

PERSPECTIVE



Livestock biodiversity as interface between people, landscapes and nature

Stephen J. G. Hall

Estonian University of Life Sciences, Tartu, Estonia

Correspondence

Stephen J. G. Hall, Estonian University of Life Sciences, Kreutzwaldi 5, 51014 Tartu, Estonia.

Email: s.hall973@btinternet.com

Abstract

1. Livestock breeds, and the genetic diversity they embody, are components of global biodiversity.
2. Intimately enfolded in human societies, they are also components of agroecosystems, providing food, non-food products, and other services including labour and social security. Under traditional management in pastoral systems, they can assure conservation of landscapes and of floral and faunal biodiversity.
3. Conservation of these genetic resources has been supported scientifically by animal genetics. This paper argues that ecosystem services science could provide further support to, and will in turn benefit from involvement in, genetic conservation. The focus is on the cultural significance in its landscape contexts of livestock biodiversity, and it is recommended that linkages be strengthened among ecosystem sciences, cultural geography and animal sciences.
4. These linkages will help development of policies that enhance the delivery, and support the resilience, of the ecosystem services provided by livestock and the systems of which they are part. Policy interventions that promote the conservation and sustainable development of livestock biodiversity are likely to confer both ecological and cultural benefits, and strengthen linkages between people and nature.
5. In turn, while the science of ecosystem services should take more account of livestock biodiversity, animal sciences should engage more with its cultural dimensions.

KEYWORDS

agri-environment schemes, animal breeds, animal genetic resources, conservation policy, cultural geography, ecosystem services, grazing livestock, landscape ecology

1 | INTRODUCTION

Inhabited landscapes and agroecosystems are to a very great extent the results of the conversion, by people and their livestock, of post-glacial ecosystems. Domesticated livestock have been,

and continue to be, subject to the interaction of natural and artificial selection. This, coupled with genetic isolation, has led to the emergence of distinct breeds. As a result, many individual countries and regions have characteristic livestock breeds (Hall, 2004), with histories rich in human interest. Livestock breeds in general

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are defined as components of global biodiversity, and the notion that they are part of the common heritage of humankind began to be formalized in the late 1940s by the Food and Agricultural Organization of the United Nations (FAO). Their conservation is an obligation of signatories to the Convention on Biodiversity (FAO, 2012).

Livestock are interfaces between human activities and the ecosystem, and are physical expressions of cultural heritage. Particularly in traditional systems, the economic performance of livestock is made more efficient, and sustainable, by the availability of a great diversity of local breeds (Hoffmann, 2013), for example, the multiplicity of upland sheep breeds in the UK (Bowles, Carson, & Isaac, 2014; Carson, Elliott, Groom, Winter, & Bowles, 2009) or of local dairy cattle in France (Vissac, 1994). Traditional breeds in particular provide many non-material benefits in addition to subsistence. These benefits are highly diverse. In northwest England, for example, the Herdwick sheep breed contributes to the scenic appeal of the Lake District (Bowles et al., 2014). African studies have often shown how animals are kept for financial security and for the maintenance of family and community affinities (e.g. the Somba cattle of Benin; Dossa & Vanvanhossou, 2016).

Paradoxically, livestock breeds do not feature prominently in cultural geography, landscape ecology or ecosystem services science. This relative insignificance of a major component of biodiversity, in the discourse of three important sciences, is troubling, and could have negative consequences for the maintenance of this biodiversity and for the development of these disciplines. There is a risk that conservation policies generally may be framed without full account being taken of livestock biodiversity. This risk would be mitigated by a wider and deeper understanding of its cultural attributes. From the viewpoint of agricultural sciences, 'cultural significance' has frequently been advanced as a justification for conservation (Gandini & Villa, 2003; Hoffmann et al., 2014) but precisely what this significance is, is seldom discussed analytically.

After considering the range and scope of ecosystem services provided by livestock biodiversity, this paper argues that a proper acknowledgement of the cultural significance of livestock biodiversity would benefit ecosystem sciences, would improve the management and conservation of animal genetic resources, and through its connections with landscapes would help to reconcile people with nature.

