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SALVERE

Semi-natural grassland as a source of biodiversity improvement

International Workshop

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CENTRAL EUROPE
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Contents

Semi-natural grassland as a source of biodiversity improvement - SALVERE

Michele Scotton[1]

1. Programme Interreg Central Europe 2007-2013

The project SALVERE has been funded within the first call of the INTERREG Central Europe Programme 2007-2013, whose **General aims**, as described in the Application manual, are:

1. strengthening the territorial cohesion;
2. promoting and intensifying the integration process;
3. enhancing the competitiveness of Central Europe.

Concerning its **geography**, the Programme comes from the former CADSES (Interreg IIC and INTERREG IIIB) area, which interested 18 EU countries (eastern Central Europe from the coast of the Baltic Sea, Eastern Mediterranean area and Balkan regions). In INTERREG 2007-2013, the former CADSES has been divided in two areas, Central Europe and South East Europe, where Central Europe includes 8 EU countries (whole or parts) (Czech Republic, parts of Germany, parts of Italy, Hungary, Austria, Poland, Slovenia, Slovak Republic) and 1 Permanent observer (Ukraine).

The Central Europe Programme **priorities** has 5, related to the specific needs of the region are:

1. Facilitating Innovation across Central Europe
2. Improving Accessibility of and within Central Europe
3. Using our Environment Responsibly
   - 3.1 Developing a high quality environment by managing and protecting natural resources and heritage
   - 3.2 Reducing risks and impacts of natural and man-made hazards
   - 3.3 Use of renewable energy sources and increase energy efficiency
   - 3.4 Use of environmentally friendly technologies and activities
4. Regions
5. Technical Assistance

For project funding, the Central Europe programme requires six main characteristics:

1. Transnational thematic focus
2. Coherent approach
3. Transnational partnership (at least three financing partners from at least three countries at least two of which are Member States)
4. Effective management
5. Effective knowledge creation and transfer
6. Concrete outputs and results

2. The project SALVERE within Central Europe

General traits of SALVERE

Within Central Europe, the project SALVERE has been funded for the period 2009-2011 and includes eight partners from 6 EU countries (see *Table 1* and *Figure 1*): Austria, Czech Republic, Germany, Italy, Poland and Slovak Republic. The project refers mainly to the programme third Priority, Using our Environment Responsibly, and, particularly to the Area of intervention 3.1 Developing a high quality environment by managing and protecting natural resources and heritage.

Background and general aims oft he project

Background of the project is the agriculture development of the last decades in Central Europe, where the agricultural intensification and the abandonment of the land more difficult to cultivate have led to a strong biodiversity decrease of extensively or less intensively managed agri-ecosystems, mainly grasslands, with a High Nature Value (HNV).

As a consequence of this development and of the 1992 Rio de Janeiro Convention on Biological Conservation, the recent EU regulations promote the protection of the biodiversity.

To implement this goal, the involved public and private institutions need the availability of native plant material. In the case of the High Nature Value (HNV) Farmland, this requirement is not sufficiently met in Central Europe as seeds of local provenance are seldom available on the market in larger quantities.

In this context, general aim of he project is to contribute to the practical realisation of the EU regulations regarding biodiversity by utilising the semi-natural grasslands as potential donor sites of seed to be used directly for the establishment of HNV Areas.

Principles and methods for the production and the use of seeds and plants of native species

According to the aim of biodiversity protection, within in the scientific community and the public institutions involved

[1] Prof. Dr. Michele Scotton, SALVERE Project coordinator, University of Padova, Department of Environmental Agronomy Agripolis, Viale dell`Universita 16, I-25020 Legnaro, michele.scotton@unipd.it

Table 1: **Institutions involved in SALVERE as project partners**

Institution name	Country	Town	Contact person	Role	N. associated institutions
University of Padova - Department of Environmental Agronomy and Crop Production	Italy	Legnaro	Michele Scotton	Lead partner	6
Research and Education Centre for Agriculture Raumberg- Gumpenstein	Austria	Irdning	Bernhard Krautzer	Project partner 2	7
Kärntner Saatbau reg. Gen.m.b.H	Austria	Klagenfurt	Christian Tamegger	Project partner 3	
OSEVA PRO Ltd., Grassland Research Station Roznov – Zubri	Czech Republic	Zubri	Magdalena Sevcikova	Project partner 4	3
Hochschule Anhalt (University of Applied Science)	German	Bernburg	Sabine Tischew	Project partner 5	6
Rieger-Hofmann GmbH	Germany	Blaufeld-Raboldshausen	Birgit Feucht	Project partner 6	7
Plant Production Research Centre - Grassland and Mountain Agriculture Research Institute	Slovak Republic	Banska Bystrica	Miriam Kizekova	Project partner 7	1
Poznan University of Life Science	Poland	Poznan	Piotr Golinski	Project partner 8	5

