



Food and Agriculture
Organization of the
United Nations

THE CONTRIBUTIONS OF LIVESTOCK SPECIES AND BREEDS TO ECOSYSTEM SERVICES



Ecosystem Services and Biodiversity



WHAT ARE ECOSYSTEM SERVICES?

Human beings benefit in countless ways from ecosystems and biodiversity. They provide food, clean water, shelter and raw materials for our basic needs. Ecosystems and biodiversity regulate our environment and sustain future production. While landscapes – the visible manifestations of ecosystems – inspire our cultures and provide a home for wildlife and people alike, building blocks such as genes and chemical compounds provide us with tools for innovation and science. These benefits are known as *ecosystem services*. Directly or indirectly, they underpin every aspect of our societies.

Some ecosystem services are more evident than others. Those that we consume directly, such as food and raw materials, are valued in markets. On the other hand, services, such as pollination and nutrient cycling, are less easily quantifiable though they play vital life-supporting roles. This lack of appreciation threatens the long-term provision of such services. Our ability to benefit from ecosystem services in the future depends critically on how we understand, value and manage them.



THE CONTRIBUTIONS OF LIVESTOCK SPECIES AND BREEDS TO ECOSYSTEM SERVICES

Livestock play a special role in the provision of ecosystem services and are an essential part of many agro-ecosystems. They do so by:

- (1) **transforming** feeds unsuited for human consumption into nutritious foods and useful products, for example, by converting grass into milk or meat;
- (2) **interacting** directly with ecosystems through grazing, browsing, trampling and the production of dung and urine; and
- (3) **moving around**, meaning they can respond to fluctuations in resource availability and climate.

Over millennia, **humans have selected and bred livestock species**, creating a range of breeds with their own special traits. Called “specialists”, these breeds are adapted to specific environments, for the conversion of particular types of vegetation and feed into locally-distinct foods, or for the production of specific products. Different livestock species and breeds are able to provide ecosystem services as a result of their **adaptation to different environments, production systems, societal needs and cultural preferences**. High-output animals – intensively bred to supply uniform products under controlled management conditions – exist alongside multipurpose breeds kept by small-scale farmers and herders, mainly in low external input production systems.



Effective management of animal genetic diversity is essential to global food security, sustainable development and the livelihoods of hundreds of millions of people. Yet, the livestock sector faces many challenges. Rapidly rising demand for livestock products in many parts of the developing world, emerging animal diseases, climate change and global targets, such as the Sustainable Development Goals, all need to be addressed. Many breeds have unique characteristics or combinations of characteristics – **disease resistance, tolerance of climatic extremes or the ability** to supply specialized products – that can contribute to meeting these challenges. However, evidence suggests that the genetic base is eroding at a worrying rate.

The roles of livestock species and breeds in providing ecosystem services depend strongly on **how people manage them and the production systems of which they form a part**. Depending on how they are managed, their impacts can be positive or negative. In well-managed production systems, services outweigh disservices. Poorly managed systems endanger future production and cause environmental hazards.



PROVISIONING SERVICES

Provisioning services are the **products people obtain from ecosystems**.

Livestock provide one-third of humanity's protein intake and 13 percent of all calories. Livestock production in 2010 was worth US\$836 787 million, equal to 37 percent of the value of all agricultural production.

Provisioning services are easier to appreciate and quantify in terms of **economic value** than other ecosystem services. Many provisioning services are **traded in markets**. However, in many regions, the survival and livelihoods of poor rural households depend on direct consumption of provisioning services. For the poor and vulnerable, **provisioning services provided by livestock, such as food and transportation, are even more vital** than can be expressed in monetary terms.

Milk, meat, eggs, dairy products and edible offal **supply essential protein, vitamins and other micronutrients**. Even a small amount of milk in the diet can be tremendously important for combating malnutrition and ensuring healthy development in children. In marginal environments where crop production is limited, well-adapted breeds of ruminants provide food security





for people and the basis of livelihoods. In mixed systems, animals such as pigs and poultry **recycle waste and crop residues** into nutritionally valuable foods.

Up to 2 billion people in developing countries rely on animals for draught power and transportation. Animal manure supplies some 15 percent of the nutrients applied as **crop fertilizer** worldwide. The **clothing industry** relies on skins and fibres of animal origin, with particular breeds providing products with unique qualities. Manure is widely **used as fuel** in cooking stoves, while its potential for use in the **production of biogas** as a source of energy is rapidly developing. The global livestock gene pool provides the basis for the adaptation and improvement of our food production systems. Biochemicals derived from animals have become indispensable for research and **medical applications**.

