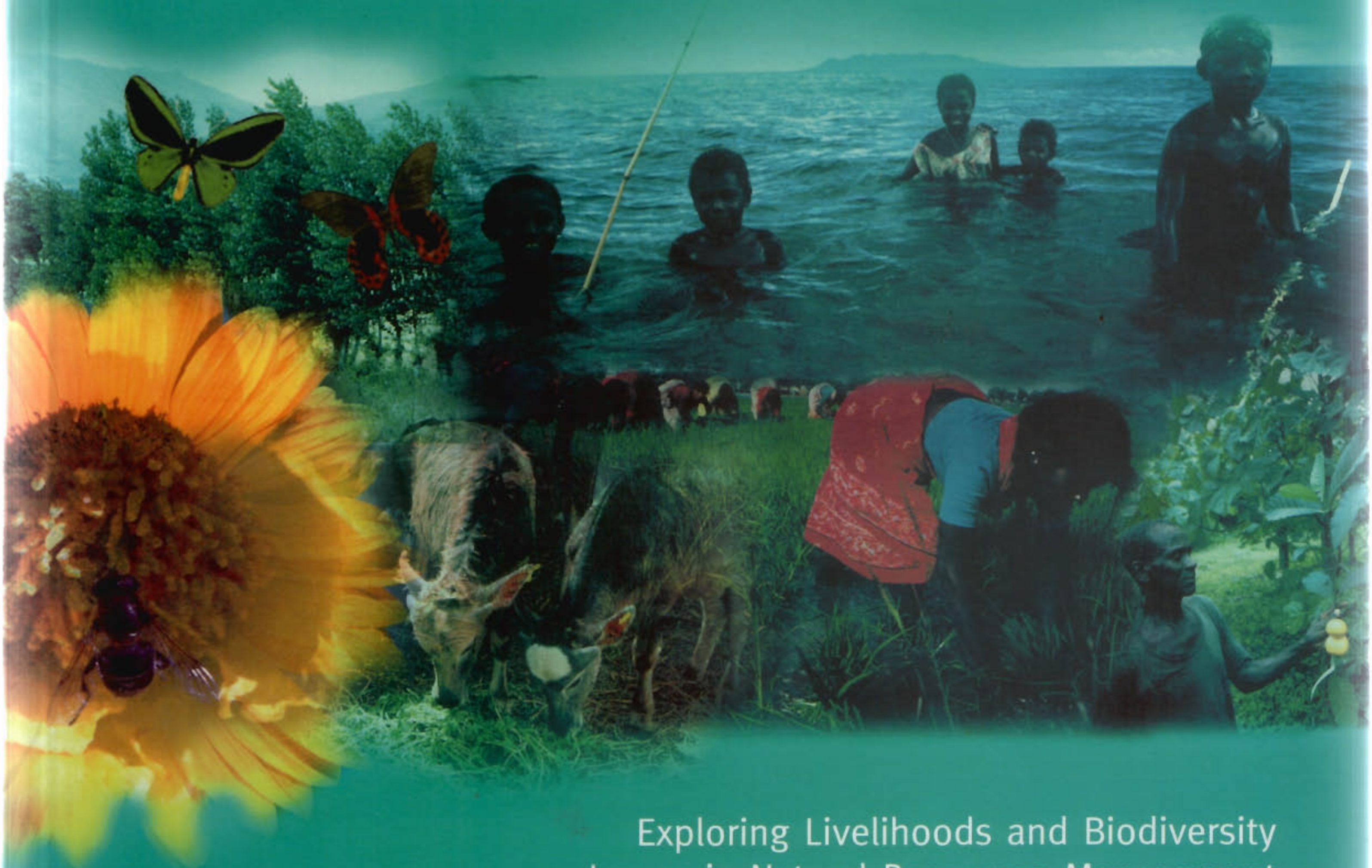
Living Off Biodiversity



Exploring Livelihoods and Biodiversity Issues in Natural Resources Management

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Chapter Four

" 'til the cows come home "

Why Conserve Livestock Biodiversity?

Roger Blench

Contents

1 Introduction

1.1 General concepts of biodiversity and their relation to domestic animals

The general methodological and theoretical frameworks for the conservation of biodiversity were developed within the context of wild animals and plants, and their application to domestic animals involves significant adaptations of some of the principles involved. Biodiversity, as usually defined, has three levels, gene, species and ecosystem. This classification is better adapted to 'wild' species and environments than to crops or domestic animals and for the purposes of this discussion can be reformulated as follows:

Wild	Domestic
Gene	Expressed as differences in breed, e.g. Criollo vs Friesian cows
Species	Herd or flock, e.g. cows vs sheep
Ecosystem	Farming system

There are, however, some important asymmetries between wild and domestic biodiversity. In the case of livestock, the most important is that 'traditional breeds' exist within farming systems managed by people, and thus cannot be simply 'conserved' in the way an ecosystem can be protected. Farming systems are anyway dynamic, and their conservation has ethical implications related to somehow 'freezing' development. Similarly, many breeds or races are quite recent constructs, unlike species, and conserving them may well be low priority (see section 1.3). This paper considers the issues surrounding livestock biodiversity, both in terms of the state of knowledge and in relation to policies relevant for the design and monitoring of projects.

1.2 Domestication, farming and taming

The process of domestication can be characterised as adapting the genetic make-up of a species to the needs of human society, a process often deleterious to the survival aptitudes of that species in the wild. Table 2 sets out the major species of domestic animal with the region of original domestication where this is known, as well as the approximate date. Broadly speaking two related processes seem to have been at work, increasing the intensity of symbiosis and the management of species that form herds. The dog, probably the earliest domesticate, is found in campsites in Iraq by 14,000 Bp. It is likely that wolves originally formed a symbiotic relationship with humans, guarding against predators and being encouraged by scraps. Selection for less aggressive traits in canids has been shown rapidly to produce domestic characteristics (Box 1).

In the case of herd or flock species such as cattle, sheep, goats, camels, donkeys and yaks, the original process of domestication may well have been the management of wild herds. By taming individuals in the camp, it is possible to re-introduce them into wild herds and use them to direct it away from predators, into corrals, or towards water. Archaeological evidence for early domestication often remains controversial because there is little or no osteological differentiation between wild and domestic ruminants. True domestication may have come with the evolution of dairying, which would provide a strong incentive to select for temperament. Species that are not milked, such as the donkey, have often maintained semi-domestic status up to the present in some regions.

Box 1 The Siberian silver fox and the domestication of the dog

A 40-year experiment in Siberia with the silver fox has shown how rapidly a domesticate can be created by careful selection from a large gene pool. The fox is a wild, extremely aggressive species that survives in the snows by ruthless predation. A large number have been kept in cages and the few animals that show tendencies towards co-operation with humans selectively allowed to reproduce. Within seven generations, the phenotypic characteristics of the fox change markedly, showing a flatter face and changes in coat colour together with a more friendly disposition towards humans. This suggests that the process of wolf domestication in ancient Iraq may have proceeded along the same lines.

Source: *Equinox*, Channel 4, Broadcast

Apart from the pig, yak and reindeer, the major species of domestic animal no longer have wild relatives in Eurasia and America. Traditional pastoral practices did not discourage interbreeding with wild forms, since this maintained diversity, prevented inbreeding and thus falling productivity. Modern breeding systems, by contrast, tend to ensure that genetic introgression from such relatives is not a significant factor in variation. Geneticists may make use of wild forms to breed for specific economic characteristics, but not simply to maintain diversity.

Taming, on the other hand, implies temporarily adapting a wild species to human requirements without altering its genetic make-up. The evolution of a social niche for pets may become a prelude to domestication; cachet can attach to taming wild animals such as cheetahs, so that the process becomes an end in itself. The taming of wild animals, especially birds, for the table is already well-documented in the iconographic records of Ancient Egypt (Brewer *et al.*, 1994). Taming also implies some selection, as many animal species revert to wild behaviour patterns once adult.

Experimentation continues, particularly in sub-Saharan Africa, and there are 'new' domesticates, wild-caught animals initially 'finished' in captivity such as the giant rat (*Cricetomys*), the grasscutter (*Thryonomys*) and the African land snail (*Achatina*), but now being selectively bred in captivity (Blench, in press a). In southern Africa, many of the larger antelopes are now kept economically together with conventional livestock and the falling price of game meat is one clear sign of the increasing efficiency of this process (Mason, 1984). Farming without domestication is also being applied to reptiles such as crocodiles and iguanas (Vietmeyer, 1991). As this market becomes more competitive, it is virtually certain that producers will be forced to select for desirable characteristics and that new domesticates will arise.

The wild relatives of all the major mammal domesticates have either disappeared or are confined to highly localised reserves. The donkey was domesticated in Africa and has interbred with wild ass populations in historic times. With the probable elimination of the last Somali wild asses, this process has come to an end and the wild relatives of the donkey are no longer a resource for maintaining genetic diversity. The guinea-fowl is indigenous to Africa and has been only partly domesticated. In west-central Africa, guinea-fowl are kept in the compound, grow fat and have little tendency to fly away, but in eastern and southern Africa they are still caught in the wild.

