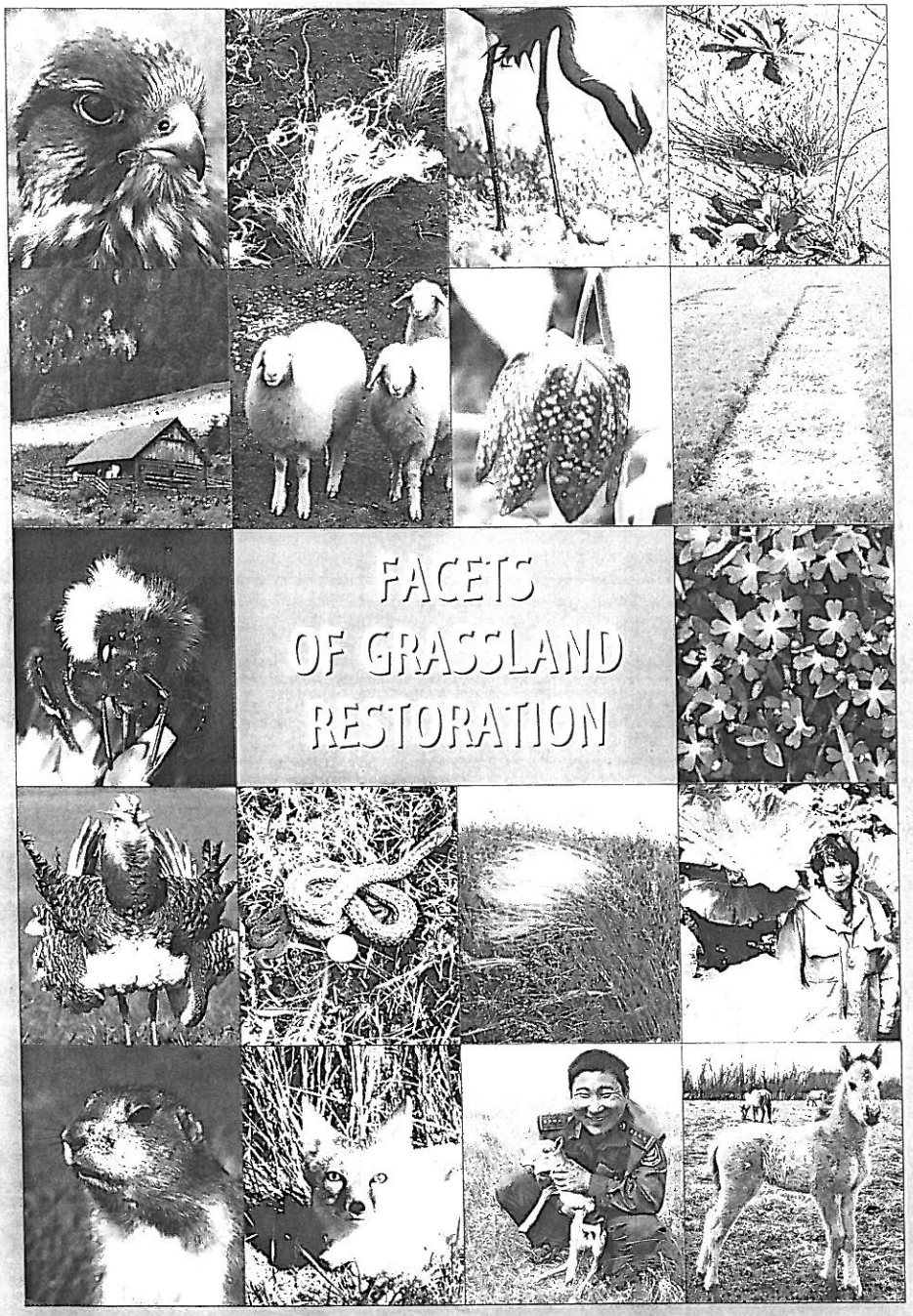

FACETS OF GRASSLAND RESTORATION

The Open Country Series

2005

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Restoring Species-Rich Grasslands in the UK: Research to Evaluate Practical Management Options for Farmers

