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Potential for Conservation of Local Livestock Breeds through Delivery of Ecosystem Services

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This presentation is unlike most of the papers that will be given at the conference as it does not present new research results. Rather I hope to link several themes and concerns to develop a thesis on the relationships between local, often endangered, breeds of farm livestock, the environments to which they are adapted and the ecosystem services that they deliver.

FAO defines a local breed as one reported by just one country; in this paper local may also be used to indicate localised within one country. Hoffmann's (2011) analysis identified 6353 extant local breeds on the DAD-IS database and 669 extinct breeds. Of the surviving local breeds 1505 (24%) are considered 'at risk', 2101 (30%) not at risk and the status of 2747 (43%) breeds is unknown.

Local breeds can contribute to the well documented socio-economic functions common to all livestock such as:

- Provision of meat, milk and other foods
- Production of non-food products such as wool and leather
- Transport and draught power
- Contribution to the economies of rural areas
- Cultural associations

This paper, however, focuses on the ecosystem services to which local breeds may contribute in addition to those socio-economic functions. These include:

- Conservation of wild species and habitat biodiversity
- Conservation of farm animal genetic resources, with the potential to contribute to disease resistance, adaptation to climate change and other future challenges
- Carbon sequestration and hence greenhouse gas mitigation
- Nutrient cycling
- Waste product recycling

Conservation of Wild Species and Habitat Biodiversity

I'll start with the premise that, in Europe, most of the habitats that are now highly regarded for their biodiversity value were created by human activity. Although the ideas of Frans Vera and others suggest that open, or half-open, habitats may have been more common than once thought, it is still considered that woodland would have dominated much of Europe before Neolithic and later farmers cleared the forests. This seems to be particularly the case in the British Isles which did not have the full complement of large herbivores that were present in continental Europe. Three habitats will serve as examples.

Following woodland clearance, most grasslands in Europe were created and maintained by grazing. Subsequently, much semi-natural grassland has been lost as inorganic fertilisers have become readily available and used to increase sward productivity. The surviving semi-natural

grasslands are now valued for their complement of plants and invertebrates, but remain under threat from either intensification or from succession resulting from under-grazing.

Annex 1 of the European Council Habitat Directive lists 65 pasture types that are under threat from intensification and 26 that are threatened by abandonment. A phrase that has been used in relation to U.K. grasslands, and which applies equally well elsewhere, is “between the hammer of intensification and the anvil of neglect”.

Another grassland type is the hay meadow, which may have a species richness of 50 flowering plant species m^{-2}. Hay meadows were specifically managed to provide winter forage for livestock, but were also grazed once the sward had recovered from the hay cut.

A final example in northwest Europe is lowland heath, which developed on areas that may once have been used for arable agriculture but where increasing nutrient deficiency, combined with often free-draining and acidic soils, led to the development of the typical dwarf shrub community. More recently these heaths were used for livestock grazing.

Thus for all these valued habitats grazing remains the favoured method for preventing succession to woodland when these areas are managed for conservation. As well as preventing succession in these habitats, grazing maintains diversity by several mechanisms:

- By reducing the competitiveness of otherwise dominant plants, allowing less competitive species to co-exist
    - grazing animals are frequently highly selective, responding to both dietary value of the various plant species and to the various protective mechanisms employed by plants
    - such selection will vary through time as plants become more or less available, palatable and nutritious in relation to other available species
- Defoliation associated with grazing is less abrupt (when considered over the entire grazed area) than cutting or burning, so allowing animals to move out of the way
- Trampling effects may create niches for species dependent on bare ground for germination or for burrowing
- Dung provides a habitat for invertebrates that in turn provide prey for birds and mammals
    - e.g. in Wales, where chough (*Pyrrhocorax pyrrhocorax*) is an endangered species, cattle grazing is beneficial because of the associated dung invertebrates
    - in upland heaths cattle dung can provide widely dispersed sources of invertebrates for red grouse (*Lagopus lagopus lagopus*) chicks that otherwise have to rely on wet flushes
- Without the addition of fertilisers, the removal of livestock products may, over time, cause a net loss of nutrients from the soil which also changes the competitive balance between plant species, preventing dominance by a few species
- Lastly seed dispersal, either attached to the animal’s coat or by passage through the gut.

