CONTRIBUTION OF HERBIVORES TO ENVIRONMENTAL MANAGEMENT AND CONSERVATION OF BIODIVERSITY

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Livestock farming uses nearly 60% of French agricultural land, and so is a major factor in the management of the countryside, especially in sensitive rural areas. The term 'management' has different implications according to whether the emphasis is on production, biodiversity conservation, landscape preservation or recreational use. Livestock farmers use their land first to feed their animals, while ensuring the persistence and quality of their forage resources. For environmentalists and the public authorities, livestock farming should preserve, and sometimes restore, local biological and heritage assets, and in certain areas it should conserve open areas, in particular to reduce fire risks. Lastly there is a social demand for the preservation of attractive landscapes for the pleasure of the local population and recreational use by city dwellers and holidaymakers. Besides these 'service' functions, a 'well-kept' countryside is an important cultural asset and forms a part of local identity. Rural features and patterns of use are a source of income through the diversity of landscape and the quality of local produce from livestock.

In what follows, 'biodiversity' means the diversity of the biosphere at the different biological scales (genes, species, ecosystems), with their specific functional and ecological variables, and forms one component of the environment. We address the issue of environment management by livestock farming in terms of the underlying processes in play. We explain trends in plant cover due to farming practice, and in particular to pasture management, in terms of both vegetation dynamics and animal grazing. We focus on grassland use, rangelands being not examined.

1. Effect of management practices on the evolution of permanent grasslands

Permanent grassland is composed of a mixture of between 10 and more than 100 different species sharing the 'same' environment and competing with each other for light, water and nutriments. The combination of management practice and soil and climate factors determines which species will become dominant or be maintained in each particular case. At any given level of fertilization and intensity of use of a plot, a species abundance profile can thus be established that is a measure of plant diversity (Fig. 1). Moderately extensive farming, combining low fertilization with late cutting, favours weakly competitive species with low growth rates and an aptitude for internal nutrient recycling, and so favours a broadly diverse flora. Conversely, intensive farming (high fertilization, early cutting) selects highly competitive species with a high capacity for nutrient capture and high growth rate, which eliminates most of the other species and so leads to an impoverishment of the flora (Cruz *et al.*, 2002). The entire grassland ecosystem and landscape can then become modified. For example, in uplands, the development of silage and bale silage practices, together with higher nitrogen fertilization makes it possible to start cutting at least one month earlier than previously, well before the plants have flowered, which in the medium term gradually narrows flora diversity by the reduced production of seeds (Carrère *et al.*, 2001). This in turn impacts on nectar-seeking and pollinating insects, especially butterflies and bees, which are deprived of the resources offered by flowers. Finally, the gradual disappearance of the colourful early summer flowering of the grasslands makes the landscape more uniform and so less attractive.

Hence, while it is possible through careful land use to combine area productivity with reduced releases into groundwater and the atmosphere, it is more difficult, and sometimes impossible, to combine high productivity and high plant diversity at plot scale. However, area productivity is not all. Extensively used grassland with diverse flora can however present characteristics that are valuable to the farmer, in particular a steadier nutritional value over the year due to the diversity of the species present and the staggering of their phenological cycle.

Concerning the dynamics of vegetation under very extensive farming, we observe that the plants in this type of environments include species of larger size, longer leaf life, and lower nutritional value owing to a greater proportion of supporting tissue. If grazing intensity is further lowered by a reduced stocking rate, then shrub and tree species can develop, gradually leading to landscape closure. Thus species diversity first enters a phase of enrichment through the coexistence of grassland and shrub species, and then narrows as grassland species are displaced. Grazing herbivores are thus necessary to keep the landscape open and preserve the biodiversity of grasslands.