Mike Hayes
Institute for Grassland & Environmental Research
Plas Gogerddan, Aberystwyth, Wales SY23 4UH, UK
mike.hayes@bbsrc.ac.uk

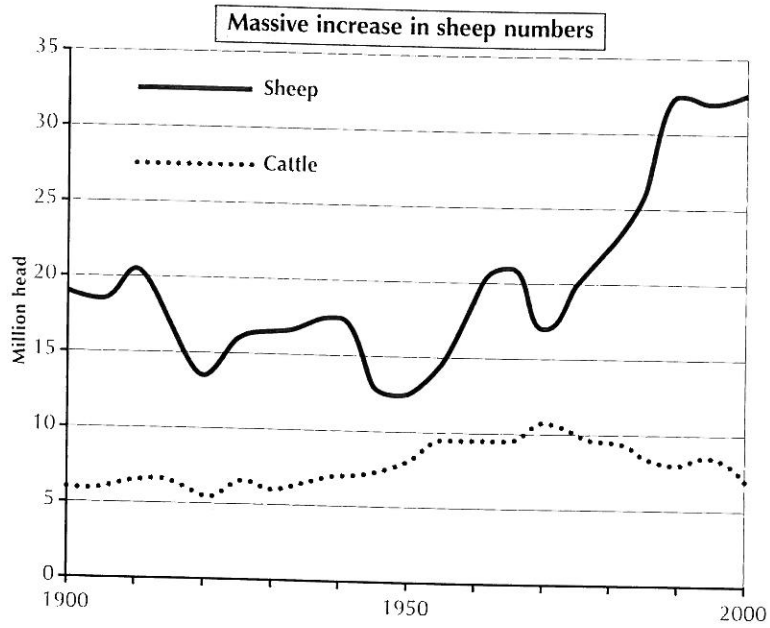
Introduction

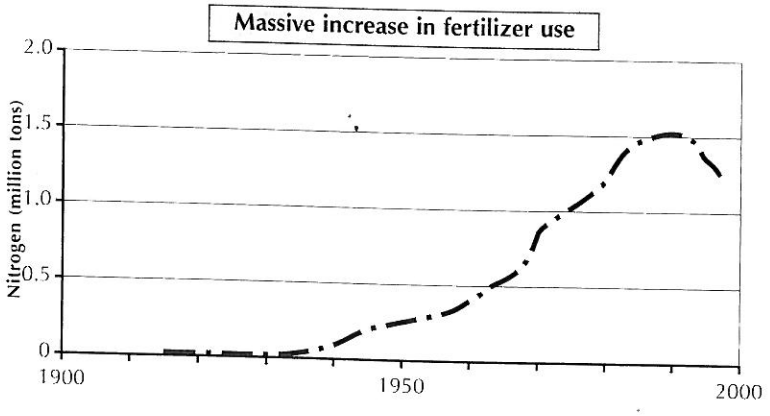
Grassland, in its various forms, dominates much of the landscape of western and northern regions of the UK. The soils, topography, and oceanic climate of these areas are well suited to low-intensity livestock farming which has historically played a major role in sustaining rural communities and maintaining the landscape, biodiversity, and culture.