These are general effects of grazing which apply to all grazing animals, although the intensity varies between species. For example, cattle tend to have a greater trampling effect, to be less selective and to need a taller sward than sheep. Horses and ponies have a similar trampling effect to cattle, but are more selective, are able to graze to a shorter sward height, but being non-ruminants need to graze for longer periods than a similarly sized cow (say 18 hours per day compared to 9 hours for cattle).

There are also differences between breeds within species, and for conservation management local, traditional or endangered breeds are often favoured over more widespread, commercial breeds. There are a number of reasons why this is so:

- Traditional, local breeds are considered to be better adapted to local environmental conditions, having been subject to both natural selection and selection of the best animals by generations of farmers
- Having developed in extensive systems with low inputs they are considered to be 'hardy' and 'thrifty', although these are not well defined terms
- They can be considered as part of the cultural heritage and can contribute to a sense of community as well as being attractive to visitors.

Hence, management of habitats for conservation by local breeds maintains the genetic resources of those breeds, including characteristics that may be valuable in meeting future challenges, such as disease resistance or ability to adapt to climate change.

A habitat that demonstrates this close association of local, traditional breeds with landscape and ecology is the Spanish dehesa, where Merino sheep, three breeds of cattle (Retinto, Morucha and Avileña) and the Iberian pig have been influential in shaping the landscape. The hams produced from the Iberian pig are a premium product, commanding between €30 and €70 per kg. Such products are benefitting from increasing public interest in traceable, traditional and environmentally friendly food products, exemplified by the Slow Food Movement.

Several critically endangered species of wildlife, including the Iberian lynx (*Lynx pardinus*) and Iberian imperial eagle (*Aquila adalberti*), are associated with the dehesa. Such species need large hunting territories and for their conservation the dehesa must be managed on a landscape scale; the local livestock breeds are well adapted to the conditions of the dehesa habitat and are crucial to its ecology and economy.

The English Lake District, an upland area in northwest England, provides another example.
The Herdwick is a hill breed centred on the Lake District. It is extremely hardy, with adult sheep surviving all year on hillsides at altitudes of 300-800m and with more than 2000mm of precipitation per year. It would probably be a rare breed were it not for Beatrix Potter, a writer of children's books and one of the founders of the National Trust charity, who insisted that Herdwick sheep should continue to be kept on the 16 farms she bequeathed to the National Trust.

In the 2002 UK Country Report of Farm Animal Genetic Resources the Herdwick population is given as 45,000 breeding females. However, it is a very localised breed: it is estimated that 95% of the Herdwick population is found within an area of just 1600 km^2 – that is within a circle with a radius of <23km (Figure 1).

The Herdwick breed is often stated to be descended from sheep brought to northwest England by the Vikings. Whilst this is unproven, the association between the main Herdwick area and Norse place names and Norse-influenced dialect makes it both plausible and an interesting story for tourists. Thus the breed exemplifies the historical connections to both Norse settlers and to Victorian landowners, is closely associated with the farming communities of the area, is instrumental in maintaining the upland heath and acid grasslands of the Lake District, is a valued element in the landscape, and has an economic function as a producer of excellent mutton and coarse wool used for carpets and household insulation.