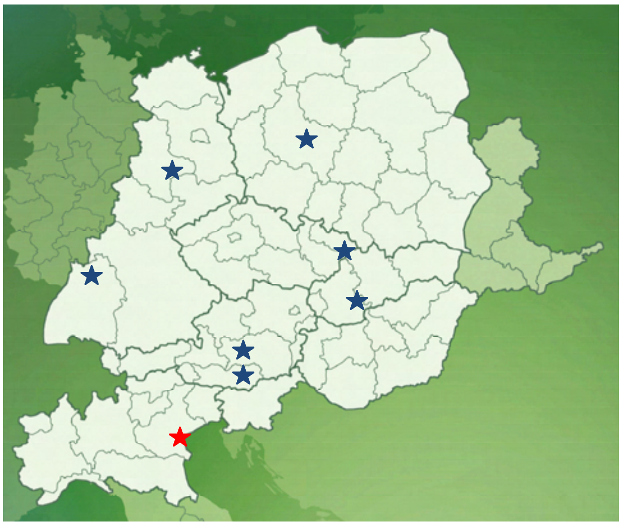

Figure 1: **Geographical distribution of the SALVERE project partners**

in ecological restoration, it is nowadays accepted that the seed and the plants to be used to restore a plant community should come from the native vegetations present in the geographically and ecologically nearest sites. For example, the Swiss Commission for Wild Plants Conservation (2001) specifies that the seed has to come from the same biogeographical region as the surface to be restored and that plants and seed have to be get from sites with similar characteristics as regards altitude (same elevation belt: hill/mountain, subalpine and alpine) and soil (humidity, nutrients contents and reaction).

The methods available to obtain propagation material of herbaceous native species are:

1. cultivations specialising in production of seed of native ecotypes. This approach needs availability of companies specialising in seed production and is easier for regions with low environmental variability (possible use of the produced seed on larger areas).
2. harvesting of seed from semi-natural grassland and its direct use for the establishment of HNV Areas. This approach doesn't need availability of companies specialising in seed production, is easily adoptable by companies working in ecological restoration in regions with high environmental variability and good availability of HNV semi-natural grassland.

The project chose to study this second approach as:

– it is a less studied approach;
– it can be adopted in every technical and environmental situation;
– it is particularly useful for environments with high species and vegetation diversity.

The project SALVERE: knowledge acquisition

Within SALVERE, knowledge concerning harvesting and direct using of the seed from semi-natural grassland will be both acquired and transferred.

With regard to knowledge acquisition the main focus of the project is to study the different methods available to harvest seed from species rich semi-natural grassland (WP5).

In connection with this main aim, also two other connected aspects are considered:

– the efficacy of the seed obtained with different methods in establishing HNV areas of different types (WP6)
– the seed amounts produced in semi-natural grassland (WP4)
– the role and the future of species rich semi-natural grassland in Central Europe (WP3)

In the project, the activities foreseen for the study of the harvesting (WP5) and restoration (WP6) methods will be inter-connected. According to the principle of geographical and ecological consistency, the establishment of new HNV areas will be done on sites (receptor sites) ecologically coherent with those, where the seed production and harvesting will be studied (donor sites).

The considered donor sites are referable to some types of semi-natural grassland important for Central Europe. According to the regional presence of the different types, some communities will be common to all partners, some others will be considered by only one or two of them.

The considered communities are:

– *Arrhenatherion elaius* communities (*Arrhenatherion elatioris*): this type, in its less fertilised and species rich forms, will be considered by all involved partners;

– *Bromus erectus*, *Molinia coerulea* and *Cnidium dubium* communities (*Mesobromion*, *Molinion* and *Cnidion dubii*); these types will be considered y by only one or two partners.