Diverse livestock species and breeds provide the key to people's ability to benefit from the provisioning services supplied by livestock in different environments. The abilities of particular livestock breeds to cope with mountainous terrain, drought or diseases are often vital for the poor and vulnerable.

Provisioning roles of livestock for rural families

Cattle: Milk, blood and meat for food and income from sales; hides for shelter, bedding, clothing and footwear; savings, dowry and bride-price; manure and animal traction.

Camels: Meat and milk for food and income; hides for shelter, bedding and footwear; savings, dowry and bride-price; manure, including for use in papermaking; transport.

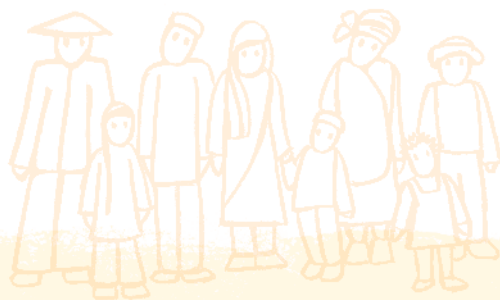
Goats and sheep: sales for cash income; milk, blood and meat for food; skins for clothing; savings; wool and wool products.

Donkeys: Transport of water and goods; milk for medicinal purposes.

Llamas and alpacas: Transport in mountainous terrain; sales of meat and high-quality fibre; income from tourism.

Pigs: Meat for food and income; savings.

Poultry: Eggs and meat for food and income; feathers for bedding.



Challenges

- 17 percent of livestock breeds worldwide are at risk of extinction. Genetic erosion narrows our ability to adapt our global food system to challenges such as population growth, emerging diseases and climate change.
- Policy environments frequently disadvantage the traditional production systems that typically harbour adapted livestock species and breeds, thus fostering genetic erosion.
- The provisioning roles of livestock in poor rural households are often not fully captured in economic data.
- Production systems that overemphasize the provisioning roles of livestock often do so at the expense of other ecosystem services.

Did you know?

- 8 774 livestock breeds are recorded in FAO's global breed database.
- Foods of animal origin contain protein, iron, zinc, vitamin A and vitamin B12, which are of special nutritional importance to children.
- Exports of breeding horses, cattle, pigs and poultry were worth US\$6.4 billion in 2012.
- The global retail value of wool products sold is around US\$80 billion per year.
- Worldwide, over 40 million donkeys assist people as work and pack animals.
- In India, about 40 percent of the dung collected is used as fuel in cooking stoves.

Useful actions

- Conduct or complete inventories of livestock diversity in your country.
- Investigate and recognize the provisioning roles of livestock species and breeds in rural livelihoods and national economies.
- Develop innovative livestock products, such as camel milk-based ice-cream, to improve rural incomes.



REGULATING SERVICES

Regulating services are the benefits humans obtain from the **internal ecosystem processes that regulate our environment, such as the fertility of soils**. People do not consume them directly. We are often unaware of them, yet they are vital in sustaining nature's provision of food and other products.

In many grazing systems, **livestock help nature perform its regulating roles**. Grazing and browsing can have a positive effect on the composition of vegetation and associated biodiversity. When managed correctly, livestock grazing can increase land cover, plant productivity and biodiversity. This has positive effects on water infiltration and filtering, reduces soil erosion and increases grassland's ability to capture carbon. In many rangelands, livestock **play a role in the maintenance of firebreaks or help control weeds and invasive species**. In high mountain areas, grazing is used to reduce the risk of avalanches.

Thanks to their digestive abilities, livestock are able to recycle waste, crop residues and fibrous vegetation into readily available nutrients for human use and organic matter for plant growth and soil formation. Roaming livestock **distribute nutrients contained in dung and urine across landscapes**. In mixed farming systems, livestock recycle waste and excess biomass into valuable plant nutrition and useful produce.

Livestock breeds and regulating services

In the Plurinational State of Bolivia, Criollo cattle's low body weight, multipurpose uses and ability to eat fodder from shrubs and trees and digest feed of low nutritional quality make them appropriate for delivering ecosystem services in mountainous environments.