Box 2 Wild and domestic: caribou and reindeer

Reindeer, *Rangifer tarandus*, are found all across the circumpolar regions and their range interlocks with the wild form, the caribou. Although reindeer pastoralism is now common across northern Eurasia, there is evidence to suggest that this represents a recent evolution. In the past, peoples such as the Saami and Yakut, may well have managed wild herds through tamed individuals. Even today, hunter-gatherers, such as the Nenets of Siberia, prefer to trap caribou rather than herd them. There are no genetic barriers between caribou and reindeer, and in regions where caribou are still numerous, such as Chukotka, herds may 'kidnap' females from domestic herds for breeding purposes.

Table 1 Management versus domestication

Kept	Farmed	Domesticated
Guinea-fowl, rock pigeon, elephant, reindeer, capybara, vicuña	Guinea-fowl, spur-wing goose, ostrich, giant rat (*Cricetomys*), land snail (*Achatina*), marine turtle (*Chelonia mydas*), iguanas, bees, silkworms, cochineal beetles, lac insects	Cattle, sheep, goats, pig, dromedary, yak, buffalo, llama, alpaca, horse, donkey, dog, cat, guinea-pig, pigeon, chicken, goose, turkey, guinea-fowl, duck

NB. Where recorded, 'English' names are given, but many of these are local and not well-known; the scientific name is thus also given.

Table 1 illustrates some species of animal that illustrate patterns of variable domestication according to geography and where the 'domestic' types are constantly subject to outcrossing with 'wild' relatives.

1.3 Breeds and research station constructs

The breeds most relevant to biodiversity concerns are those that have co-evolved with a particular environment and farming system and represent an accumulation of both genetic stock and management strategies in relation to a particular environment. These have usually taken a long time to evolve and have characters, such as humidity-resistance, that cannot be easily developed. Breed, however, is a broad church, covering ornamental breeds of dog and rabbit and also what may be called 'research station constructs'. Many catalogues of breeds include recently developed crosses between, for example, a local breed and an exotic. This is particularly the case in the former Soviet Union where many existing 'breeds' have no natural habitat but only persist in fields outside research stations (see Dmitriev and Ernst, 1989). The second FAO Worldwatch List (Scherf, 1995) includes a large number of breeds of turkey and goose in sub-Saharan Africa. These are not indigenous species and reading the text, it appears that all are twentieth-century introductions, some of which have never left the research station. There appears to be no significant case for the conservation of such breeds except at the level of individual country priorities.

1.4 Asymmetry between livestock and crops

It is often tempting to treat crops and livestock together and somehow apart from 'wild' fauna and flora. Despite being often treated together, livestock contrasts strongly with crops in the pattern of biodiversity and conservation status. The main factors are:

- absolute numbers of domestic animal species are very low compared to plants;
- breed diversification can be high in species kept principally for leisure pursuits or aesthetic reasons (e.g. horses, dogs, rabbits) especially in the developed world;
- breed diversification is highest in the developed world because of amateur interest, but many breeds are not preserved for economic reasons;
- introgression from wild relatives of domestic animals is rare;
- one subclass, insects, is not considered biodiverse as a domestic animal.

Even more than crop plants, livestock exists within a matrix of the farming system, and this makes all types of *ex situ* conservation problematic. Genes are useful in context, rather than in general. For example, some breeds of cattle are highly adapted to grazing in flooded grasslands, such as the Criollo of Brazil and the Kuri of Lake Chad. This adaptation is of limited use to the great majority of cattle producers who do not operate in swamps.

2 Biodiversity in domestic stock world-wide

2.1 The major domestic animal species

Table 2 sets out the major domesticated animal species, together with their putative wild relatives and their probable area of original domestication. Mammals constitute the dominant genera of domestic animals, and of those, the majority are ruminants. No reptiles are included, although there are some farmed reptiles, notably the crocodile. Birds represent the other major component, with some domesticated insects. There is nothing to suggest that the genetic diversity of domesticated insects, such as bees, silkworms, lac insects and the cochineal beetle, are threatened and they are not considered further here.

2.2 The major protected and semi-domesticated species

Table 3 sets out the major farmed animal species that have not yet been substantially altered genetically through the domestication process. It combines both the species found in large-scale commercial enterprises and typical 'village' enterprises. The table makes it clear that:

- the overall number of species of domesticated animals is small;
- the vast majority are mammals in terms of biomass;
- a few Eurasian species, cattle, sheep, goats and pigs, dominate a large proportion of the world livestock economy;
- despite a pre-Columbian culture of domestication, the turkey is the only New World species to make a major impact on the Old World.

The reasons for these imbalances have been much debated, and Diamond (1997) has recently used this, combined with the co-evolution of pathogens, to explain Western European cultural and economic dominance. Even without subscribing to such a theory, it is evident that a long experience of adapting animals to inherently inimical environments, combined with political hegemony, allowed Eurasian species to colonise other continents and drive out or massively reduce the importance of indigenous species. In other words, it may be that the potential of llamas, vicuñas and guinea-pigs was not necessarily less than the introduced ruminants, but that they were simply associated with defeated cultures. Had the same intensive investment in promotion been applied, they might well be similarly widespread, as the contrasting situation of New World cultigens, such as cassava and maize, suggests.

2.3 Levels of diversity and the continuing scientific agenda

The uncovering of levels and layers of biodiversity is a dynamic process, especially in terms of DNA research. Phenotypic classifications of diversity often produce results very different from those emerging from the laboratory bench. In recent years there has been substantial research on the mitochondrial DNA (mtDNA) of domestic cattle (see summary in MacHugh *et al.*, 1997). This research showed, somewhat surprisingly, that cattle were domesticated twice, once in India and once in the European-African area. Even more recently, research has begun to focus on microsatellite or nuclear DNA, i.e. paternally inherited, which generally shows more variation. In the case of African cattle it appears that, while the different breeds have relatively uniform mtDNA, their nuclear DNA shows considerably more variation. The likely explanation is that there was a movement of male zebu from India and perhaps also across the Sahara in prehistoric times, brought in to breed with locally adapted females.

Similarly perplexing findings have arisen in the area of wild animals; all the cheetahs in Africa appear to have similar mtDNA, presumably indicating a 'bottleneck' in a relatively short period in the past. White rhinos, in contrast, despite being defined as one species, have such genetic variation between geographical areas, that they would be classified as several species at the genetic level. The implications of these results are far from clear and accelerating research is likely to produce more surprising data. For example, some newly available data on the Yakut cattle of Siberia suggests they are genetically very remote from other cattle, and perhaps should be treated as a different species, something that is not at all obvious from a simply phenotypic characterisation (David MacHugh, pers. comm.). However, two important points emerge when considering practical policy implications:

- continuing scientific research is currently producing a changing picture both of the origins and the incidence of genetic diversity;
- the classic phenotypic characterizations that have dominated biodiversity evaluations may not agree with DNA results and even sub-types of DNA can producing differing results.

It is clear that policy must evolve to reflect this.

3 The present situation: legal, institutional and social and economic

3.1 Legal

Virtually no country in the world has legal constraints on the conservation, or otherwise, of livestock genetic resources. Laws concerning intellectual property rights (IPRs) are usually framed in terms of plant resources. Even these have proved hard to enforce unless multinationals voluntarily engage in agreements with governments, usually for public relations purposes. Ethically, there is little doubt that the livestock genotypes bred over long periods by communities are in a certain sense their 'property'. Livestock, however, are highly mobile, especially those owned by pastoralists, and often spread over a much greater area than crop cultivars. The potential to identify and make good claims against large companies for the value of genetic resources would seem minimal. In a remarkable fit of *hubris*, a US agribusiness company recently patented tef, the staple grain of Ethiopia, and similar actions, both legally dubious and ethically disingenuous, can be expected in the future. No such action has yet been taken in respect of livestock breeds, since the genetic qualities that are most valuable in developing country livestock are rarely those valued by the large livestock companies.

3.2 Institutional: conventions and international agreements

Domestic animals are the one class of living creature apparently largely ignored by international, regional and species conventions. The exhaustive list in Groombridge (1992: 479 ff.) lists none and Henson (1992) makes no mention of them. The Convention on Biological Diversity (CBD) of 1992 makes specific mention only of plant genetic resources. Following this, however, FAO organized a series of expert consultations to initiate the 'Global Programme for the Management of Farm Animal Genetic Resources' in 1993 and is developing the Animal Descriptor system used for AGRI (Animal Genetic Resources Information). In 1995, the FAO Conference suggested the mandate of the Commission on Plant Genetic Resources should be widened to include domestic animals. In January 1997, the Ad Hoc Group of Experts on Animal Genetic Resources recommended the establishment of an intergovernmental mechanism. The first Intergovernmental Technical Group on Animal Genetic Resources met in September 1998[1].

At the World Food summit in 1996, governments, in affirming the Rome Declaration on World Food Security and the World Food Summit Plan of Action, recognised the importance of the sustainable utilisation of animal genetic resources. Similarly, at the third meeting of the Conference of the Parties (COPIII/11) to the CBD they acknowledged the importance of the Global Strategy for the Management of Farm Animal Genetic Resources and gave strong support to its further development.