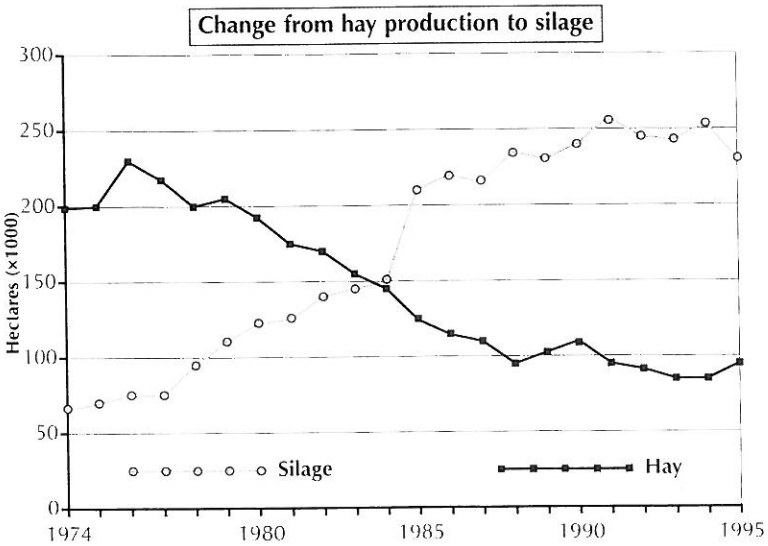
Many of Britain's most valued grasslands are closely associated with a long history of traditional pastoral practices.

However, over much of the last century the widespread adoption of intensive farming methods across the enclosed lowland landscapes of Britain caused major increases in agricultural production at the expense of a wide range of semi-natural grassland communities.

Impacts of 20th-century intensive agriculture in the UK:







The greater reliance on chemical fertilizers, re-seeding with productive grasses, drainage, and abandonment of many traditional management practices all contributed to dramatic reductions in the floral and faunal diversity of grasslands, as well as their overall extent. Indeed, scientists estimate that 97% of semi-natural lowland meadows and species-rich grasslands has been lost in England and Wales since the 1930s. As a result, grasslands of conservation value currently account for only a small proportion of the UK total and are largely confined to protected sites within a landscape dominated by intensive agriculture.

In the 1980s mounting concerns about wildlife and landscape conservation resulted in a reappraisal of attitudes and a re-balancing of government agricultural policy. This led to the adoption of the European Community's Agri-environment programme and changes in agricultural support mechanisms which seek to reconcile both agricultural and wildlife conservation objectives through financially supported land management agreements. The widespread introduction of such schemes now offers increasing opportunities for the restoration of various forms of semi-natural grassland habitats on agricultural land.

Research to Overcome Constraints on Restoration

Research has a vital role in providing a scientific basis for both the conservation and restoration of species-rich grassland communities. A primary requirement for successful grassland restoration is the need for a good understanding of the composition and associated key processes controlling existing "target" communities so that similar conditions can be re-created at potential restoration sites. It is also accepted that only with time can degraded grasslands evolve through the various stages of natural plant succession to truly replicate the diverse flora and fauna characteristic of former unimproved communities. However, research can help to identify the key stages necessary and propose management techniques that can be undertaken to speed up the restoration process. Moreover, each geographical region will usually require different restoration techniques and managements depending on local environmental conditions, the degree of site degradation, and the specific target community to be restored.

Within the agriculturally enclosed lowland areas of the UK previous intensive farming activities have imposed a number of specific physio-chemical and biological constraints on the restoration of species-rich unimproved grassland communities. The most important of these are the modification of the chemistry and physical structure of soils and the degradation of the local species-pools through agricultural improvement and habitat loss and fragmentation. Provided that minimum levels of soil nutrient are available, generally nutrient-poor soils tend to support higher species densities, since limited nutrients prevent the growth of potential dominants. Where significant applications of inorganic fertilizers have occurred over several years, raised soil fertility poses limitations on the re-assembly on target communities. Previous research has shown that high concentrations of available phosphorus and potassium in soils, often persisting for many years after agricultural inputs have ceased, can be a particular problem for restoration of species-rich grassland. As a consequence, it is usually necessary to alleviate/modify levels of such plant

Topsoil removal can help to reduce soil fertility, but is not a sustainable practice.