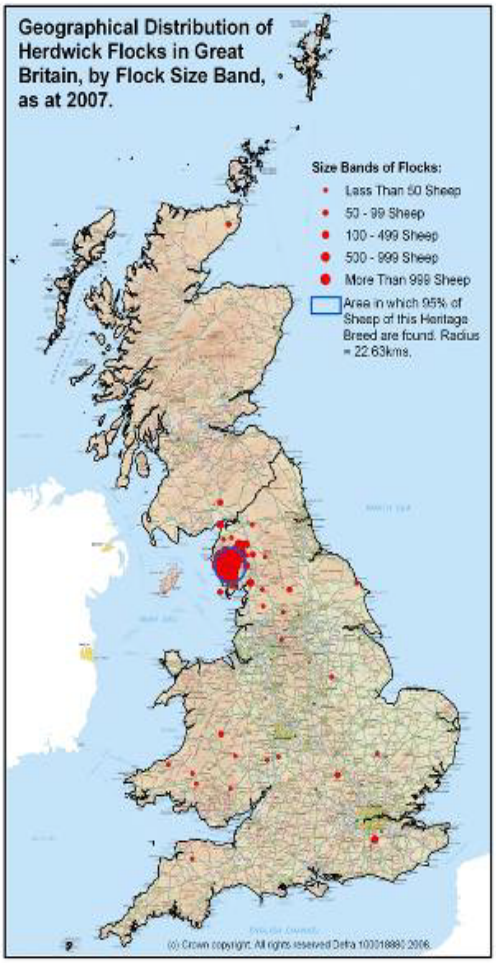

Figure 1: Geographical distribution of Herdwick flocks in Great Britain, by flock size band, as at 2007. Map courtesy of Carson, A., Elliott, M., Groom, J., Winter. A. and Bowles, D. 2009 ©The Sheep Trust / Defra

Some native breeds of ponies in the U.K. are still closely associated with their areas of origin, often upland moorlands. Examples include the Exmoor, Dartmoor, New Forest, Welsh Mountain, Fell, Dales and Highland. Some of these have suffered from introgression from other breeds to improve their riding characteristics, but the Exmoor has remained relatively pure and is widely used for the management of habitats for biodiversity.

Although the primary source of breeding stock is still its native Exmoor, this new use for conservation has led to the Exmoor pony's dispersal across the U.K., so that it is beginning to lose its local (within the U.K.) breed status.

This trend can be seen in other breeds in the U.K. For example, there are seven recognised breeds of primitive sheep, although the Castlemilk Moorit is a fairly recent (approximately 100 years) creation from assorted primitive breeds. Some of the U.K.'s primitive breeds, such as the Boreray, Manx Loaghtan and North Ronaldsay, are still found in their areas of origin and are also distributed in small numbers throughout the U.K., but remain relatively rare breeds.

Others are more numerous and widely distributed, such as the Shetland which is valued for its fine, multicoloured fleeces. Another is the Hebridean, which like the Exmoor pony, has developed a new function in the delivery of habitat management for biodiversity.

The Hebridean sheep survived as remnant population of multicoloured sheep on islands in the St. Kilda group 100km off the coast of mainland Scotland, from which black individuals were selected to grace estates first in Scotland and then in England, but it became extremely rare. When the

Rare Breeds Survival Trust was founded in 1973 the population was approximately 500 sheep and it was no longer present in its native Hebridean islands.

Throughout the 1970s and early 1980s pedigree registrations averaged 250 per year (Figure 2). Then in the late 1980s the breed established its reputation for effective habitat management, especially because it readily browsed woody species and so slowed succession. This new function, and an enthusiastic group of breeders, allowed numbers to increase more rapidly and there are now an estimated 3000 registered, and probably an equal number of unregistered, Hebridean sheep and registrations are approximately 2000 per year (Figure 2). Thus largely through a demonstrated ability to manage habitats this breed is now numerically safer than at any time in the last 250 years.