2. Impact of dietary choices of herbivores on the evolution of grasslands

Herbivores make dietary choices in all types of pasture, but diet selection becomes increasingly important as vegetation becomes more heterogeneous and grazing pressure is reduced. An animal that has access to diverse resources and a quantity of grass in excess of what it can graze will tend to feed selectively on its preferred species and leave others ungrazed. An understanding of how the animal's choice is determined is thus an important factor in predicting the vegetation dynamics. A lot of the choice differences between different herbivore types (species, breed, physiological stage, age, etc.) can be explained by differences in energy requirements, intake capacity, dental and digestive anatomy (Rook *et al.*, 2004). Thus small ruminants, which require more energy relative to their gut capacity than large ruminants, tend to select higher quality foods. The shape of their dental arcades and their mobile lips enable them to sort plants and vegetative organs in the plant cover. In contrast, the larger muzzles of cows make them less able to sort plant items and to graze on short swards, where they no longer meet their requirements. On the other hand they are better

able to digest rough forages because of their longer residence time in the rumen. This is why cattle switch to poor quality grass sooner than sheep as the height of high quality swards is reduced (Dumont *et al*., 1995). These choice differences can result in a different evolution of pasture grazed by these two species. The proportion of *Nardus* within a good *Agrostis-Festuca* sward fell from 55% to 30% after 5 years grazing by cattle, whereas with the same stocking rate it increased to cover 80% of the sward when grazed by sheep (Grant & Hodgson, 1986).

The choice made by animals is also influenced by how familiar they have become with different foods by individual learning, and even more efficiently by social transmission. Early grazing experience of harsh vegetation at a young age prepares the animals to deal with these resources later on.

How animals graze a plot also depends on the distribution of preferred food resources. Sheep and cattle use their spatial memory to efficiently return to preferred feeding sites they have previously grazed. As it is easier to remember a few large patches than many small ones, they graze a preferred resource more readily when it is concentrated in a few large patches rather than disseminated throughout the plot. (Dumont *et al.*, 2002). This can favour the persistence of disseminated species of low abundance in the sward.

The positioning of points of attraction such as shelters, salt blocks and drinking troughs can improve how herbivores distribute within large and extensively-grazed pastures. Not installing all these points of attraction in the same location reduces damage to sward by trampling, provides a more even distribution of excreta, and induces the animals to move on from one point to another, and to exploit vegetation along their grazing journey.

3. Management and preservation of biodiversity at the farm scale

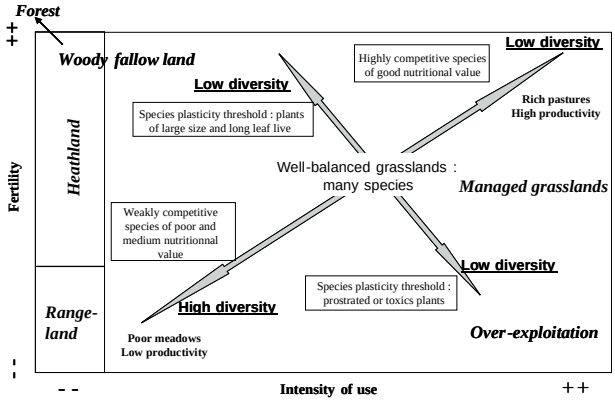
Environmental management and preservation of biodiversity cannot be conceived solely at the plot level. They have to be considered at larger scales, such as the whole farm or rural area. Within a livestock farm there is a great diversity of land use, from intensive use in early-cut plots (silage or bale silage) or plots near farm buildings, to a very extensive use for the least productive or least accessible plots, often left for grazing by animals with lower requirements. This diversity of plot management creates a mosaic of vegetation states conducive to an increased plant biodiversity at farm level through the juxtaposition of different plant communities (Fig. 1), and which also favours grassland microfauna. Orthoptera and lepidoptera will be favoured by the presence of extensively grazed plots, where they can find shelter and food, while coprophagous insects and predaceous ground beetles will be more numerous where plots are grazed intensively (WallisDeVries *et al.*, 2004). In addition to cut or grazed plots, a farm has hedges, isolated trees, stumps, stone heaps, ponds and ditches, the maintenance and preservation of which also contributes to the diversity of the flora and fauna.

Conclusion

Livestock farming, whether grazing is extensive or intensive, contributes to environmental management by maintaining open landscapes. However, the more intensive production systems reduce biodiversity for the sake of higher productivity, although the mosaic of differently managed plots at the farm level helps to preserve a certain overall biodiversity.

The income of livestock farmers in grassland areas depends closely on European funding linked to production or to agri-environmental measures. If the aim is to preserve biological diversity, whether for environmental protection or to conserve the specific features of local produce, then it is important to continue providing financial incentives to help livestock farmers maintaining extensive management practices (late cutting, low fertilization and stocking rates) on part of or the entire farm.

Figure 1 : Relationship between intensity of use, fertility, and biodiversity level in grasslands



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