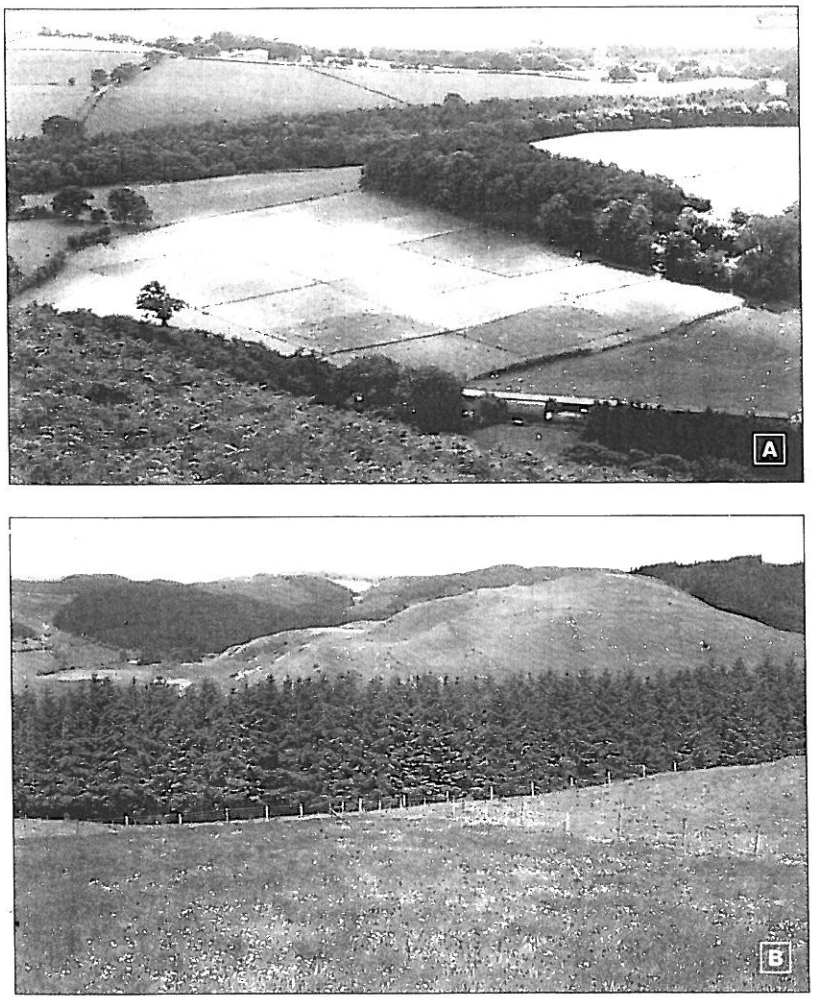
available nutrients to levels more characteristic of target communities. Biological constraints such as loss of desirable species, dominance of established competitive species, and inappropriate grazing management, also need to be overcome as a first stage toward the ultimate goal of restoring a fully functioning ecosystem.

Grassland Restoration Field Trials

The Institute of Grassland and Environmental Research is actively involved in a broad range of government-funded studies in relation to environmental management in UK farming, aimed to define and

manipulate sustainable grassland-based systems for the benefit of producers, consumers, and the rural environment. As part of a wider research programme on grassland conservation management, research is being undertaken to identify practical techniques for use in agri-environmental schemes for the restoration of various forms of semi-natural grassland on former intensively managed lowland pastures. Such information is specifically required for the more agriculturally and economically marginal areas of western Britain, where participation in agri-environment schemes is becoming increasingly important in helping to sustain viable farming enterprises. However, in order to be widely adopted by farmers, any proposed restoration measures need to be relatively non-intensive, inexpensive, and practicable; in such situations it is highly unlikely that widespread intensive restoration operations (e.g., deep-plowing, soil stripping or use of expensive seed mixtures) would be either acceptable to farmers or ecologically desirable.

In the early 1990s, large-scale field trials were set up at contrasting sites to compare a range of extensive restoration managements for their success at re-creating species-rich meadows (specifically forms of *Centaureo-Cynosuretum* grassland). The field trials were originally established in typical areas of agriculturally-improved species-poor pasture on sites selected to represent different edaphic and climatic conditions (see photos on the opposite page). Management treatments involve cessation of fertilizer inputs and application of a range of different combinations of cutting/grazing systems designed to reduce residual soil fertility and ameliorate soil/sward conditions to assist species recruitment and colonization. Restoration managements are applied to individually fenced plots laid out in fully replicated experiments. Changes in the species composition and diversity of the originally species-poor pastures are being monitored, together with associated changes in available soil nutrients and sward productivity. An additional, yet important, role of these field trials is to provide demonstration sites for the active communication of research findings to farmers.