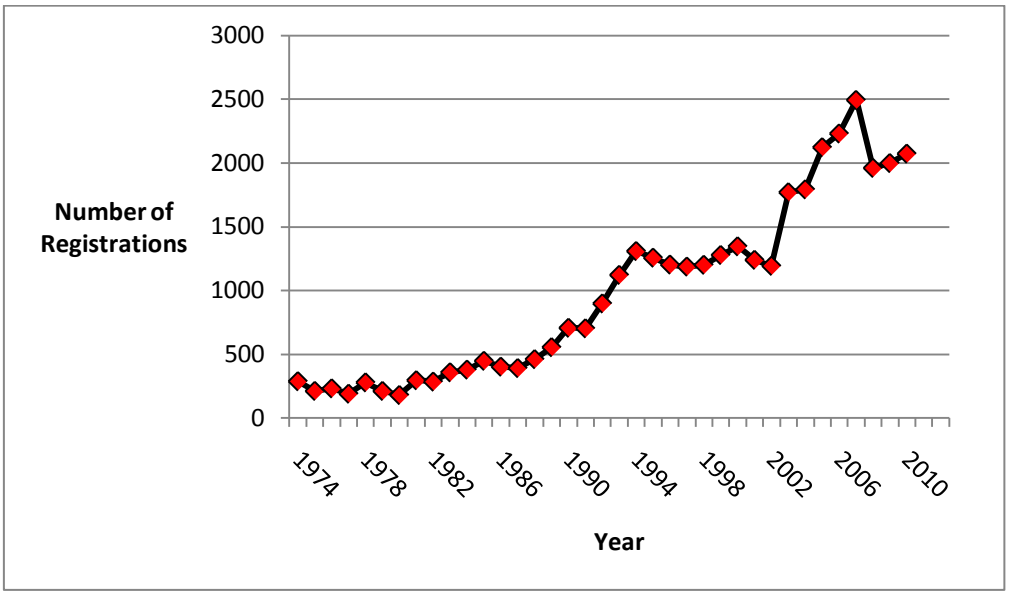

Figure 2: Hebridean sheep registrations 1974-2010

Although local in the FAO sense of reported from one country (there are a few small flocks in other European countries e.g. Belgium), it can no longer be considered as local to any particular locality within the U.K. (Figure 3). Only a few counties have no flocks, and several of those are predominantly urban.

Clearly such increases in population and wider distribution can be beneficial for previously local breeds, but may it also pose a threat to other breeds? Use of a non-local breed may not matter provided it does not displace an existing local breed, but unfortunately conservation managers are as prone to livestock fashion as are farmers.

The Konik pony, a Polish breed, has been used on continental European conservation sites, most notably at Oostvardersplassen in the Netherlands, but also in northern Germany and Belgium. In the UK it is also used on an ever-increasing number of conservation sites, from Kent in southeast England to Scotland and Northern Ireland.

There is no doubt that the Konik is extremely hardy, surviving outdoors in continental winters, and is said to be particularly suited to wetland habitats such as fens, but I would argue that the widespread adoption of the Konik is hindering the conservation of native breeds, some of which are probably as capable as the Konik, at least under western European climates.

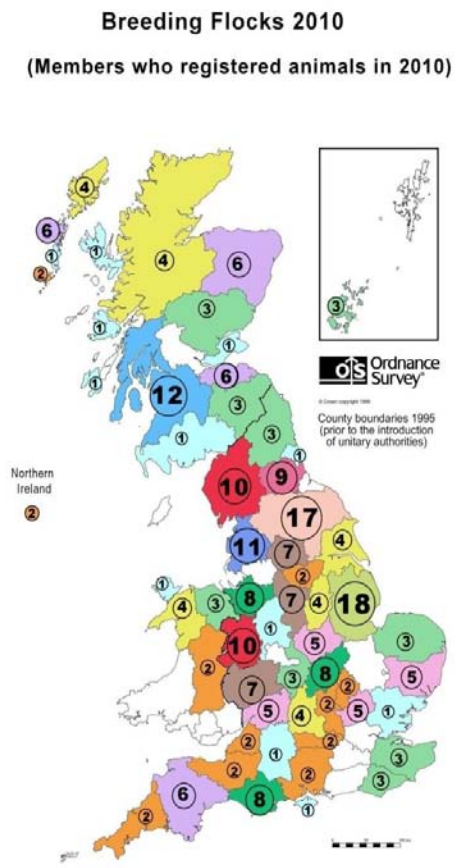

Figure 3. Distribution of Hebridean flocks in U.K. counties in 2010; as not all Hebridean Sheep Society member flocks registered sheep in 2010 the numbers of flocks are minima.

In the UK native ponies such as Exmoor, Welsh Mountain and Highland would be acceptable alternatives and there are likely to be suitable breeds in many European countries. Thus while the Konik is flourishing local breeds may be struggling to maintain their numbers through lack of use. In her recent paper in *Livestock Science* Irene Hoffmann makes a compelling statement: 'Under-utilization is a bigger threat to genetic resources for food and agriculture than over-use…' (Hoffmann, 2011).