This might seem encouraging, but the reality is that these are voluntary systems for interested parties, and individual countries may feel released from the obligation to establish policies or support institutions

[1] No proceedings or summary are yet available for this meeting but informal discussions suggest the conflict between the supporters of disappearing breeds and those who believe the modern livestock production techniques are the appropriate response to feeding rural populations remains a subject of intense debate.

Table 2 Domestic animals and their wild counterparts

Domestic form		Wild progenitor		Date and region of first domestication		Distribution of wild progenitor
Common	*Scientific*	*Common*	*Scientific*	*Date*	*Place*	
MAMMALS						
LAGOMORPHA						
Rabbit	*Oryctolagus cuniculus*	European rabbit	*O. cuniculus*	36BC	South Europe	South West Europe, possibly North Africa
RODENTIA						
Guinea-pig	*Cavia porcellus*		*Cavia aperea*	1000BC	South America	South America
CARNIVORA						
Dog	*Canis familiaris*	Wolf	*Canis lupus*	12,000BC	Iraq	Northern Hemisphere
Ferret	*Mustela furo*	Polecat Steppe polecat	*Mustela putorius* *Mustela eversmanni*	20 AD	South Europe	Europe USSR, China
Cat	*Felis catus*	Wild cat	*Felis silvestris*	1600BC	North Africa	Europe, Asia, Africa
PERISSODACTYLA						
Horse	*Equus caballus*	Wild horse	*Equus ferus*	3500BC	South Ukraine	Russia, Central Asia
Donkey	*Equus asinus*	African ass	*Equus africanus*	4000BC	Egypt	North Africa, possibly West Asia
ARTIODACTYLA						
Pig	*Sus domesticus*	Wild boar	*Sus scrofa*	7000BC	Turkey	Europe, Asia and North Africa
Llama	*Lama lama*	Guanaco	Possibly *Lama guanicoe*	5500–4200BC	Andean plateau	South America
Alpaca	*Lama pacos*	Guanaco	*Lama* sp.	?	?	South America
Dromedary	*Camelus dromedarius*	Dromedary	*Camelus* sp.	3000BC	West Asia	Asia, possibly North Africa
Bactrian camel	*Camelus bactrianus*	Bactrian camel	*Camelus ferus*	3000BC	Central Asia	Russia, Central Asia
Reindeer	*Rangifer tarandus*	Caribou	*Rangifer tarandus*	?	?	Arctic, sub-Arctic, (feral: Greenland, Iceland, South Georgia)
Water buffalo	*Bubalus bubalis*	Wild buffalo	*Bubalus arnee*	Not known	China/South East Asia	India, South East Asia
Cattle (taurine) Cattle (zebu)	*Bos taurus* *Bos indicus*	Aurochs —	*Bos primigenius* *Bos primigenius namadicus*	6200BC <4000 BC	Turkey India ?	Europe, Asia, North Africa India/ South East Asia
Yak	*Poephagus grunniens*	Yak	*Poephagus mutus*	Not known	Not known	Tibet, Himalayas
Mithan	*Bibos frontalis*	Gaur	*Bos gaurus*	2500BC		South and South East Asia
Bali cattle	*Bibos javanicus*	Banteng	*Bos javanicus*	Not known		South East Asia, including Borneo
Goat	*Capra hircus*	Wild goat	*Capra aegagrus*	7000–8000BC	West Asia	West Asia
Sheep	*Ovis aries*	Mouflon	*Ovis orientalis*	7000–8000BC	West Asia	West Asia
BIRDS						
GALLIFORMES						
Chicken	*Gallus gallus*	Red junglefowl	*Gallus gallus gallus*	8000BC	South China	North East Thailand
Turkey	*Meleagris gallopavo*	Wild turkey	*Meleagris gallopavo*	1500BC	Europe	Central-North America
ANSERIFORMES						
Goose	*Anser anser*	Greylag goose	*Anser anser*	<500BC	Europe, Central Asia	North Europe, North Asia to North West Africa
Chinese goose	*Anser cygnoides*	Swan goose	*Anser cygnoides*	<500BC	? China	Europe, Asia, North America, North Africa

Table 2 *cont.*

Domestic form		Wild progenitor		Date and region of first domestication		Distribution of wild progenitor
Common	*Scientific*	*Common*	*Scientific*	*Date*	*Place*	
ANSERIFORMES cont.						
Muscovy duck	*Cairina moschata*					Mexico to Peru and Uruguay
Mallard duck	*Anas platyrhynchos*			500BC		Europe, Asia, North America, North Africa
COLUMBIFORMES						
Pigeon	*Columba livia*	Rock-pigeon	*Columba livia*	3000BC		Europe, North Africa, India to Japan
INSECTS						
Honey bee	*Apis mellifera* and other *Apis* sp.			2000BC		Africa, Europe
Kermes	*Kermes ilicis*		*Kermes ilicis* and other *Kermes* spp.	<0 AD	Mediterranean	Mediterranean
Lac	*Laccifer lacca*		*Laccifer lacca*	?	India, China	North India to Yunnan, China
Cochineal bug	*Dactylopius coccus*		*Dactylopius coccus*	<1200AD	Central America	Americas
Silkworm	*Bombyx mori*		Possibly *B. mandarina*	2500BC	Asia	
Silkworms – other semi-domesticated species	*e.g. Antheraea pernyi, A. mylitta, Attacus ricini, Anaphe* spp.					

Source: adapted and expanded from Groombridge (1992: 390)

Table 3 Selected semi-domesticated species used or farmed

Name	Scientific	Used/farmed in	Native range	Reason for production
MAMMALS				
Elephant	*Elephas maximus*	India, Laos, Myanmar, Thailand	India and South East Asia	Work
Red deer	*Cervus elaphus*	World-wide	North Eurasia, North America	
Otter	*Lutra* spp.	China	Eurasia	Fishing
Pig-tailed macaque	*Macaca nemestrina*	South East Asia	South East Asia	Tree-climbing for fruits
Capybara	*Hydrochaeris hydrochaeris*			
Amazon river dolphin	*Inia geoffrensis*	Amazonia	Amazonia	Improved fishing
BIRDS				
Cormorant	*Phalacrorax* spp.	China	China	Fishing
Ostrich	*Struthio camelus*	World-wide	Africa	
Barn owl	*Tyto alba*	Malaysia	Eurasia, Africa	
REPTILES AND AMPHIBIANS				
Green turtle	*Chelonia mydas*	Cayman Islands, Réunion, Surinam	World Oceans	
Green iguana	*Iguana iguana*	South America	Costa Rica	
Frogs	*Rana* spp.	Asia	Asia	Food

Source: adapted from Groombridge (1992: Table 26.18) that would change the local and national situation. The situation is quite similar for crop plants, although the scale of voluntary activities is much larger. The reasons for this failure to engage with legislation and regulatory frameworks compared to, for example, wildlife, are less than transparent. However, it is clear that 'wild' animals have powerful emotional associations that 'farm' animals lack. Indeed public revulsion with intensive farming methods in much of the developed world reinforces the negative image of livestock. Moreover, many development agencies, comparing the productivity of traditional breeds with modern breeds, are yet to be convinced of the importance of conserving indigenous breeds; they may be characterised as obstructive antiquarianism in the task of ensuring food security. This is largely in contrast with wildlife or tropical forests, where almost all agencies are now convinced of the necessity for conservation.

Few countries have established national institutions specifically to conserve livestock breeds[2]. Livestock breeds are either conserved by institutions such as universities, where they are kept for research purposes, or by research stations, where they are typically kept to produce crossbreeds. In almost all cases, attention is paid to large ruminants rather than micro-livestock. This is problematic as priorities change, infrastructure collapses and what were once emblematic programmes fall into disarray and breeding histories are lost. IMF interference in the livestock production systems of Mongolia represents a typical example (see Box 3).

Box 3 The IMF gets involved in animal breeding

Prior to 1991, all livestock in Mongolia were kept on collective farms and considerable attention was paid to livestock breeding and histories. Mongols have always paid great attention to bloodlines of domestic stock and this system was institutionalised in the communist era. Animals with records of quality offspring were organised in 'élite herds' and these were used for breeding. With the exodus of the Russians and the dominance of IMF advisers after 1991, the faintly socialist tinge of these farms was deemed to be unacceptable and the IMF insisted they all be broken up. The élite herds were dispersed, leading to a loss of bloodlines and turning the carefully accumulated records into waste paper. A very distinctive triumph of ideology over common sense, curiously something the West has always been eager to attribute to the communist world.

3.3 Social and cultural

Social and cultural forces are often the single most important factor in both diversifying livestock and developing breeds, although not in the original process of domestication. In the case of horses and dogs, their leisure and decorative value implies a strong pressure to conserve bloodlines and races in many cultures. However, similar forces are at work with ruminants in some parts of the world. For example, the Uda sheep, a Sahelian breed of West Africa, is largely kept by pastoralists in extensive transhumant flocks. The FulBe clan, Uda'en, that breeds the Uda exclusively, is named after them and individual flock-owners go to considerable trouble to maintain bloodlines. Analogous situations are found in other pastoral areas of the world; Mongol pastoralists consider that animal breeding should be subject to the same constraints as human marriage and historically, records were kept of an animal's genetic history in order to conserve its breed characteristics.