Saanen and Anglo Nubian cross-breed goats on the Cook Islands in the South Pacific help prevent the spread of invasive plant species.

Scottish Highland cattle, with their ability to digest plants of lower nutritional value, are used to improve pasture by removing unwanted species before other breeds are introduced to pastures.

Different livestock species and breeds can perform these roles in different environments across the globe. Certain breeds are adapted to dry areas. Others can survive in very cold climates or have the ability to navigate steep and rocky terrain. A breed's feeding behaviour can mean that it is well matched to a specific type of vegetation. When soils are fragile, lighter breeds are more appropriate than heavier ones. These various traits are a vital link between livestock diversity and nature's regulating and supporting services.

Challenges

- We do not consume regulating ecosystem services directly. Therefore their value is often under-appreciated.
- While the contribution of livestock species and breeds to regulating services is increasingly recognized, very little data and information are available on specific locations, environments and breeds.
- Breed extinctions and the erosion of animal genetic resources narrow our options to sustain nature's regulating services.

Did you know?

- Grassland systems are estimated to cover about 32 percent of the world's land area. In 40 countries, grasslands cover more than 50 percent of the land area.
- 45 percent of the world's breed populations for which links to specific habitats have been recorded are adapted to mountainous terrain or climatic extremes.

The roles of pastoralists

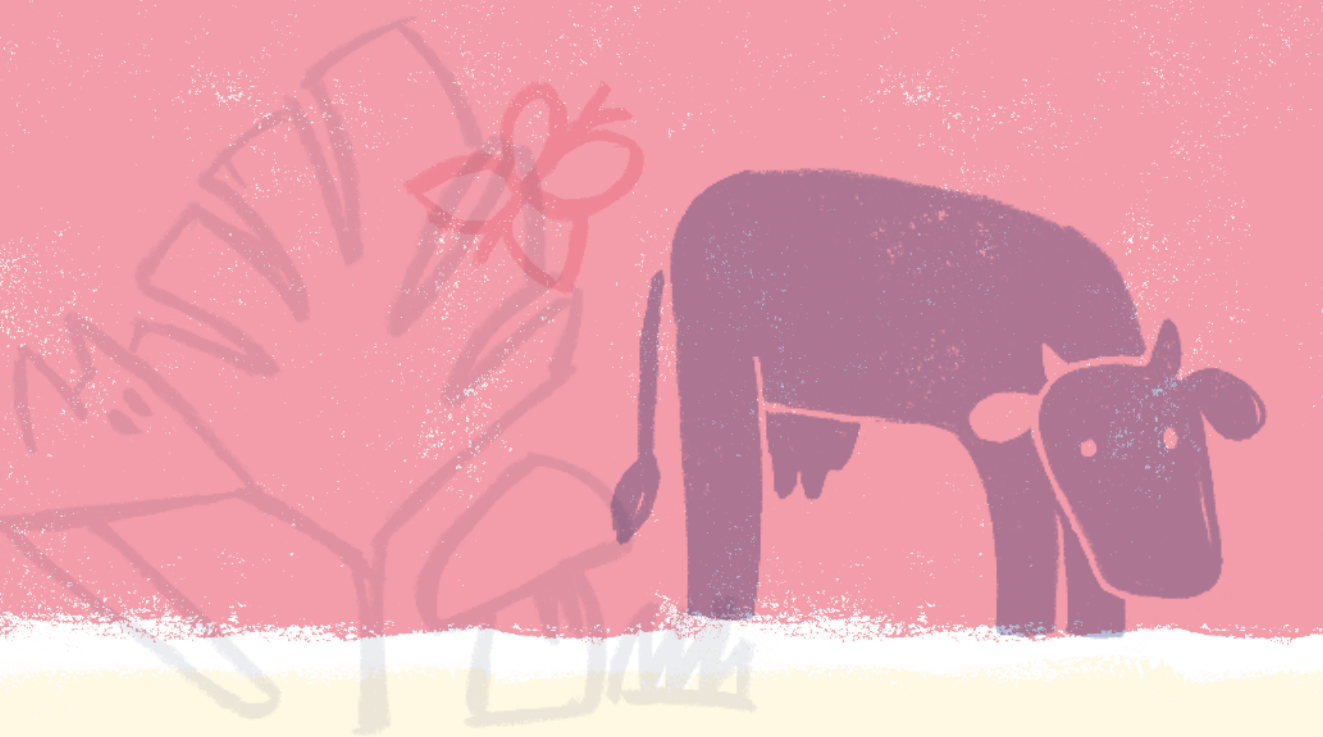
Some 100 to 200 million pastoralists, mostly raising indigenous breeds, are the predominant managers of the world's vast rangelands. Because pastoralists depend directly on nature, their cultures and livelihood systems often reflect a high appreciation and knowledge of ecological processes. While their numbers are relatively small, they make globally significant contributions to regulating and supporting ecosystem services through their careful management practices. Insecure tenure, political marginalization, cultural prejudices and poverty are among the factors undermining their invaluable roles.