In the studies performed on the donor sites, the central point is the experimentation of the efficiency of different harvesting methods (WP5). The techniques considered by all partners are the harvesting as Green hay and with Thresher, i.e. those which need the lowest and the greatest cost of harvesting equipment. Other considered techniques, which require middle equipment investments, are Seed stripping and the harvesting as Dry hay.

The programmed trials and analyses are organised to check the differences among the considered techniques as regards:

– the amount of the harvested seed;

– the quality of the harvested seed, and, in particular, the average seed weight and its botanical composition as compared to the donor site.

Of each harvesting technique a comparison will be done also with regard to:

– the possible effects on the donor site and, particularly, on its botanical composition;

– the harvesting costs.

Connected with the harvesting trials the following aspects will be considered:

– the methods of analyses suitable for the evaluation of the quality of the seed mixtures obtained from species rich semi-natural grassland. The standard methods used to test the seed of single species (normally germinability tests at germination conditions suitable for each species) are not necessarily suitable for all species present in a seed mixture. The aim is to identify germination conditions suitable for more or less all species of the mixture;

– the procedures, which can be used to separate seed of single species within a seed mixture obtained from semi-natural grasslands. The separation could be useful to compose mixtures different than those obtained from the grassland and to use the separated seed for the propagation of single species.

The studies on the seed production of the species rich semi-natural grassland (WP4) are carried out for two reasons:

– to obtain some basis knowledge on an aspect of the semi-natural grassland, which has only seldom been studied;

– to obtain the information necessary to evaluate the results of the harvesting trials.

Concretely, the foreseen activities are:

1. the analysis of the total seed production of some important species of the considered grassland types, both grasses and forbs. Due to the different phenological behaviour of the several species and to the variability of phenological development of the single plants within a single species population, the total amount of seed produced by each species is normally much greater than the amount, which can be found on the same grassland at the harvesting time. The comparison among total seed production, standing seed yield at the time of seed harvesting and seed production actually harvested will allow to evaluate the total seed harvesting efficiency and the possible harvesting impact on the community.
2. the quality of the produced seed, mainly with regard to germinability.
3. a first attempt to model the total seed production and the standing seed yield in a semi-natural grassland, which would allow to estimate its development as a consequence of the temperature development.

The studies on the efficiency of the several harvesting methods done in WP5 find their completion in the experimental assessment of the herbaceous covers, which can be obtained with propagation material coming from semi-natural grassland. This is the main aim of WP6, which foresees the analysis of the quality of the communities as a consequence:

– of the harvesting method used to obtain the propagation material;

– of the type of receptor site (ex-arable field, mined area etc.).

The characteristics of the herbaceous covers considered to assess the effectiveness of the restoration will be the botanical composition (number and cover of the sown species) and the density of the herbaceous cover as compared to the donor site.

The second aim of WP6 is to show the target groups the efficacy of ecological restoration carried out with propagation material from semi-natural grassland. To this aim, both the experimental restoration trials and the demonstration sites organised on wider surfaces but with simpler methods (less propagation materials and not-experimental methods) will be used. The demonstrations, too, will regard different types of degraded areas, as degraded grasslands, ex-arable fields, ski slopes etc.

The activity of WP6 will be completed with the cost/benefits analysis of the restoration techniques considered in the project.

In the third work package, the concrete activities of acquisition of new knowledge foreseen in WP's 4-6 will be put into the context of the importance of HNV semi-natural grassland in Central Europe. Their recent development is characterised by a clear reduction of their total extent and of the contained biodiversity. Based on this fact, the work package foresees the evaluation of three aspects:

- the status quo of the HNV semi-natural grassland in some Central Europe regions included in the countries represented in the project;
- the analysis of the recent agro-environmental policies and of their impact on the extent of the HNV semi-natural grassland;
- the possible future development of the HNV semi-natural grassland;
- a study on the attitudes of the affected stakeholders;
- the proposal of possible strategic approaches to maintain and increase the presence of HNV semi-natural grassland in Central Europe.

The studies will be based on available information and on questionnaires and discussions done with technicians, stakeholders and policy makers.

The project SALVERE: knowledge transfer

This part of the project meets two explicit requirements of the Central Europe programme, that is the Effective knowledge creation and transfer and to the production of Concrete outputs and results.

In this project part, the main aims are:

- to integrate the acquired knowledge with that available in the literature;
- to exchange the obtained integrated knowledge within the project group and to transfer it to the main project target groups.