Another force leading to breed maintenance is social or geographical isolation. Curiously, this seems to be of greater importance in Eurasia than in the tropical world. England and Ireland have conserved unusual breeds in isolated places; North Ronaldsay sheep and Chillingham and Dexter cattle spring immediately to mind. This might suggest that New Guinea, with its dissected terrain and 800 languages, would have developed large numbers of pig breeds. However, the contrary is true; Melanesian pigs do not really form distinctive breeds. By contrast, in China it is estimated there are over 100 pig breeds (Peilieu, 1984). The likely explanation is that the principal motivation for pig production in Melanesia is to take part in the wide-ranging exchange systems that dominate the cultural systems of this region.

[2] An FAO initiative to do this began in South East Asia. Led by David Steane, the object has been to encourage 12 South East Asian countries to undertake a national breed survey and to prepare a national strategy for breed conservation. The first phase of this project recently ended and funding is being sought for a second phase.

Although there is some breeding of pigs for phenotypic characteristics, the constant exchange of pigs between villages has never allowed the long-term genetic isolation that allows distinctive local traits to evolve (e.g. see Groves, 1981).

A similar situation applies in West Africa, for example, with goats. Village goats are very similar across West-Central Africa, responding in coat colour and dimension to ecological conditions. So, although the reference books list 'West African Dwarf' as a typical breed, this is really an external construct. Goat producers make almost no effort to control breeding or bloodlines and if goats are adapted to sometimes extreme conditions, this simply reflects preferential mortality over time rather than distinctive breeding practice. This is not to argue that the genes that have allowed these goats to survive in extreme conditions on a poor quality diet are not of value. However, it is the genes rather than the goats themselves that are very numerous.

4 Why conserve livestock biodiversity?

4.1 General

The arguments for conserving livestock biodiversity are by no means self-evident, and many of those advanced for biodiversity as a whole have to be seriously modified to be effective. The arguments for general biodiversity conservation are economic, indirect economic (protection against epidemic pathogens), ecological, aesthetic, religious and ethical (Ehrenfeld, 1992; Ehrlich and Ehrlich, 1992). Some of these either do not apply to livestock or must be adapted radically to be of any value.

4.2 Future shock: evaluating productivity over time

The argument from economics is most commonly heard in the discourse of development. Broadly speaking, it has two elements: 'unmined riches' (i.e. undiscovered genetic resources of use to society) and relative outputs from land use systems. In the case of wild plants, the potential for new genetic resources is probably applicable, but its relevance to livestock is very doubtful. There are relatively few livestock species and breeds and they are relatively well-known; the likelihood that a little-known breed will have major economic potential is low, especially since the useful attributes of most 'traditional' breeds are rarely attractive to outsiders. The same is *not* true of species, of course; changing societal patterns can often make new domesticates attractive. The demand for stronger-tasting meat with a low fat content has begun to make antelope and ostrich domestication an economic proposition.

More attractive is the relative output argument, which is that high-input, high-output exotics are usually measured over a short time period which makes them look attractive compared with landraces. However, over longer periods, when subjected to environmental stress, subclinical pathogens and unpredictable feed supplement costs they are often less economic, if only because mortality is almost inevitably higher. In the case of the economics of large ruminants, for smallholders even one dead animal can be a catastrophic loss, because accumulated profits from outputs are unlikely to allow another animal to be bought. Collecting data to show this is difficult because project cycles are typically 3–5 years and this is barely time for exotics to be introduced and to reach their productive phase. The typical structure of evaluations does not allow sufficient time to elapse for a true comparison to be made, which would have to

Box 4 Measuring output over time

Non-diverse livestock production systems are profitable because revenues are sufficient to cover the cost of the special attention needed to preserve a uniform and non-climax vegetation. Where such effort relies on planted pastures, it may also benefit from economies of scale. Outputs from such systems are usually higher when measured over short periods of time against 'complex' diversified production systems such as those involving an elaborate interface with woodland. The greater the simplification of the genetic base, the greater the risk from pathogens. The likelihood of a pathogen eliminating the resource base and thereby causing major food insecurity is hard to quantify. The political pressure for food in the present can often outweigh the potential for famine in the future.

be over a period of a decade or more in the case of slow reproducers, such as cattle, camels and yaks. No absolute figure for such a period can be given as it follows the reproductive cycle of individual species, but it should allow a female to develop from birth to a maturity represented by several parturitions.

4.3 Livestock biodiversity and evolving pathogens

Livestock biodiversity creates a defence against pathogens; the more genetically uniform a population is, the more vulnerable it is to epizootics. Pathogens co-evolve rapidly with domestic species because intentional breeding tends to increase homozygosity. This is generally seen as a contribution to food security as desirable traits are spread in a population. This strategy is not without costs because transplanted animals face an alien array of pathogens. Many will be harmless, but it is possible for a 'super-pathogen' to evolve that could be extremely damaging to the imported animal. European domestic animals were carried to the New World where they were parasitised by the screw-worm. Screw-worm infestation initially had near 100% mortality but co-evolution over the last few centuries has made it less dangerous in the neotropics. However, in the Old World, it is transmitted rapidly between animals which have no resistance, and is almost always fatal. Screw-worm was carried to North Africa in the 1980s and was only eliminated after a costly and lengthy campaign (FAO, 1992). Further outbreaks must remain a distinct possibility. A recent similar case was the outbreak of poultry 'flu' in South East Asia requiring the destruction of millions of birds and affecting the livelihoods of many household and low-level producers.

Such outbreaks can also have unfortunate consequences for wild relatives of domestic animals. The rinderpest pandemics of the late nineteenth century entered Africa as cattle pathogens, but were also responsible for massive mortality among indigenous wild bovids, such as the buffalo which had no natural resistance.

4.4 Aesthetic

Aesthetic arguments suggest that diversity has a value in itself, that it is aesthetically desirable. Despite an absence of scientific or economic rationale, this has powerful appeal in the case of 'wild' plants and animals; they should be conserved simply for their beauty. This has a limited but not trivial importance for livestock: all over the developed world, private associations conserve rare breeds for essentially aesthetic reasons. In the case of some types of working animals or pets, such as horses, cats and dogs, private resources devoted to breed conservation predominate.

The consequence, however, is that rare breeds are being conserved in the one place where their particular traits are no longer essential, i.e. the developed world. This is not to say that private associations may not become a force in the future in the developing world, but any programme that derives its intellectual underpinnings from aesthetics is subject to fashion and changing opinion and thus is not a sustainable strategy.

4.5 Ethical

Ethical approaches to nature and the environment have a long history in human society, especially in parts of Asia. Animals and plants must not be killed because they are part of a larger spiritual web. This has a strong historical association with food taboos, making vegetarianism a prestigious behaviour in South Asian society, for example. Even in India, where prohibitions on eating beef may have previously had a passive role in maintaining cattle biodiversity, specialised dairy breeds are rapidly displacing older races. Ethical arguments have a strong emotional appeal but remain extremely culture-bound; in pluralistic economies ethical approaches often give way to commercial interests.

4.6 Livestock biodiversity and poverty

Projects and development aid for livestock have historically focused on large ruminants, and tend not to focus on work animals or small species (or 'micro-livestock', to adopt Vietmeyer's felicitous term). The only significant exception to this is occasional chicken projects, and even these have been dominated by attempts to establish large-scale intensive poultry production. These agendas have been wholly set by the priorities and economies of developed countries, reflecting both their research structures and commercial interests. The most notorious example of this is probably ILCA (the so-called 'International

Livestock Centre for Africa'), a CGIAR centre which refused to countenance research on animals other than cattle, sheep and goats, ignoring key African domesticates and work animals such as donkeys, camels and all types of poultry.

If poverty and sustainable livelihoods are the key agenda, and even if they are not but the priority is to work with species important to the majority of rural farmers, then the evidence is extremely strong to suggest that these priorities are very skewed. Most poorer households depend on a scatter of small species for protein, with the slaughter of cattle or sheep as an occasional festival meal. Micro-livestock often do not have to be fed, do not require substantial labour inputs and do not require access to land beyond the backyard. Sale of individual animals can provide small cash sums without threatening household capital in the same way as the sales of larger animals.

In many regions of the world where livestock are an important element in overall subsistence, large ruminants belong to professional pastoralists or ranchers. Such systems make an important overall contribution to national meat and dairy supplies, but often the majority of their output feeds the cities. Pastoralists in both tropical Africa and Central Asia have historically made significant investments in breeding races of domestic animal appropriate to the environment they exploit and are constantly exchanging and adapting bloodlines to meet changing external conditions. Typically, animals are bred for their ability to survive subclinical pathogens and to digest poor and variable pasture with yields of meat and milk only a secondary consideration. Local breeds are thus a key element in trying to ensure food security.