The discussion here focuses on grazing livestock. It draws on published research in which livestock biodiversity is considered within the settings of animal science, cultural geography, landscape ecology or ecosystem services. This research has mostly been funded and conducted in Europe, perhaps because genetic resource conservation is embedded in policy and institutional environments (largely due to the Common Agricultural Policy of the European Union and non-governmental organizations such as the Rare Breeds Survival Trust of the UK; Hall, 2004). However, worldwide there is a great wealth of breeds and associated cultural landscapes as historical witnesses to millennia of people-landscape interactions (Blench & MacDonald, 2000; Porter, Alderson, Hall, & Sponenberg, 2016).

Ecosystems services now influence policy in many jurisdictions and the general approach outlined here will therefore be relevant wherever this is the case.

Animal genetic resource conservation has an overarching global policy setting under the guidance of FAO (see for example Hoffmann, 2013, Hoffmann, From, & Boerma, 2014); but these policies are ultimately put into effect at a national or regional level.

What precisely is meant by the term 'breed' depends on the context (Hall, 2004) and will vary from one country to other. However defined, they are the results of socio-economic as well as biological processes and they are subject to a wide range of forms of administrative oversight. Global breed biodiversity has been influenced not only by ecological and geographical conditions, but also by the diversity of human economic and social needs including those resulting from urbanization (Hall & Ruane, 1993). Whether or not a breed is accepted officially as such depends on what definition of a breed a given country chooses to adopt (Hall, 2004), and in many countries, the definition includes reference to their institutional context. For example, the UK government's definition of a breed is 'an interbreeding population of husbanded or formerly husbanded domesticated animals of consistent genotype and phenotype with a recognized history and administrative framework (that) fulfils a role in the rural economy' (Defra, 2012). Member states of the United Nations have entered the breeds of domesticated animals that they acknowledge to exist in their territories in the official register maintained by FAO (<http://www.fao.org/dad-is/en/>). This database is complemented by Porter et al. (2016), which is the fifth revision of a work that first appeared, as a dictionary of breed names, in 1951.

2 | LIVESTOCK BREEDS IN CULTURAL LANDSCAPES

The role of livestock has been considered explicitly and critically in a few cultural landscape systems (e.g. Bernues, Rodríguez-Ortega, Ripoll-Bosch, & Alfnes, 2014; Meuret & Provenza, 2015; Oteros-Rozas et al., 2014; Speed et al., 2012), but breed diversity is usually not mentioned in these studies and there has been little if any overall discussion of the role of livestock breeds in cultural landscapes. The relationship between breeds and landscapes is, however, widely acknowledged. For example, England is divided into 159 National Character Areas (NCA; Natural England, 2014). In all except two (Inner London and Merseyside), cattle and/or sheep were noted. Considering the 157 other NCA descriptions, 55 (35%) mention specific breeds, though this is in purely qualitative terms without cultural interpretation. Although many famous cultural landscapes are very strongly associated with particular breeds (e.g. Camargue cattle and horses in France; Connemara ponies in Ireland; Kuri and Fulani cattle in Lake Chad and the savannas respectively of west Africa; Brahman and Santa Gertrudis cattle in Texas rangelands: Porter et al., 2016) published material on the breed-landscape relationship is generally purely descriptive.

Livestock breeds arose from the daily lives and habits of the farmers of a region so today's breeds are the physical manifestations of historic and current social interactions. Examples abound, across the world. Thus for example, in the USA, Texas Longhorn cattle and Navajo-Churro sheep recapitulate such phases in the nation's development as the bovine colonization of the southwest (Sponenberg & Olson, 1992) and the adoption by some Native Americans of livestock husbandry (Maiwashe & Blackburn, 2004). In contrast, and particularly in the western world, development of breeds has been particularly rapid in the last 200–300 years usually involving the activities of elite breeders, breed societies and industrialized agriculture. Often, this can be seen as an assertion of social status (Hall, 2014). Following cultural studies paradigms, breeds can be seen as expressions of vernacular culture, and also of the apparently countervailing (Eagleton, 2016) cultural force of intellectual and social innovation. Using this dualistic perspective, Gandini and Villa (2003) assigned relative degrees of cultural significance to Italian cattle breeds by tabulating (a) the degree to which each acts as a historical witness (through featuring in such media as visual arts and literature) and (b) their prominenances as custodians of local tradition (principally in relation to local food and handicraft practices). Indeed, the aspect of livestock biodiversity that has been most extensively used in geographical studies of culture, certainly in Europe, has been the notion of custodianship of local food tradition (Pouta, Tienhaara, & Ahtiainen, 2014; Zander, Signorello, Salvo, Gandini, & Drucker, 2013). Tieskens et al. (2017) used 'Protected designation of origin' (PDO) databases in mapping cultural landscapes. While some food traditions are strongly linked to the use of a particular breed, others are flexible. Many PDO and related designations do not specify the breed of origin (references: Dias & Mendes, 2018), though many do (examples from Italy: Parmigiano Reggiano cheese from Reggiana cows, Cinta Senese pork from pigs of the eponymous breed; Bigi & Zanon, 2008). Another set of food traditions is the ceremonial feast function of some African cattle breeds, e.g. the dwarf, humpless Muturu cattle of Nigeria (Blench, 1998). This is a member of the west African shorthorn group of breeds, which includes the Somba (Porter et al., 2016). These breeds are a particularly rich resource for the study of cultural significance of livestock and landscape, and many of them are almost undescribed. They and their relatives are scattered across Africa between the Sahara and the northern edge of the central forest belt, from Liberia to Ethiopia, and, reportedly, to Oman and the island of Socotra.