Trial sites: A — lowland (alt. 60 m); B — upland (alt. 310 m).

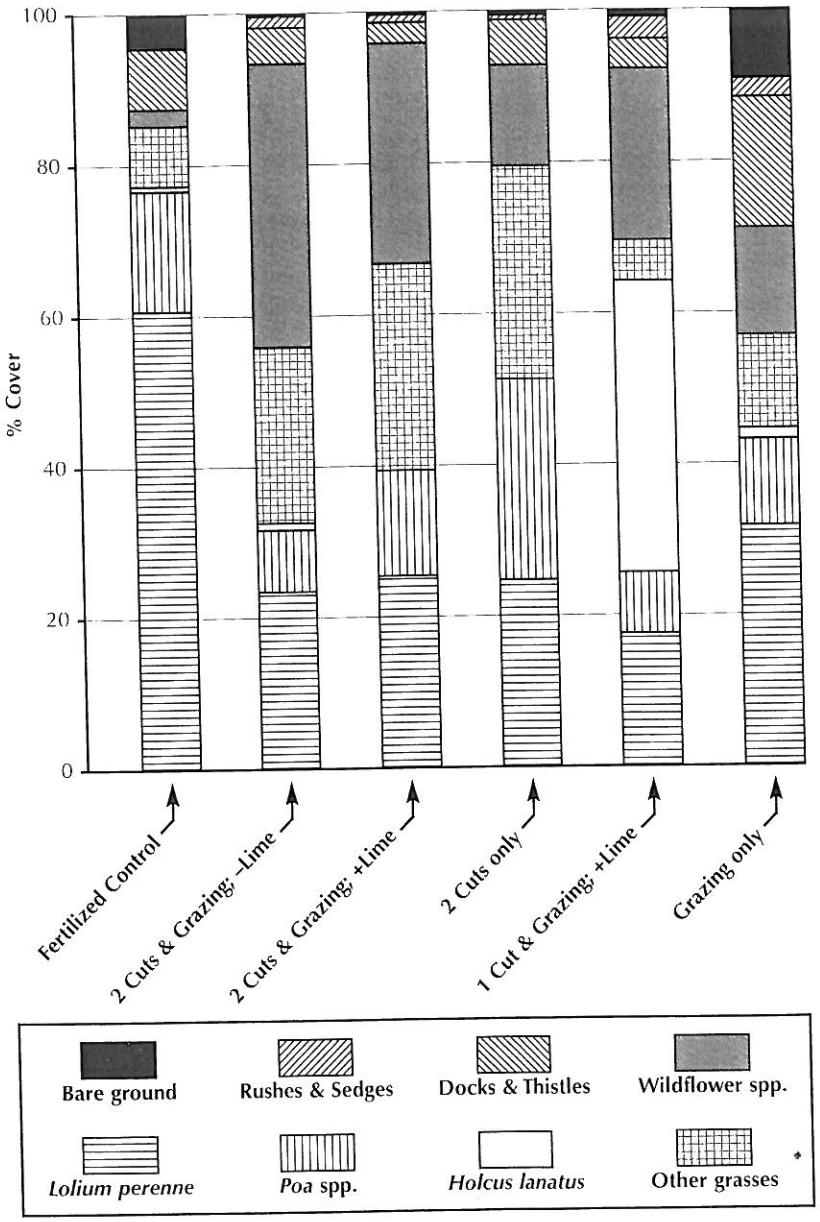
To date results have demonstrated that in the case of improved swards overlying soils of inherently low to moderate fertility (typical of many western regions of the UK), the promotion of receptive soil/sward conditions capable of facilitating grassland diversification can start to occur within a relatively short time scale (e.g., within 3–5

years). In such situations it appears that development of desirable target communities may be constrained more by the absence of appropriate species, rather than by problems of prolonged maintenance of raised soil fertility levels. This contrasts with findings from certain other parts of the UK, where more fertile soils (and, in particular, high phosphate levels) can maintain overly competitive sward conditions for many years, if not decades.