Although traditionally New World indigenous species were used for a type of transhumant pastoralism, this has been largely replaced by ranching systems based on Eurasian ruminants. In the New World, much of the output from South America goes to supply the 'fast food' market of North America. This may be important in terms of the priorities of the civil servants with whom developers often have to deal, but not necessarily central to the concerns of those at whom their interventions are purportedly aimed.

Box 5 The expansion of micro-livestock in Nigeria

Livestock production in Nigeria has been historically dominated by ruminants and these have been the focus of both veterinary services and animal production extension. However, an extensive national survey in 1990/91 demonstrated that the preceding decades had seen a significant expansion of backyard species, both newly introduced and experimentally domesticated. Among these species were turkeys, rabbits, guinea-pigs, *Achatina* snails, turtles and giant rats. The principal reasons advanced for preferring these species were their low capital costs, the simplicity of feeding them with household scraps, the potential to keep them in confined spaces, the ease with which they were turned into cash, the absence of ritual accretions meaning that anyone could keep and sell them and the low veterinary costs. Poorer households were diversifying species to match the diversity of sources of their livelihoods.

Source: RIM (1992)

Similarly, the demand for cheaper food, as well as Northern consumption patterns may seriously impact on local access to diversity in the South.

While some poorer communities place great value on single species, such as reindeer for Lapps, and whales for Inuit, there is a often a strong correlation between poverty and a high degree of genetic diversity, both for livestock and crop plants. This has been subject to two differing interpretations:

(a) poor people keep a biodiverse range of species[3] because they do not have access to high-output breeds and would like to switch to these if resources were available; or

(b) because a range of species and breeds enables them to continue producing in uncertain environments and thus to manage risk effectively, as well as using a diverse range of outputs and permitting flexible allocation of labour.

[3] This does not contradict the previous observation that the highest density of breeds is found in the developed world. Rural households can map a range of low-input species against diverse capital and labour availability.

Interpretation (a) is clearly favoured by many development agencies wishing to promote exotics, crossbreeds and high-input systems. It also has the advantage of appearing to increase food security. However, interpretation (b) seems to be emerging from several decades of ethnographic study of rural subsistence systems, suggesting that poor rural households trying to ensure their food security are, above all, interested in minimising risk. The risks induced by natural phenomena, such as weather anomalies and insect or disease surges, have now been compounded by an increasingly unstable socio-economic environment, where sudden changes in policy can make their produce uncompetitive. Development agencies sometimes add to the risk by rapid changes in policy and a lack of adequate long-term support to introduced species or inputs. An analogous situation is found in the health sector where Western medicine does not replace a diversity of local remedies but is simply added to them, sometimes with unfortunate effects.

4.7 Crossed wires: when one type of biodiversity threatens another

Biodiversity is only a unitary concept in the minds of those who write vast syntheses. Out there, individuals and institutions have their own subset of biodiversity to promote and these are often in conflict with one another. All types of project, intervention or study must bear in mind the potential crossover effects, when promoting one subclass of biodiversity may have a negative impact on another. An example of this would be the conservation of sheep and goat breeds and the potential impact on wild caprids. Shackleton (1997) points out that wild sheep and goats are extremely threatened, even in relation to other mammals in similar habitats, because domesticated sheep and goats specialize on exactly similar pastures and thus compete directly with their wild relatives. Expansion in numbers and quality of pastoral caprids is likely to reduce habitat availability still further for the 103 species of wild caprid still extant. Similar problems have occurred with escape of farmed salmon and crustaceans, crossbreeding with their wild relatives. There is no simple answer to avoiding such conflicts except to be aware of their importance and to try and consider them at the stage of ptoject planning. However, this is an unusual case where co-conservation and making seasonal use agreements with pastoralists will not work. The only clear response can be demarcated protected areas and policing.

Similarly, promoting the interests of livestock can have extremely negative effects on plant biodiversity. Probably the clearest example of this is the creation of anthropogenic savannas, such as those in South America, where the tropical forest is burnt off to create ranches. However, this is not a new process; much of the present-day African savanna is similarly of human origin. High densities of single species can reduce grassland biodiversity dramatically, as has been shown both in the grassy uplands of Adamawa in West Africa and in northern Australia.

4.8 Decision paths

This untidy nexus of considerations may have the effect of blurring the case for or against the conservation of livestock biodiversity. To make practical decisions in a given project, research strategy or intervention, it is necessary to follow through on a decision path. There are a number of crucial considerations to make when evaluating a project proposal or trying to design a new project.

- Is the project genetically neutral or does it have implications for livestock biodiversity? In particular; will it increase genetic uniformity and thereby susceptibility to pathogens?
- What is the likely impact on livelihoods over a full reproductive cycle (see section 4.2), in particular, will external political and economic shocks negatively affect the overall value to the householder?
- Will it make unsustainable demands on vegetation/the environment?
- Is it single-product oriented and likely to affect total animal output negatively?
- Is it likely to affect the wild relatives of the species in question?

Livestock projects, even conventional ones, have a poor record of success, which argues for even greater care in the initial design phase.

5 Erosion and maintenance of livestock biodiversity

5.1 Livestock races and breeds: statistics and characteristics

The successive editions of Mason (1988; new edition in press) have previously been the most significant synthesis of global livestock breeds. However, presently the most comprehensive source of data on endangered livestock is the Worldwatch List maintained by FAO. Originally deriving from EEAP (European Association for Animal Production) data held in Hanover, this is essentially a database of significant genetic and production parameters of global livestock breeds, with particular emphasis on those at risk. This has been published in book form in two successive editions (Loftus and Scherf, 1993; Scherf, 1995) but it is represented most fully by the DADIS (Domestic Animal Diversity Information System) database[4].

Mason's book and DADIS depend largely on information supplied by national governments or their scientists, which can produce problems as a result of the recording of 'ghost' breeds through a failure to match up local names. Especially in pastoral areas such as the West African Sahel and Central Asia, individual breeds range over many countries and tend to have a different name in each region; in large, ethnically complex countries such as Nigeria, one breed may have several names. Similarly, they include both 'traditional' breeds and recent imports, the main threat to which is the intermittent financing of the research station. It is likely, therefore, that when the data are consolidated, the overall numbers of breeds will fall, especially for major ruminant species.

Despite these limitations, such data can provide a thoughtful overview of the global status of livestock breeds. Such an analysis is given in Scherf (1995) from which Tables 4 and 5 are drawn, showing threatened livestock breeds by species and region.

This shows that the developed world has both the highest numbers of overall breeds and the highest percentage at risk (North America shows a broadly European pattern of species and breeds). This reflects the historical situation of livestock in Europe with village-based production confined to distinct regions with an overall high population density. The high percentage 'at risk' reflects the massive changes in agriculture that have promoted specialised productivity above other values during the present century and have tended to drive out local breeds.

Table 5, showing breeds at risk by species, again illustrates the dominance of cattle, sheep and chickens in the overall pattern. It is very notable that the percentage at risk figures are consistently higher for poultry than for mammals. This must reflect the relative ease of adapting poultry to intensive production methods and the relative success of such methods in parts of the developing world. This has stimulated governments and development agencies to promote these methods heavily, thereby driving out high proportions of local breeds. The high percentage for horses indicates their falling significance as work animals.

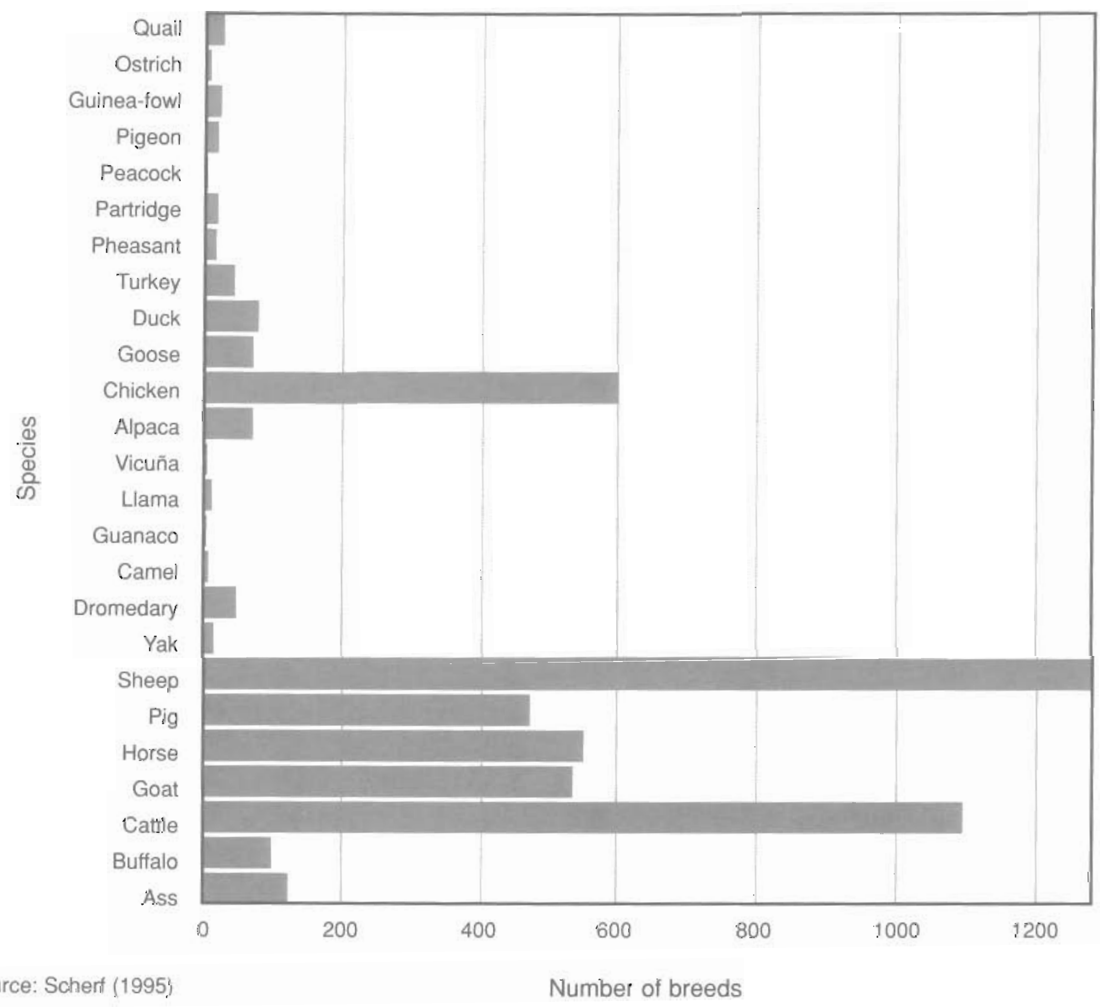
Figure 1 presents absolute numbers of breeds disaggregated further showing minor species. Figure 2 shows the ratio of breed numbers to global population.