- Out of the world's 8 774 recorded livestock breeds, 1 074 are considered to be adapted to drylands.
- Grasslands worldwide have the potential to sequester 1.5 gigatonnes of CO₂ per year under sustainable grazing management.
- Livestock plays a large role in nutrient cycling, which accounts for about half the economic value of all non-provisioning ecosystem services.

Useful actions

- Undertake an assessment and/or economic valuation of regulating and supporting services provided by livestock species and breeds in your country or area.
- Invest in infrastructure and services to livestock keepers in remote and marginal areas, thus removing barriers to the economic viability of livestock systems that provide valuable regulating and supporting services.
- Create labelling systems, niche markets and other reward mechanisms to offset livestock keepers' opportunity costs for sustainable management in remote and challenging environments.





SUPPORTING AND HABITAT SERVICES

Supporting services underpin other ecosystem services. Habitat services are an example, and refer to the role ecosystems play in **providing habitats for wild plants and animals, and in maintaining healthy gene pools.**

The world's grasslands harbour a tremendous diversity of plant and animal life. **Grasslands teem with herbaceous plant species, butterflies and other insects, birds, wild herbivores and predators.** Nearly a third of the world's globally outstanding areas for biodiversity are grasslands according to the World Wildlife Fund. Many of these landscapes have evolved along with livestock-keeping practices. In such landscapes, **livestock grazing can be vital in maintaining habitats for wild plants and animals.**



Biodiversity and ecosystem services

Biodiversity – understood as the variability of living organisms on Earth and the interactions between them – has a two-way link with ecosystem services. Biodiversity is an ecosystem service in its own right: for example, as a source of medicinal substances, a source of inputs for plant and animal breeding or as wildlife, with its recreational and existence values. Biodiversity is also indispensable for other ecosystem services such as pollination, pest predation and soil formation. Biodiversity ensures continued biological evolution and adaptation. It increases our planet's resilience in the face of environmental shocks and provides us with the raw materials to adapt our food systems to a range of possible futures.

When grasslands are lightly grazed, biodiversity tends to benefit, compared with intensive grazing or no grazing at all. Under careful management, livestock increase the diversity of habitats in the landscape (mosaic landscapes and mini-habitats). By altering the vegetation, they often maintain vital habitats for birds. Their selective feeding can help the growth of, or allow access to, plant species and parts preferred by wildlife (feed facilitation). By carrying seeds in their guts and coats, livestock distribute plant life across habitats (habitat connectivity).

Most of the world's prime areas for biodiversity are found in marginal, mountainous, dry or forested areas. Indigenous breeds are well suited to coping with these challenging environments. **There is a strong overlap between habitat services and the prevalence of indigenous breeds and the management practices of small-scale livestock keepers.** Human management practices are key. Overstocking or mismanagement can easily tip the balance from habitat services to disservices.

The significance of breed differences is mostly felt on low-quality pastures or on rugged and high-altitude terrain. The animals' hardiness, pasturing behaviour and dietary choices, along with their weights and sizes – all traits that differ between breeds – play a role. Particularly on dry pastures, only breeds that have few offspring and are low-producing can be sustained. On degradation-prone soils, the weight of the animals, their use of the terrain and their spatial mobility are important.



Livestock breeds and habitat services

Nublang cattle in Bhutan help control the bamboo *Yushania micorphylla* at altitudes of 2 400 metres or more above sea level. This bamboo crowds out indigenous plant species and reduces vegetation regeneration.

In Switzerland, the Engadiner sheep is the only sheep breed able to eat the leaves and bark of the green alder shrub (*Alnus viridus*), which can overgrow pastures quickly and prevent the growth of indigenous plant species.