In terms of the success of the different management treatments in allowing progression towards semi-natural target communities, there are continuing significant differences in the extent and rate of change between treatments (figures 1 and 2 illustrate some of our findings). To date results have highlighted the importance of combinations of both nutrient depletion and sward disturbance to increase the rate of early successional change. Under these conditions there were significant increases in diversity through natural re-colonization by indigenous species, although the extent of this remains highly site-specific. The most successful management treatments for progression towards restoration targets are those incorporating the imposition of summer hay-cutting (ideally involving at least two summer cuts per year) followed by autumn/winter livestock grazing. These treatments appear to produce the most favorable conditions for rapid natural increases in diversity and progression toward target communities. Repeated hay cutting accelerates soil nutrient depletion and allows indigenous species to spread vegetatively (and also to flower and seed); aftermath grazing during the autumn and winter creates sites for seed germination, prevents seedling competition, and allows seed to be spread by grazing animals.

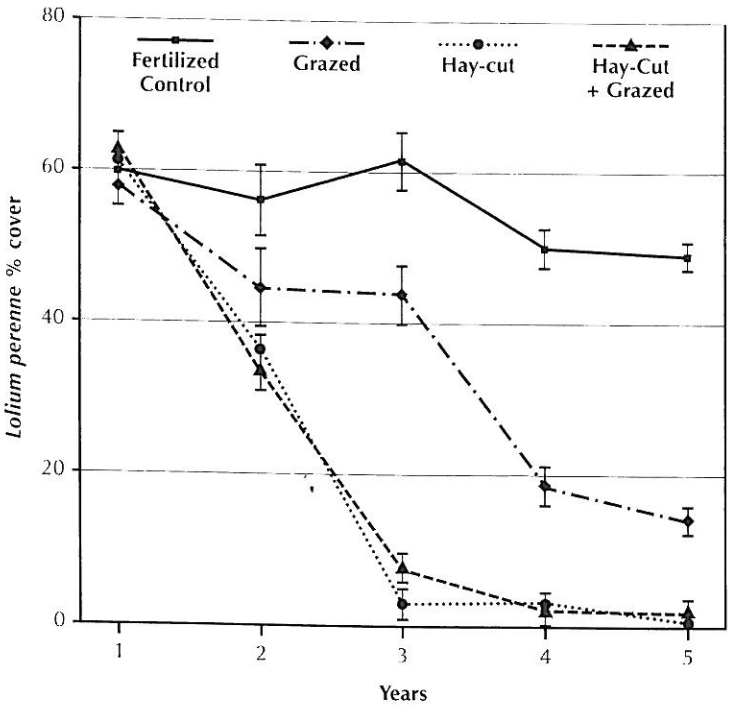
On sites with higher levels of residual soil fertility results have shown that the immediate imposition of the more traditional hay-meadow management (i.e., with just a single annual hay-cut in July with aftermath grazing) can result in a tendency for other aggressive colonizers (such as *Holcus lanatus*) to proliferate in the early stages of reversion. Such species were able to flower and seed under a July-cut system and thereby take advantage of the developing semi-fertile,

Figure 1. Lowland site: Botanical composition after 5 years



yet receptive, sward conditions.[1] Treatments involving hay-cutting alone (i.e., without any grazing) have produced poor results to date with only minor increases in desirable forb species (despite achieving the lowest soil fertility levels), which demonstrates the important role of grazing to create an open sward with microsites for seedling establishment as well as to reduce total biomass and nutrients. Treatments involving grazing alone have also been slow to reduce competitive sown species and only moderately successful at increasing diversity; they also tended to lead to undesirable increases in potentially problematic weed species, particularly thistles (*Cirsium* spp.).