To demonstrate that I am not selecting solely a breed that has been imported into the U.K., the Highland breed of cattle is possibly more widely used in conservation management in continental Europe than it is in England (although it is widely used in Scotland). There are examples of its use for conservation management in Germany, the Netherlands as well as northern England and its native Scotland.

Again the concern is that local, or at least, native breeds of cattle may be overlooked when a breed such as the Highland becomes widely adopted. The problem is frequently a lack of data on the characteristics of local, traditional and native breeds, and particularly a lack of comparative data that would allow local breeds to be evaluated against alternatives. Consequently conservation managers adopt breeds largely on the basis of anecdotal evidence or recommendations by their colleagues.

Using non-local breeds may also mean that they are no longer exposed to the environmental conditions in which they were developed, and consequently may lose important characteristics, whereas using local breeds has the advantage that it maintains the breed *in situ*, where it can respond to changing environmental conditions and its genetic resource is conserved.

Carbon Sequestration and Greenhouse Gases

Turning to other ecosystem services, the grassland soils supporting grazing livestock are important carbon stores, which may contain more carbon than forest soils and certainly more than arable soils.

There is some debate about the balance between this carbon sequestration and the greenhouse gas production of livestock, and between the relative contributions from intensive and extensive livestock systems. To an extent this depends on the carbon accounting methods used and the boundaries set; an example is the flawed report from Eblex, the organisation charged with promoting English beef and lamb. In contrast, there are some cogent contributions to the debate that suggest extensive systems are less damaging, and that local breeds may be better adapted to such systems. Many of the published life cycle analyses exclude the carbon sequestration in grassland soils, or the carbon cost incurred by importing feed inputs from other countries, consequently tilting the balance against traditional, local, grass-fed breeds. There is little information on between-breed differences, so the consequences for local breeds cannot be assessed.

Nutrient Cycling

Although better studied, the role of livestock in nutrient cycles also involves a balance. Livestock excretion does not add nutrients (except N from ruminant organisms) to the system significantly unless the stock are fed supplementary feedstuffs. However, the nutrients in excreta are more readily available to plants either directly or through microbial action and the nature and distribution of dung may also increase the heterogeneity of plant nutrient distribution. Contributions to nutrient cycling probably do not differ greatly between breeds except in terms of breed size and ability to utilise relatively poor quality forage: local breeds are often smaller and are able to survive on rougher forages and crop wastes, albeit with lower productivity, than international breeds.

Fire Risk Reduction

Finally, in some areas, such as parts of the Mediterranean region, a reduction in livestock grazing as marginal lands are abandoned leads to an expansion of shrubby vegetation. Although this may have desirable consequences for some wild species, the accumulation of woody biomass presents a significant fire risk, and arguably continued keeping of local breeds that can utilise the vegetation would reduce the fire risk.

Supporting Local Breeds

Thus local breeds can contribute to a range of ecosystem services, but how are the keeping and use of local breeds to be encouraged? Perhaps the most obvious, but possibly over-simplistic, means is to pay a subsidy to breeders. Many European countries have such subsidies, which in EU countries are allowed under Council Regulation 1698/2005 and Commission Regulation 1974/2006 for support of '*Local breeds in danger of being lost to farming*'.

Under the regulations both *in situ* and *ex situ* measures are allowed, and the standard rate of €200 per livestock unit may be increased by national governments in their Rural Development Plans. In most instances the subsidy is designed to replace 'income foregone', that is the difference in income derived from keeping a local, traditional or rare breed compared to that which might be expected if a more commercial breed was kept. This difference is often difficult to estimate,

especially as the more commercial breeds may not fare as well as a local breed in its challenging native environment.

However, Rural Development Plans also allow measures that support farming communities in regions where farming is difficult – the Severely Disadvantaged Areas of the CAP. In the U.K. it is doubtful that farming in the uplands would be economically sustainable without subsidies. To return to the Herdwick as an example, the value of the products is unlikely to provide an economic return, even with marketing schemes targeted at visitors and specialist food outlets. Lambing percentage for ewes on the hills is usually <100% and lambs are slow growing; some lambs can be marketed for meat in their first year, but most will need over-wintering in lowland areas and consequently the meat is unlikely to provide a satisfactory income that will sustain farms and farming families. Similarly, although the wool has uses for carpets and insulation, the value of each Herdwick fleece is less than the cost of shearing. Thus the Herdwick breed is largely dependent on the general support measures for upland farming in the U.K., sometimes supplemented by agri-environmental schemes.