5.2 Sources of erosion of diversity

Local races and breeds of livestock disappear for a variety of reasons, some representing rational responses to changing economic, ecological or social conditions, others pressure from government bodies, development agencies or simply an inappropriate understanding of short-term gains against long-term viability (see Box 6). Where communities voluntarily replace one breed with another or cease keeping livestock in order to concentrate on other activities such as tree-crops, it would be inappropriate to pressurise these communities into conserving breeds; this should be the role of national institutions. Livestock breed conservation is a public good, both nationally and internationally, and is a long-term investment in future genetic resources. In many areas

[4] The DADIS database is available on the internet at http://dad.fao.org/cgi-dad/$cgi_dad.exe/summaries. Version II of the DADIS database was due to be released on CD-ROM on 12 August 1998 and as a Web site on 7 September 1998.

Figure 1 Absolute numbers of livestock breeds (all species)



Source: Scherf (1995)

Figure 2 Ratios of livestock population in ('000) to total number of breeds

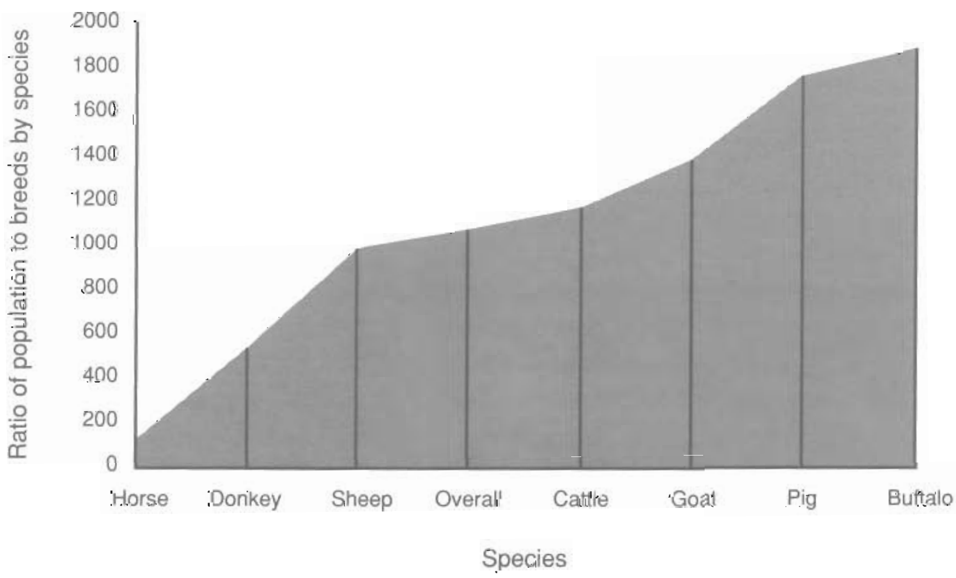


Table 4 Livestock breeds at risk by region

Region	Recorded	At risk	At risk (%)
Africa	396	27	6.8
Asia Pacific	996	105	10.5
Europe	1688	638	37.8
Near East	220	29	13.2
South-Central America	378	15	4.0
North America	204	59	28.9
World	3882	873	22.5

Source: adapted from Hammond and Leitch (1996)

Table 5 Livestock breeds at risk by species/genera

Species	Recorded	At risk	At risk (%)
Cattle	787	135	17.2
Buffalo	72	2	2.8
Yak	6*	0	0.0
Goats	351	44	12.5
Sheep	920	119	12.9
Pigs	353	69	19.5
Donkey	77	9	11.7
Horses	384	120	31.3
Bactrian	7	1	14.3
Dromedary	50	2	4.0
Alpaca	4	0	0.0
Llama	3	0	0.0
Guinea-pig	?	?	?
Duck	62	29	46.8
Turkey	31	11	35.5
Chicken	606	274	45.2
Muscovy Duck	14	5	35.7
Goose	59	28	47.5
Guinea-fowl	22	4	18.2
Quail	24	16	66.7
Pigeon	19	4	21.1
Total	3851	872	22.6

Source: adapted from Scherf (1995)

*As Li and Weiner (1995) make clear this figure is for China alone and there are probably many more breeds in neighbouring countries, but these have never been characterized.

The totals in this table do not completely match Table 4 because some species in Scherf, such as the vicuña and pheasant, were omitted as not truly domesticated.

in southern Nigeria, rising prices of tree-crops such as cocoa and palm-oil have caused the communities to dispense with their traditional dwarf cattle and goats to concentrate on these profitable crops. This is a perfectly rational medium-term strategy, but it would be short-sighted of the national government to lose the genetic resource these livestock represent simply because of a temporary pattern in world trade. As to whether such a strategy is sustainable on the part of government, the analogy is not with an economic enterprise but an investment against unpredictable future developments. New antibiotics are expensive to discover and produce, and when discovered they may have to be reserved against future, still unknown epidemics. So it is with genetic resources.

Existing baseline data remain too imprecise to estimate the rate of loss, although this is possible in some developed countries. New breeds are always being created, especially by large livestock companies and on research stations, but this points to a fundamental asymmetry. A breed that has evolved over centuries in a particular socio-economic and pathogen niche cannot be 'replaced' by a modern breed, any more than a wild plant or animal that becomes extinct can be recreated in the laboratory.

The recent advances in cloning, first with sheep and then mice[5], could be significant for *ex situ* conservation strategies (see section 5.3.3), but it is more likely they will lead to further erosion. Just as foresters are increasingly using cloned trees for plantations since they can multiply the desirable qualities of an individual tree, so livestock producers may rapidly reach the same conclusion. Cloned domestic animals will lead to greater productivity for those in possession of the technology and will tend to make local breeds and production systems yet more unviable.

[5] Confirmation that 'Dolly' the sheep is a true clone of an adult and the cloning of mice in Hawaii have recently been published in *Nature* (week ending 21 July 1998).

Box 6 What goes around, comes around

The Nguni of South Africa, is a small but hardy local cattle breed that resists disease and thrives on poor pasture. In the 1960s and 1970s, the government forcibly 'upgraded' most of the cattle in the homeland areas, by crossbreeding local cattle with 'improved' European breeds. At the time, they also supplied the inputs (vet drugs, dipping) needed to keep these high-input animals alive. In the 1980s, large-scale farmers realised that local breeds had advantages, bought them from research stations (where they had been conserved) and turned them into a high-input breed with stud books, etc. In the 1990s, with the changes, the whole system of input supply to rural areas broke down and the crossbred cows in local hands then began to die or severely underproduce. By this time, however, all the stock of true-bred Nguni cattle was in the hands of the white farmers and the prices had gone sky-high, so African farmers could not afford to restock with their 'own' cattle. Now the farmers are clients of aid projects to return Nguni to the villages. Not only has their genetic property been stolen, but they have become impoverished and have to suffer the indignity of aid projects to return these breeds to the very same villages whence they came.

5.3 Institutional strategies for conserving livestock biodiversity

5.3.1 General

Table 7 summarises the main strategies available for conservation of livestock biodiversity. The advantages and disadvantages of these are considered in more detail below.

5.3.2 *In situ* conservation

From what has been said, it will be clear that the most desirable solution is *in situ* conservation, where livestock function within the production system and environment with which they have evolved. Livestock, as crops, can come under pressure from external forces and a breed can be lost through introgression or as a result of development or private sector projects without any clear motivation. Livestock have a much longer cycle than crops and it may take 10 years for it to become clear to farmers that the high level of inputs required to keep an 'improved' breed productive are uneconomic. In that decade it is possible for all the original genetic material to disappear.