Figure 2. Upland site: Changes in mean *Lolium perenne* cover (means of +/– lime treatments)



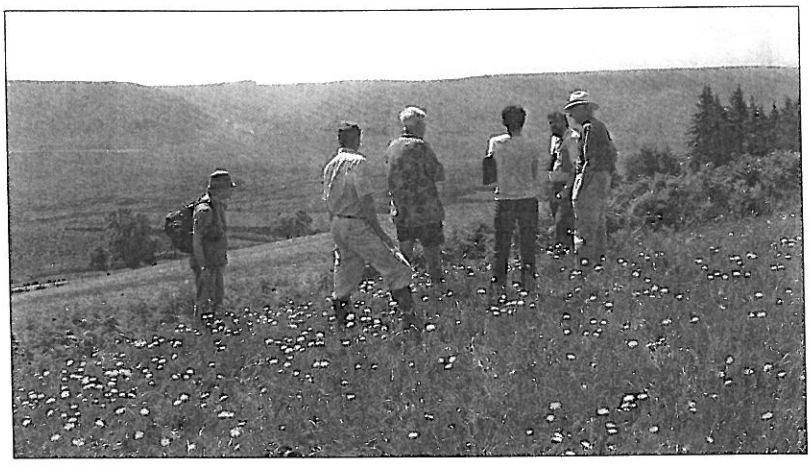
[1] *Holcus lanatus* is known to be a particularly aggressive colonizer and can form extensive dense patches that can prevent forb seedling establishment.

Despite the encouraging increases in diversity under appropriately managed treatments, most experimental swards are still in a highly dynamic state and are only at the early/mid-term successional stage. The precise time-scales for achieving target communities are yet to be determined and will clearly vary according to individual site conditions and depend particularly on initial soil fertility levels, soil type, the presence of colonizing species, rapidity of nutrient leaching through rainfall, and the management regime applied.

The Role of Phased Restoration Managements

Although the experiments are still ongoing, findings to date suggest that it may be advisable to introduce a "phased-management approach" for improved pastures entered into grassland restoration schemes. This would involve an initial fertility depletion and site-assessment phase, followed by a second phase concentrating on species colonization and further spread. For the first 3–5 years, site management should concentrate on reducing residual soil fertility by withholding all fertilizer inputs and imposing up to two hay-cuts per season where growth conditions allow. This would help to maintain the beneficial effects of inherent sward/soil heterogeneity and also facilitate the colonization of any surviving indigenous species by reducing sward competition. During this initial "fertility-depletion" phase, the potential for an individual site to be colonized naturally by desirable target species (i. e., without recourse to active species introductions) should be determined. On sites where suitable species are able to re-colonize naturally (from either soil seed-banks or from within the surrounding vegetation), there would then follow a second phase involving a return to a traditional management regime (such as a single summer hay-cut followed by aftermath grazing) allowing further seeding and dispersal of colonizing species. In practice the time-scales for these phases will need to be considered on an individual site basis, depending on assessments of the development of suitable soil fertility conditions and species colonization.

On those sites deemed to have only limited natural species colonization potential (e.g., those with a long history of agricultural improvement and/or botanically-isolated sites), it will probably be necessary to introduce seed of appropriate species to assist and speed-up the restoration of target communities. This needs to be considered as a separate "intermediate phase" in the restoration process and should be accompanied by suitable managements during the establishment period. Seed could be transported either by direct seed harvesting methods or, more easily, through spreading of species-rich hay. Findings from such seed-introduction studies have indicated that a range of desirable target species can be successfully introduced by seed, particularly if accompanied by frequent defoliation during the establishment year. Studies have also shown that it is often necessary to repeat seed introductions at periodic intervals as different regeneration niches tend to develop over time. However, in order to conserve and enhance both the species and genetic integrity of a locality, it is crucial that if seed is to be introduced that very careful consideration is given to its origin. The importance of conserving the genetic integrity of localized regional grassland populations and species is an integral part of the restoration of grassland communities.



Transfer of research findings to farmers.