Interactions between livestock breeds and culture are therefore a current field of academic interest, but their landscape affiliations are much less extensively studied. Very little is known on how the public generally view livestock breeds as components of landscapes; social science studies of this topic are remarkably few. Indeed, the importance of animals in general in contributing to people's relationships with the rural landscape has been largely overlooked in academic studies (Jones, 2013). Tovey (2003) had previously commented on the 'invisibility' of animals, wild and husbanded, to rural sociologists. There is a growing interest in livestock, on the part of geographers (e.g. Sellick & Yarwood, 2013) but surprisingly, while livestock would be expected to be a component in most people's notion of the countryside, there

are virtually no formal data on public attitudes. In a brief study, in rural England, Halfacree (1995) found that only 7% of respondents mentioned animals as helping to define what is meant by 'rural'. This lack of demonstrable awareness of farm animal diversity is perhaps due to lack of appropriate study rather than to a genuine public indifference to the presence or absence of livestock. But farm animals are not always invisible, as demonstrated by the 2001 foot and mouth disease outbreak in the UK which had far-reaching political, as well as economic effects (Convery, Bailey, Mort, & Baxter, 2005; Winter, 2008).

The general status of livestock biodiversity in its cultural landscapes therefore seems under-researched, and with little theoretical underpinning.

3 | LIVESTOCK BIODIVERSITY AND ECOSYSTEM SERVICES SCIENCE

The ecosystem services concept was formalized in the Millennium Ecosystem Assessment of 2005 (MA, 2005), but ecosystem service approaches are only beginning to be applied to livestock breeds. Breed-specific ecosystem service studies of livestock have been 'almost impossible' to find (Hoffmann et al., 2014), perhaps because, in the absence of a recognition of livestock biodiversity by the ecosystem services community, these would have been considered limited in their wider academic interest and policy relevance. Recently Ryschawy et al. (2017) mapped the regional provision of bundles of ecosystem services by the livestock of France. Here, differentiation of animal systems at the very general level of meat or dairy proved informative. Although diversity of breeds was taken into account, breeds were not distinguished in this study.

3.1 | Provisioning and supporting services

'Supporting services' are defined as those which sustain the provision of other ecosystem services. The role of livestock breeds in provisioning (the furnishing of marketable goods and services) is clear. There is a less widely acknowledged supporting service that is vital for the sustainability of the provisioning role, namely the maintenance of reservoirs of genetic variation (Hall, 2004). These confer resilience by conserving the genes that will enable livestock systems to respond to future challenges including climate change and emergent diseases (Boettcher et al., 2015; Hoffmann, 2013). The potential economic benefits (for resilience and sustainability) of this variation are well known (Drucker, Gomez, & Anderson, 2001; Mitchell, Smith, Makower, & Bird, 1982). Scientific techniques for characterizing and conserving these resources are well established (Bruford et al., 2015), but discussions within the animal science community of how to take into account the cultural significances of breeds are nowhere near as advanced.