Where breeders of local breeds are supported directly, there is considerable variation between countries in the requirements placed on breeders applying for the subsidy. In some countries merely possessing the animals seems to be sufficient, provided minimum requirements for Good Agricultural and Environmental Condition are met. This misses a potential opportunity to achieve additional aims.

In England (other countries in the U.K. differ) support is only available through the current agri-environmental scheme, Environmental Stewardship. There are two measures associated with livestock:

- Cattle grazing supplement – promoting grazing by cattle to benefit plants, invertebrates and farmland birds. For this supplement the breed of cattle used is immaterial.
- Native breeds at risk grazing supplement – promoting more wide-spread use of native breeds to graze difficult terrain to achieve conservation objectives. For this supplement a list of eligible cattle, sheep and goat breeds is based on the EU's thresholds for at risk livestock breeds.

These are, however, secondary objectives and farmers are only able to claim the supplements if the cattle grazing or use of native breeds at risk contribute to a primary objective such as wildlife conservation or maintenance and enhancement of landscape quality and character. Not only is this a limitation on potential participation, but it means that local, endangered breeds of some species, notably pigs and poultry, are left without any support mechanism.

In addition, I have concerns that there is no requirement for farmers claiming these subsidies to pure-breed their animals – farmers are equally eligible if they cross breed or, in principle, don't breed from their livestock at all. I have suggested, to the consternation of senior government officials, that although this creates a market demand for local or endangered breeds, such use may even represent a 'sink': farmers wishing to claim the additional livestock payments may buy in pure-bred animals that are then cross-bred and hence never contribute to the maintenance of the genetic resource of the breed.

Julian Hosking and I recently reviewed Rural Development Plan support for farm animal genetic resources on behalf of the U.K.'s Farm Animal Genetics Resources Committee. We noted that many European countries require recipients of farm animal genetic resources subsidy to participate

in an approved breeding programme. The details varied between countries but, at a minimum, breeders have to breed pure and register the offspring. More advanced programmes, as in Austria, took the opportunity to recommend, or even mandate, which sires and dams should be used to optimise the genetic conservation of the breeds.

Although these programmes are directed at genetic conservation, it would be possible to also include other breeding aims, such as reduction in greenhouse gas emission per kg of product. Such support can also be applied to all species, unlike the English agri-environment measure which apparently doesn't recognise farm animal genetic resource conservation as a worthy objective in its own right.

Summary

In summary, the ecosystem services to which local breeds can contribute include:

- Biodiversity conservation through grazing of sensitive habitats and creation of niches through trampling and dung
- Conservation of farm animal genetic resources which may be valuable in future commercial breeding objectives, such as disease resistance or adaption to climate change
- The economics of managing marginal lands that may otherwise be lost to farming and/or change adversely
- Supporting local communities that may have a strong affinity to the traditional breeds kept by their ancestors
- Contributing to landscapes that are valued by local people and visitors alike, the latter providing additional sources of income
- Production of some agricultural products: meat, wool, hides etc., including premium products that improve the economics of farming marginal areas
- A possible, but debated, contribution to green house gas reduction through storage of carbon in pasture soils
- Contribution to nutrient cycles, which may also contribute to biodiversity, but is otherwise difficult to assess as an ecosystem service
- Reduction in fire risk
- Finally, local breeds are part of our cultural heritage and should be valued as much as works of art and historic palaces.

However, the problems are:

- that most research focuses on production and hence the international breeds and intensive production systems that dominate world agriculture
- that funding in the form of current subsidies encourage farmers to adopt high-output (and high input) breeds in place of traditional local breeds and
- our lack of understanding of, and inability to put an economic value on, ecosystem services to convince policy makers that local breeds of livestock are more than just an historical curiosity.

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