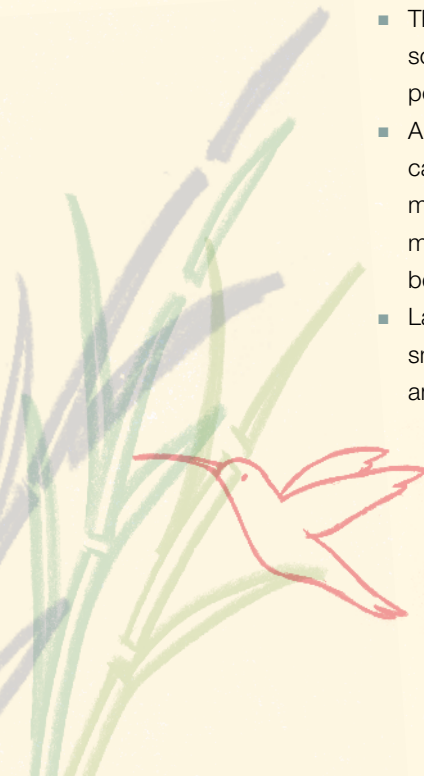
In East Africa, pastoralist and their drought- and disease-resistant breeds have co-existed with abundant wildlife in places such as the Serengeti plains and the Ngorongoro highlands for some 2 000 years. Forced removal and restrictions on grazing in protected areas can cause unwanted ecological succession and bush encroachment in wildlife habitats.

In France, the introduction of conservation grazing by Bretagne sheep and Chèvre des Fossés goats led to a 50 percent increase of birdlife and flora on degraded lands.

In Costa Rica, the government encourages seasonal livestock grazing in forest areas to control vegetation.

Challenges

- The removal of livestock keepers and their animals from landscapes can sometimes cause a decline in biodiversity. Recognition of livestock's positive roles in biodiversity conservation is still limited.
- A lack of reward to livestock keepers for the habitat services they provide can discourage them from continuing their beneficial practices. When markets value only provisioning services, the costs of sustainable grazing management and operating in remote and challenging environments can be forbidding.
- Land-tenure regimes and policies that discourage the practices of small-scale livestock keepers can lead to the loss of indigenous breeds and related habitat services.





Did you know?

- Rangelands harbour a rich flora: the combined diversity of the world's various climatic zones amounts to about 750 genera and 12 000 species of grass.
- Grasslands contain 11 percent of the world's Endemic Bird Areas, and contribute to the maintenance of pollinators and other insects that have important regulating functions.
- 53 of the 224 habitat types of the European Union's Habitats Directive are directly linked to agricultural practices, mostly grazing and mowing.
- In North America and Latin America, respectively, 10 of 32 regions and 9 of 34 regions rated as "globally outstanding" for biological distinctiveness comprise grassland ecosystems.
- A European survey found that most of the breeds grazing in protected areas were locally adapted and/or at-risk breeds, indicating the possibility of linking breed conservation with nature conservation.

Useful actions

- Start collaborations between nature conservation organizations, livestock keepers, businesses and policy-makers to define projects and programmes around common biodiversity and socio-economic goals.
- Invest in infrastructure and services for livestock keepers in remote and marginal areas to remove barriers to the economic viability of livestock systems that deliver habitat services.
- Create labelling systems, niche markets and other reward mechanisms to offset livestock keepers' opportunity costs for sustainable management in remote and challenging environments.





LIVESTOCK'S CULTURAL SERVICES

Cultural services are the non-material benefits people obtain from ecosystems through **recreation, spiritual enrichment, aesthetic experiences, cognitive development, a collective or individual sense of belonging, reflexion and inspiration**. Cultural services are an essential part of human well-being.

In most cultures, livestock infer social status and represent a socio-economic safety-net. Gifts of animals play a major part in human relations and at social events such as rites of passage, weddings and funerals. Animal sacrifice and the consumption of milk, blood and meat play a part in religious ceremonies the world over. Specific livestock species and breeds are sometimes **intimately tied to the cultural identity of a people**, a bond that features in creation stories and oral histories.

Indigenous livestock breeds have played a role in the formation of many unique cultural landscapes. **A breed's visual appearance may be an essential feature of a landscape**, while its particular characteristics (e.g. grazing behaviour) may be required for landscape maintenance. Indigenous-breed products that have particular tastes or textures feature prominently in many local cuisines. Local knowledge about food systems and food processing are important components of cultures.