3.2 | Regulating services

Livestock are fundamental to the sustainable conservation and practical management, through conservation grazing, of some of

the most highly valued European landscapes. Particularly in high nature value pastures and marginal lands, livestock play key roles notably by maintaining semi-natural ecosystems in conditions that favour important species, habitats and ecological interactions—in the terminology of ecosystems services, these are regulating functions. Probably the first breed-specific study on this topic was that of Williams, Wells, and Wells (1974) who described the main advantages of Galloway cattle for managing English fenland vegetation as being lack of sensitivity to biting insects, low selectivity of forage and tendency to disperse over their range. These are all characteristics about which the formal experimental literature is very scanty (Mills et al., 2007). Practical advice is available (e.g. Chapman, 2007) and breeds are usually chosen on the basis of local conditions. In general, hardy breeds of horses or beef cattle, requiring little routine management input, are commonly used in conservation grazing schemes (e.g. Galloway, Scottish Highland cattle; Konik horses: Redecker, Finck, Härdtle, Riecken, & Schröder, 2002).

The availability of genetic resources in the form of these breeds and of composite breeds derived from them, such as Heck cattle (Lorimer & Driessen, 2016), has thus facilitated landscape conservation management. This also highlights some of the benefits of the conservation of breeds that have been superseded in production agriculture.

Conversely, intensive livestock farming can deliver ecosystem disservices (Vaz et al., 2017) and this also can be related to the characteristics of specific breeds. Across most of the world, high-yielding dairy cows of Holstein type are fed on specially harvested forages and housed for most or all of the year and the resulting environmental footprint reduces landscape multifunctionality (Willemen, Hein, Mensvoort, & Verburg, 2010) in that a given landscape becomes less able to provide (e.g.) biodiversity, cultural heritage, and agricultural production. The relationship between breed diversity and environmental impact is evidenced by the differences among Holstein-Friesian dairy cattle varieties, some of which have been selectively bred for adaptation to grass-fed dairy systems (Horan, Faverdin, Delaby, Rath, & Dillon, 2006; O'Brien et al., 2010). Feral livestock (Long, 2003) are notorious for rendering ecologically damaging ecosystem disservices though cultural effects on established human populations can be quite complex and not always negative (e.g. feral camels in Australia: Vaarzon-Morel & Edwards, 2012).

3.3 | Cultural ecosystem services

'Cultural ecosystem services' are the non-material benefits people obtain from ecosystems including aesthetic, recreational and spiritual benefits (MA, 2005). Many studies have shown how important the keeping of traditional breeds, and the attendant social activities, can be in rural societies (e.g. Gandini et al., 2010). Benefits to wider society also include 'cultural heritage, identities and a sense of place' (Fish, Church, & Winter, 2016). The cattle of the island of Jersey provide an example (Hall, 2014). Here, the native breed is considered 'iconic', and public policy, supported by legislation, is geared towards the continued presence of 'brown cows in green fields'.

In terms of ecosystem services science, for formal acceptance of livestock biodiversity as a cultural ecosystem service, the beneficiaries need to be identified and valuations made of the service (Braat & de Groot, 2012). Examples of this having been achieved in livestock biodiversity include the study of Martin-Collado, Díaz, Drucker, Carabaño, and Zander (2014) of Alista-Sanabresa cattle. In this case, non-market values (defined in terms of willingness to pay for such benefits as maintenance of local rural culture and increased certainty of the breed's future existence) account for 80% of total economic value. Domestic animals other than grazing species can also contribute to cultural ecosystem services, as shown by Marsoner et al. (2017) who considered 261 breeds of 14 species of domesticated mammal and bird, in the European Alps. They suggested that geographical areas with high-breed diversity could, as a result, have high potential for development of distinct local products.