In situ conservation is thus the most desirable situation. Nonetheless, there are various approaches, each of which has its advantages and disadvantages (Table 8).

In situ conservation can also become a default situation, whereby communities keep their traditional breeds simply because no strong forces oppose them. In many countries, the powerful influence of the livestock companies may be said to constitute such a force. Traditional strategies such as crossbreeding and the introduction of high-yielding exotics are being amplified by programmes of artificial insemination (AI) and embryo transfer. Emphases on single production traits, such as meat, milk, eggs, etc., suggest strongly to government officials, NGOs and private farmers that indigenous breeds need to be 'improved' or 'replaced' and this proposition is re-enforced by glossy brochures and posters. Rural householders know considerably more than those in government institutions and are less likely to be swayed by the seductions of glossy brochures.

5.3.3 Conventional *ex situ* conservation

Conventional *ex situ* conservation has involved the freezing of semen and embryos. It has the advantage that it is relatively cheap to collect and maintain and is not subject to genetic drift and the vagaries of management. Moreover, stored products can relatively easily be exchanged with other institutions around the world. This process is more developed for some species than others (e.g. viable embryos of pigs and poultry cannot be thawed out successfully once frozen), but is likely to increase in importance even for minor species, because of several disadvantages.

- Maintenance of cryopreservation requires stable inputs such as electricity and liquid nitrogen which may not be available in many developing countries. They are also vulnerable to political instability and natural disaster. This may mean that the developed world dominates in cryopreservation and thus perpetuates inequity unless the terms of reference are carefully established.
- It has no visible benefit which may lead to it being cut in periods of financial austerity.

Table 6 Factors accelerating erosion of livestock biodiversity

Factor	Description
Development interventions	Preference given to high-input, high-output breeds developed for benign environments. Commercial interests in donor countries promote use of relatively temperate-adapted breeds and create unrealistic expectations in developing countries.
Specialisation	Emphasis on a single productive trait, e.g. dairying, leading to exclusion of multi-purpose animals.
Genetic introgression	Crossbreeding and accidental introgression leading to loss of indigenous breeds.
Technology	Machinery replaces work animals.
Biotechnology	Cryopreservation equipment inadequate to store germplasm of threatened breeds. Artificial insemination and embryo transfer rapidly displace indigenous breeds.
Political instability	Can eliminate local breeds owned by vulnerable populations.
Natural disaster	Floods, drought and epizootics preferentially affect remote or isolated human and livestock populations.

Source: adapted from Hammond and Leitch (1996)

Table 7 Livestock biodiversity conservation strategies

Biodiversity conservation strategies	Comments
Government station, conserving or multiplying	Variable management quality
NGO, charitable institution, university, private individuals conserving or multiplying	Contingent upon economic and social conditions in individual countries
Legal restrictions or financial inducements to support indigenous breeds	Rarely tried and modalities not worked out
Protection of wild or feral population	Only applies to some species
Cryopreservation of semen or embryos	Depends on continuously effective infrastructure and likely to remain North-controlled

Table 8 *In situ* conservation strategies

Category	Advantages/disadvantages
Community	Research identifies and removes the constraint leading to breed disappearance. Animals remain within their original context, but long-term subsidies probably required. Threats may come from policy or socio-economic shifts.
Zoos/farm parks/ research stations	Animals are kept visible to the community, healthy and subject to recorded breeding programmes. However, plucked out of their socio-economic and disease context, the features for which are valued may be eliminated. Threat from inconsistent management in some countries.
Living genebanks	Specialized farmers nominated to keep herds/flocks of endangered breeds. Long-term subsidies probably required. Same disadvantages as zoos, etc.

Cryogenic populations do not adapt to changing disease and environmental stress and thus, given the long lead-time required to revive a population, many of the traits for which they were originally conserved may be of limited value.

- Cryogenic conservation is better adapted to the conservation of genes which can be preserved in small samples, than breeds where the relative frequency of genes is relevant.

5.3.4 Hi-tech *ex situ* conservation and monitoring

Recent scientific advances have made more intricate possibilities available for conservation and monitoring. Cloning is presently carried out in real time, since the goal is not aimed at breed conservation. However, it is clear that the same technology could be adapted to clone extremely rare breeds or individuals containing valuable genes. Indeed, it was reported in July 1998[6] that museums are exploring cloning technology to multiply 'rare' specimens. Nonetheless, cloning technology is subject to the same objections as conventional cryopreservation, that it does not reproduce the evolving responses of a live population.

Mitochondrial DNA of cattle is now routinely extracted through polymerase chain reactions (PCRs) and can be used not only to establish the evolutionary history of breeds and species, but also for routine monitoring of genetic variability within populations. DNA can be used to measure directly levels of homozygosity and thus the degree of inbreeding and so form the basis for planning conservation programmes.

All these techniques are strictly concentrated in the developed world at present and within the scientific establishment of a few countries. Some are controlled by patents owned by large agricultural companies who will only license these technologies for their own profit. Nonetheless, as with transgenic crops, the technology will probably spread quickly to parts of the developing world with a sophisticated science infrastructure and not at all to many other countries. The whole area is too new to make any secure predictions, but access to information, as in many other areas, may perpetuate inequity, although not along conventional developed/developing world dichotomies.

6 Policy recommendations

Livestock biodiversity is poorly represented in international conventions probably because neither the strategies nor the status of domestic animal breeds are analogous to wild species. Recent publications and expert consultations at FAO are making progress in this area, but an internationally agreed position is still elusive. The following sections suggest how this situation might be remedied through:

Box 7 Yaks: the crucial role of wild populations

Yaks are the principal domestic species of the high plateaux of Central Asia, since they can withstand lower temperatures and higher altitudes than other species (Li and Weiner, 1995). They are crucial to the survival of pastoral nomads, especially in Tibet. Yak genes also play an important role in crossbreeding domestic cattle to resist colder and mid-altitudes. It appears that domestic yaks derive from a relatively narrow genetic base and that the system of uncontrolled breeding has allowed inbreeding to occur. Significant diminution in size, milk yields and increases in birth defects have been recorded in domestic yaks over the last 30 years. As a result, it was decided to use wild yak stock to re-invigorate the domestic herd. However, the only remaining population of wild yaks (*Poephagus mutus*) has been reduced to *c.* 1000 animals, living on the Changtang Plateau in Tibet. Although notionally protected, they have been reduced by habitat encroachment and illegal hunting and their own genetic diversity has been reduced. However, crossbreeding using AI has been shown to increase calf survival and other productivity indices. The productivity of millions of yaks and thus, the food security of their owners may, therefore, depend on the survival of a 1000 threatened wild yaks. The conservation lesson may be evident, but even now a coherent strategy for protecting the Changtang wild yaks is not in place.

[6] *Sunday Times*, Innovation Section (19 July 1998).

- building biodiversity impact assessment into projects
- exploring innovative approaches;
- support to policy re-orientation;
- support to research re-orientation.

6.1 Building biodiversity into projects

Biodiversity awareness is increasing throughout the spectrum of natural resources development activities, but greater emphasis has been placed on 'wild' animals and plants than on crops and livestock. The strong association between traditional breeds and adaptation to marginal environments suggests that a much greater awareness of the potential genetic impacts of various types of project is required, a type of genetic 'audit'. It seems important, therefore, that a consideration of the impact on biodiversity be written into all types of natural resources projects. Points to consider should be:

- Will the proposed intervention have an impact on overall biodiversity (i.e. wild and domestic)?
- If the impact is negative, what justification is advanced for supporting it? Will it contravene UK obligations under the CBD?
- Will it have an impact on genetic diversity of livestock, either directly or indirectly?
- If the impact is negative, can it be justified through a rural livelihoods approach?

6.2 Innovative strategies

Biodiversity conservation can be viewed either as simply another obligation to be stacked alongside the many other filters through which development interventions must now pass, or as a positive opportunity to contribute both to the environment and rural livelihoods. The explosion of research on all types of ecology and environment can be monitored for the potential to contribute innovative conservative strategies.

6.2.1 Co-conservation and interactive benefits

In Africa and Central Asia, where wildlife and livestock interact in rangelands and compete for pasture, there is increasing potential for co-conservation (Bourn and Blench, 1999). Livestock and wildlife have usually been seen as in opposition, both because of the competition for forage and because zoonoses, i.e. diseases, can be transmitted both to and from cattle. Traditional breeds, with a history of interaction with wildlife, evolve an interlocking pattern of vegetation exploitation so that the pasture can support a maximum of biomass (see examples in Blackburn *et al.*, 1996). Exotic breeds brought in may compete directly with wildlife with corresponding risks of disease and shortage of pasture. Indigenous breeds can better withstand environmental stress and, therefore, interact with wildlife in a pattern beneficial to both parties. Attempts to conserve Ankole cattle in Uganda through permitting preferential access to national parks are under way and this has considerable potential for expansion. Similar systems operate in Europe with horses, notably in the Camargue in France and on Dartmoor in the UK.