Painters, writers and philosophers have drawn inspiration from landscapes since the beginning of history. The beauty of landscapes and the spirit of adventure they evoke help us relax, reflect and enjoy ourselves. Ponies, horses, donkeys, camels and cattle, for example, provide for many recreational and educational activities. Traditions surrounding livestock keeping can attract tourists, either directly or as part of the identity of tourist destinations. Advertising makes frequent use of imagery of livestock and their keepers.

In the case of many small-scale livestock keepers, livestock species and breeds are associated with unique indigenous knowledge systems and management practices, accumulated over countless generations.

The loss of livestock breeds and related production systems can cause rapid erosion of this heritage.

Cultural services can have a positive influence on how ecosystems are managed. They can inspire and regenerate values, normative systems and management practices that embody respect for nature's roles. Certain cultural services, such as landscape beauty or historical values, can be converted into significant income through practices such as eco- or agrotourism. Others are not directly economically tangible, but remain vital for human well-being and help maintain ecosystems by influencing people's choices.

Studies show that, in many cases, several breeds of similar adaptive type are able to provide the same or similar regulating and supporting ecosystem services. In such cases, the distinctiveness of traditional breeds lies in their

Livestock-related tourism

On the shores of Lake Natron in the north of the United Republic of Tanzania, Maasai pastoralists operate a community-based cultural tourism programme, where visitors can participate in herding and other livestock-related activities.

In Peru and other Andean countries, llamas and alpacas are part of many farm-related cultural tourism activities, while their meat provides many tourists with an authentic dining experience in local restaurants.

roles in the cultural and social lives of their keepers. Despite delivering the same or similar regulating and supporting ecosystem services, alternative breeds cannot replace the cultural value of a traditional breed in the short- to mid-term.

Challenges

- The economic value of certain cultural values is inherently difficult to quantify. This often means policy-makers give them low priority in spite of their vital roles in human well-being.
- A lack of reward to livestock keepers for the cultural services they provide can discourage them from continuing their beneficial practices.
- Insecure land tenure and policies that discourage the cultural practices of small-scale livestock keepers can lead to the rapid loss of cultural services.

Did you know?

- 16 UNESCO World Heritage Sites and three Globally Important Agricultural Heritage Systems are directly linked to pastoralism.
- Many populations of small-scale livestock keepers and pastoralists are identified as indigenous peoples.
- The annual value of pastoralist land use to the tourism industry in the north of the United Republic of Tanzania is estimated to be US\$83.5 million.
- Many of the world's most biologically diverse areas are also the most culturally diverse.
- Cultural values can be economically important. For example, Madura cattle in Indonesia that perform in cultural events have been found to attract prices 2 to 3.5 times higher than animals of the same breed that do not take part in such events.

Useful actions

- Develop opportunities for eco- and agro-tourism.
- Develop product labelling systems or niche markets for culturally unique produce derived from livestock breeds.
- Promote the inclusion of livestock dimensions in cultural policies and heritage conservation, as well as in nature conservation measures.
- Maintain vibrant rural communities by providing good of social services.
- Enable small-scale livestock keepers, especially pastoralists and indigenous peoples, to continue their livestock-keeping ways by providing secure tenure and respecting their rights.





UNDERSTANDING, VALUING AND INCENTIVIZING ECOSYSTEM SERVICES

To ensure the continued provision of all the ecosystem services provided by livestock species and breeds, their roles need to be protected and managed with care. The public-good nature of most non-consumptive services makes them a responsibility for governments. Our global interdependence on ecosystem services requires international cooperation. Action is required in three main areas.

Research and economic valuation

Ecosystem services provided by livestock species and breeds still need to be much better understood. The interactions between ecosystem services and the management of livestock, including the roles of breeds, need to be clarified. This will help experts and livestock keepers to make the right management and breed choices. Crucially, the social and economic value of livestock diversity's contribution to ecosystem services needs to be assessed and quantified where possible. This will enable policy-makers to prioritize and take the necessary measures. There is an urgent need for more research in this area.

Breeds for hire

In northern Europe, livestock keepers are hired by conservation organizations and governments to graze their adapted breeds in areas that depend on grazing for the maintenance of habitats and firebreaks.