4 | LIVESTOCK BIODIVERSITY AND PEOPLE-LANDSCAPE-NATURE RELATIONSHIPS

Conservation aims to reconcile people with nature. The ecosystem services approach is one of several conservation narratives to have become prominent in recent decades, and there have been discordances (Murray, 2017) between its instrumental view of nature and more explicitly aesthetics-based philosophies. The ecosystem services concept needs to be refined, with a wider range of cultural ecosystem services being used in ecosystem valuation (Hirons, Comberti, & Dunford, 2016). I suggest a proper appreciation of livestock biodiversity would contribute to ecosystem valuation; it has already been acknowledged that animal sciences can contribute to the development of ecosystem services and natural capital concepts (Tancoigne, Barbier, Cointet, & Richard, 2014). A better awareness within the ecosystem services discipline of the cultural significance of breeds would be of mutual academic benefit. This would be promoted by the refinement, through interdisciplinary collaboration with animal sciences, of underpinning theoretical aspects of the cultural significance of livestock biodiversity. For this to be achieved, genetic studies, based on hypothesis testing, will need to be combined with a cultural studies approach. The possibilities for a productive collaboration do exist; an example is the study of Colino-Rabanal, Rodríguez-Díaz, Blanco-Villegas, Peris, and Lizana (2018) who applied a Mantel correlation test to genetic distances matrices. Results supported a hypothesis that had originated from cultural studies (Hall, 1996), that genetic distances between present-day human populations would be correlated with those between their respective livestock populations.

For this deepening of understanding to be applicable to the fundamental aim of reconciling people with nature, it must be translated into science-based policy options. This requires the demonstration of institutional capability in the broad sense, strategic alignment between conservation of livestock biodiversity and of flora and fauna, evidence of practicability of this approach, and evidence that future policy

trends are likely to be favourable. Commonality between conservation of livestock biodiversity and floral and faunal conservation is in principle achievable. A study in Scotland (Wright, Dalziel, & Ellis, 2002) suggested that conservation of local livestock breeds and crop varieties could help in the conservation of floral and faunal diversity on farmland. However, the topic has not been extensively explored though there are specific case studies, such as the Chillingham cattle in northern England (Hall, 2013), and the Knepp estate in West Sussex (Tree, 2018). The policy environment within which livestock biodiversity has been supported, in the European Union, has been that of environmental conservation and rural development. The main policy instrument has been agri-environment schemes which can include measures for the support of traditional and local breeds. The alignment with conservation of flora and fauna has been demonstrated in the UK where the opportunity has been taken to link breed support, synergistically, with floral and faunal conservation in that state support for breed conservation requires applicants to be enrolled in broader environmental conservation practices (Small & Hosking, 2010).

Under the EU Biodiversity Strategy to 2020, Target 3 'Achieve more sustainable farming and forestry' covers genetic resources (European Commission, 2016). If this continues to be the case after 2020, there are some policy implementation issues that should be considered, notably, whether livestock biodiversity conservation elements in agri-environment schemes should be 'action-based' or 'results-based'. In action-based schemes, farmers are compensated for income not received, while results-based schemes pay farmers for achieving specific results (European Commission, 2017; Sabatier et al., 2015). Fischer, Hartel, and Kuemmerle (2012) argued that the action-based approach can arrest socio-economic development, but experience shows that with results-based schemes, the results could also be perverse. This is because breeds may continue to be kept but their traditional husbandry systems may be modified in ways which reduce their value as genetic resources. Breeds previously kept as multipurpose animals (sheep for meat, milk and wool; cattle for beef, milk, labour and social security) may then be kept simply for meat, which could select against important ancestral characteristics. Examples cited by Martyniuk, Saether, and Krupinski (2011) include six Norwegian and three Austrian local cattle breeds. This risk may be avoided by well-designed results-based schemes, through promotion of innovative forms of traditional farming systems, based on local traditional breeds, and these could also be more effective for collateral habitat and species conservation (Burton & Schwarz, 2013). Interdisciplinary collaboration, from conservation biologists, ecosystem services specialists, and livestock scientists, will be essential for adequate scientific input to be made available to policy makers.

5 | CONCLUSIONS

The provisioning ecosystem services rendered by livestock biodiversity are of fundamental importance to humankind, while their regulating functions can enable the conservation of much floral and

faunal biodiversity. These services are supported and made sustainable by the conservation of distinct livestock breeds. Their cultural significance is acknowledged, but under-researched. The science underpinning their conservation will be strengthened by input from ecosystem services science which will itself benefit, both in terms of its development as a discipline, and in terms of the cogency and relevance of the policy advice it can offer.

As a first step, the ecosystem services community should acknowledge more clearly its acceptance that livestock biodiversity is a component of global biodiversity, as already made clear in the Convention on Biodiversity. The animal science community should, whenever possible, include, in the design of its studies, investigations which will shed light on the present-day cultural status and functions of breeds.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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DATA AVAILABILITY STATEMENT

No data are included in this paper.

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