6.2.2 New marketing initiatives to add value to unusual livestock products

Concern about the uniformity and quality of food products in recent years has created a major expansion of the market for unusual and organic foods, especially those of plant origin. The situation is less well-developed for livestock products but this is probably only a matter of time. Poor and vulnerable populations should be particularly well-placed to exploit this market, as they not only conserve breeds with traits that do not appeal to large-scale enterprises, but have labour available to manage low-output breeds. For example, in Uttar Pradesh, Gujjar buffalo-herders were initially expelled from a newly established national park. However, after some negotiation, a scheme was established to assist them in marketing their buffalo milk to visitors and pilgrims, thereby increasing their income while maintaining access to grazing (Köhler-Rollefson, 2000).

The main roadblocks in preventing such communities from gaining access to potential markets are knowledge and organisation. To establish clearly the likelihood of particular products being marketable is usually beyond the capacity of poor communities with limited access to infrastructure. Even if this is established, unfamiliar institutions such as producers' co-operatives and systems of quality control must be put in place. Both international agencies and national agricultural research systems (NARS) should be in a position to support this process.

6.2.3 Recognition of animal breeders' rights

Bioprospecting and the issues surrounding the rights of indigenous peoples in respect of wild plant resources have recently been the subject of considerable publicity. Some companies with ethical policies have begun to draw up benefit-sharing agreements with communities who have identified plants with active properties. Large biotechnology companies have recently been patenting crop plants, including those representing thousands of years of breeding by indigenous communities. The uncertain legality of this process has allowed these companies to reap large profits without returning any percentage back to the source communities. In a similar way, many livestock breeds developed by such communities have been appropriated by international businesses, without any pressure for compensation.

Box 8 Co-conservation: capybaras and Criollo cattle

The capybara, the world's largest rodent, lives in swamps in the flooded grasslands between Venezuela and Paraguay. Although never truly domesticated, it has been raised from captured animals and tamed since pre-Columbian times. Since the seventeenth century, it has been defined by the Church as a fish, so that Catholics can eat it on Fridays. It eats short coarse swamp-grasses that few other species can exploit. Criollo cattle and horses in the Pantanal of the Mato Grosso have been shown to resist extremes of high temperature and flooding. They are presently threatened by imported zebu breeds, but this trend is being reversed by support from EMPRABA, the Brazilian livestock NARS. Criolla and capybara can be used to co-exploit flooded grasslands, producing more protein than each species alone[7].

Source: Vietmeyer (1991); Ojasti (1991, 1996); Henson (1992)

Ironies abound: genes deriving from the Vechur, a dwarf breed of cattle from Kerala with disease and heat-resistance traits, have been patented in the UK. A state breeding programme in Kerala itself that prohibited the use of Vechur bulls for breeding has driven them to the point of extinction (Köhler-Rollefson, 1997).

Benefit-sharing may be harder to implement than with wildlife or plants; animals are mobile and often so are their owners. Determining who has rights in their genetic make-up may be more complex, but this should not become an excuse to ignore the situation. Part of the responsibility of NARS in auditing and inventorying livestock biodiversity within a nation state should be to assess the actual and potential 'ownership' of livestock genetic resources, in the event of the genes being considered of commercial significance.

6.2.4 Multi-purpose animals

In Western Europe, for example, where large horses were bred as work animals, mechanisation has meant that these breeds are no longer required for work and are now largely the preserve of rare breed societies. However, mechanisation has had a very patchy record of success in the developing world and often can collapse without continuing subsidies. For example, Russian-subsidised mechanical haymaking in Mongolia collapsed after 1991 and the hand-scythe now predominates. Owners of rusting horse-drawn scythes are now seeking to repair them and re-train horses in their use.

The conventional notion of working animals usually involves animal traction and generally implies large, fully domesticated species, but a wide variety of human-animal interactions are possible, particularly the encouragement of useful species and training of animals. Trained hunting dogs are a classic example, but the use of pigs to find truffles or cormorants to catch fish by Chinese fishermen, or encouragement of barn owls to reduce rodent depredations (see Box 9) suggest this area has much greater potential.

[7] It appears the Reverend Moon of the Unification Church has purchased a large area of the Pantanal and proposes to convert it to a 'heaven on earth' complete with golf courses and amusement parks. It may well be that the Criollo and the capybara will be converted into animatronic versions of themselves possibly tended by lifelike models of the rural householders who have been presumably thrown off their land.

Box 9 Why can't we be like that wise old bird?

Working animals can also be tamed species, and their importance just as great to rural livelihoods. The use of the barn owl, *Tyto alba,* to keep down rodents in tree-crop plantations, is typical. Barn owls are likely to have anthropic distributions; in other words, they are attracted to areas where human activities increase numbers of rats and mice. By attracting them to oil-palm plantations in Malaysia through the provision of nest boxes, rodent numbers are kept down without the other types of damage to the trees. This also avoids the use of chemicals and traps and thus, collateral damage. Further trials are underway to extend this concept to grain crops.

Source: Vietmeyer (1991)

6.3 Policy, projects and research

6.3.1 Introduction

Current approaches to livestock issues in the context of biodiversity are still uncommon, and often ill-co-ordinated. Even the FAO, which is leading on the DADIS initiative, continues to send out free semen from Friesian cattle under the auspices of another programme, with no clear control on the use to which it will be put. Large livestock companies have significant political influence, especially in the US, and approaches which run counter to their commercial philosophies often get short shrift in international decision-making. This is particularly striking in the Americas, where US aid and the purchase of 'modern' livestock breeds in development projects is still very prevalent. Even in South East Asia, where work is beginning in earnest on the evaluation of local breeds, development projects involving crossbreeding remain commonplace. The recent financial collapse in South East Asia and Brazil is likely to demonstrate rather bluntly just how unsustainable these strategies are, as householders who accepted the blandishments of these projects will no longer be able to afford the inputs necessary to keep their stock alive. The primary task then is to co-ordinate approaches, propagating an understanding of the parameters of long-term sustainability in livestock projects and their distinctive time-scales which are ill-adapted to typical project cycles.

Box 10 Policy re-orientation suggested to support livestock biodiversity

- Support to the conservation, use and international exchange of animal genetic resources
- Support to the re-orientation of national research institutes towards research on indigenous livestock of relevance to the poor?
- Support a re-orientation of research from a focus on individual traits to lifetime and herd productivity risk reduction?
- Support a re-orientation of research and extension towards species and uses relevant to poor people, i.e. micro-livestock and work animals
- Support a switch to more responsive (participatory) methods of determining selection goals
- Support to innovative initiatives such as co-conservation, co-exploitation, exploration of new domesticates, and improved management of existing semi-domesticates
- Support to new marketing initiatives to add value to unusual livestock products – how to ensure poor benefit too?
- Support to inventory projects that add value through cross-border and regional co-operation through economies of scale
- Support to the implementation of the CBD and its COP extensions – and what is particularly relevant to livestock biodiversity?

6.3.2 Policy

The policy re-orientation suggested by the paper is summarised in Box 10.

6.3.3 Research

Much of the research recommended follows directly from the policy re-orientation proposed in the previous section, and is summarised in Box 11.

Box 11 Research and project re-orientation proposed to support livestock biodiversity

- National programmes of breed characterisation, both at the genetic and phenotypic level
- Monitoring and inventory projects to identify breed conservation status
- Base selection criteria on realistic modelling of environmental stress
- Focus more attention on genetic traits such as disease resistance which may be regional rather than breed-centred
- Develop technical parameters for experimental domestications and co-conservation initiatives
- Extend mtDNA characterisation to all domestic animal species and improve techniques for monitoring degree of homozygosity

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Acronyms

AGRI	Animal Genetic Resources Information
AI	Artificial insemination
BP/bp	Before present (lower case represents uncalibrated radiocarbon dates)
CBD	Convention on Biological Diversity
CGIAR	Consultative Group on International Agricultural Research
COP	Conference of the Parties (of the Convention on Biological Diversity)
DADIS	Domestic Animal Diversity Information System
EEAP	European Association for Animal Production
FAO	Food and Agricultural Organisation of the United Nations
ILCA	International Livestock Centre for Africa
IMF	International Monetary Fund
IPRs	Intellectual Property Rights
NARS	National Agricultural Research Systems
NGO	Non-governmental organisation
PCR	Polymerase chain reaction
UNEP	United Nations Environment Programme

Appendix

Status categories of livestock and required response

Category	Number	State	Action
Extinct	0	No pure-bred males or females remain	Population cannot be restored
Critical	<500	Genetic variability below that of ancestral population, action essential for population survival	*Ex situ* conservation becomes as crucial as *in situ* conservation
Endangered	<1000	Effective population size is too small to prevent genetic loss	*Ex situ* conservation should be intensified while *in situ* conservation is strengthened
Insecure	<10,000	Population numbers decreasing rapidly	Captive propagation programmes established, germ tissue collected for storage, reproductive technology researched
Vulnerable	<100,000	Some evidence of population decline	Surveillance of status and trends monitored
Normal	>100,000	Population stable and reproduces without genetic loss	None

Source: Adapted from Henson (1992: Tables 3 and Appendix 3.1)