Farmers in temperate climates hire herds of Scottish Highland cattle to improve the composition of pastures before other breeds are introduced.

Recognition

The life-sustaining roles of ecosystem services that we do not consume directly, such as regulating and supporting services, habitat and certain cultural services, lack visibility in many societies and economic systems. Education and awareness-raising are key to improving the appreciation and recognition of the vital services provided by livestock species and breeds, as well as the managing roles played by livestock keepers. This is a task for all stakeholders.

Incentives

Because many ecosystem services are economically invisible, the livestock keepers providing these services frequently come under pressure to abandon their traditional practices for more financially-rewarding opportunities. To address this problem, it is possible to develop incentive mechanisms that can enable the continued provision of these services, by compensating the livestock keepers for the economic value of ecosystem services not captured by existing markets.

Incentives can take various forms – ranging from regulatory (permits, laws, quotas) to voluntary (certification, labelling) – and can be packaged in various combinations. Incentives for Ecosystem Services (IES) are a form of remuneration under which the people who provide ecosystem services are compensated by those who consume them. For example, IES can be provided by private-sector entities that benefit directly from a given service, as a means of ensuring that supply is maintained. Public transfer payments or subsidies can help bring about systematic changes in livestock systems. Such incentives can include the creation of secure tenure systems, investments in infrastructure, extension services, electrification or improvements to access to water resources that enable livestock keepers to

Labels and niche markets

Voluntary schemes in Australia, Uruguay, the United States of America and Brazil certify and label beef from grass-fed cattle, helping producers to get premium prices for their produce.

In Italy, a fast-food chain found a niche in the market by exclusively using meat from the Chianina cattle breed.



improve their livelihoods while providing rich bundles of ecosystem services. This can be especially helpful in remote or inaccessible environments, away from markets, where livestock keepers are less able to rely on revenues from livestock products.



In order to create suitable incentives schemes, short- and long-term measures can be combined and supported by a variety of private and public stakeholders, linking the interests of producers and consumers of ecosystem services.

Challenges

- While the contribution of livestock species and breeds to ecosystem services is increasingly recognized, very little data and information are available on specific locations, environments and breeds.
- The economic value of certain cultural values is inherently difficult to quantify, which makes their protection a matter of societal and political choice.
- Pastoralists and smallholders are the guardians of much of the world's livestock biodiversity. Their capacity to continue this role may need to be supported – for example by ensuring adequate access to grazing land.
- In spite of grasslands' huge role and potential in capturing carbon, voluntary carbon markets for grasslands are underdeveloped compared to those for forests.
- Policies and financial mechanisms supporting incentives for ecosystem services schemes are not yet well developed.





Useful actions

- Develop research agendas that will improve understanding of the economic value and management of ecosystem services.
- Include ecosystem services issues in school curricula and economic development planning.
- Develop product labelling systems or niche markets for produce linked to ecosystem services, other than provisioning services, derived from livestock breeds.
- Promote investments in infrastructure, extension services, electrification and water resources in areas and livestock systems that produce rich bundles of ecosystem services.
- Develop incentives for ecosystem services schemes in your country or area.
- Enable small-scale livestock keepers, especially pastoralists and indigenous peoples, to continue their livestock-keeping ways by providing secure tenure and respecting their rights.



Find out more!

If you want to learn more, please see the following webpages:

- Learn more about livestock species and breed diversity at <http://www.fao.org/ag/anagr.html>
- Learn more about biodiversity and ecosystem services at <http://www.fao.org/ecosystem-services-biodiversity/en/>
- Read the full study Ecosystem services provided by livestock species and breeds, with special consideration to the contributions of small-scale livestock keepers and pastoralists at <http://www.fao.org/3/a-at598e.pdf>
- Visit the Pastoralist Knowledge Hub at <http://www.fao.org/pastoralist-knowledge-hub/en/>
- Learn more about incentives for ecosystem services at <http://www.fao.org/nr/aboutnr/incentives-for-ecosystem-services/en/>
- Learn more about Globally Important Agricultural Heritage Systems at <http://www.fao.org/giahs/giahs/en/>

**Human beings benefit
in countless ways from
ecosystems and biodiversity.
They provide food,
clean water, shelter and
raw materials for
our basic needs.
Directly or indirectly,
they underpin every aspect
of our lives.**