The Internal knowledge transfer will be carried out through:

- sharing of the adopted methods and of the results obtained in WP's 3-6;
- joint drafting of the Manuals and Guidelines by all partners, included those not directly involved in the knowledge acquisition (WP's 3-6);
- the participation of all partners in the national workshops foreseen within the project (WP2).

Here, the general aim is to contribute to the creation of a common background concerning the use of semi-natural grassland to establish new HNV areas. While taking into account the different environmental and agro-economic conditions of Central Europe, the common background should be made up by the principles, that can be shared in all situations and, at the same time, by the different methods, consistent with those principles, which are concretely applicable and adaptable to the different environments.

The intra-partnership sharing of principles and methods obtained in the three project years will be the basis of an effective transfer by each partner of the common knowledge within each country, also in the years after project completion.

The external knowledge transfer is addressed to several target groups:

1. decision makers and technicians of public administrations and private companies working in the conservation and the restoration of HNV Areas, who need knowledge about the methods of harvesting seed in semi-natural grasslands and of using it for the restoration;
2. farmers: farmers of regions characterised by intensive agriculture, who need biodiversity rich seed to reconvert to a less intensive management and farmers of the less favoured areas, who will be able to „sell" the biodiversity of their HNVF for the creation of new HNV Areas.

The transfer to these groups will be carried out with different tools:

- publication of Guidelines and Handbooks:
  - 3 Guidelines: Guidelines on Seed harvesting in HNV Farmland; Guidelines for Donor sites; Guidelines for High Nature Value Farmland establishment;
  - 1 Handbook for the utilisation, the seed harvesting and the establishment of High Nature Value Farmland;
  - 1 Proposal of a Native Plant Certificate;
- actions of direct contact carried out within:
  - the pilot actions foreseen in each involved country: guided visits to the surfaces restored within the project, organised in each involved country and addressed to a local public;
  - the national workshops and the international conference foreseen with six months frequency within the project in Austria, Poland, Czech Republic, Slovak Republic, Germany and Italy;
- actions of indirect contact:
  - website (www.salvereproject.eu);
  - electronic newsletter (six months frequency);
  - press releases and articles.

Conclusions

To achieve the foreseen aims, the project SALVERE provides the integration of components of different types:

- partners with different backgrounds and competences;
- the public interests of biodiversity protection with those of the private companies;
- the acquisition of new knowledge and the exploitation of already available knowledge.

The project will succeed insofar as the involved partners will be able to carry out all these integrations.

Relevance and functionality of semi-natural grassland in Europe – status quo and future prospective

Alan Hopkins[1]

Abstract

An overview is presented of the role and functions of semi-natural grassland (SNG) in Europe. SNG has declined in recent decades and, despite policy support through agri-environment schemes, threats from further intensification and abandonment remain. Evidence of their agricultural value in terms of productivity, forage quality and product value is reviewed. Production from SNG is typically less than 50% that of improved grasslands but comparable to unfertilized sown grassland; feed value is also variable with lower digestibility in SNG but differences in chemical composition may enhance the nutritional, health or gastronomic value of meat and dairy products compared with conventional feeding systems. SNG has an important role in biodiversity protection and in delivering ecosystem services which can contribute further to socio-economic values for rural communities. Many uncertainties surround the future for SNG as land management adapts in response to global changes including issues of security of food, water, energy and other agricultural inputs. Climate change poses threats to SNG in some areas, notably through water stress, but some types of SNG may be more resilient and contribute to mitigating the causes and effects of climate change. The role of SNG within the concept of multifunctionality is discussed.

Introduction

European grasslands vary greatly in terms of their management, agricultural productivity, sustainability, wider socio-economic values and their nature conservation status. Grasslands have existed in the temperate areas of Europe over millions of years. Their history of expansion and contraction, their co-evolution with large mammalian herbivores, and the exchange of species between other biomes such as steppe, forest, alpine and Mediterranean communities, and the effects of physical disturbance associated with grazing (by wild or domesticated herbivores), fire and farming (including mowing) have shaped their biota and diversity that remains today (Vera, 2000; Pärtel et al., 2005). The pivotal role of human intervention over thousands of years, mainly through farming, has led to the adoption of the rather imprecise term ‘semi-natural grassland’ (Van Dijk, 1991). Semi-natural grassland (SNG) is essentially that which has developed as a consequence of pastoral agriculture being imposed on cleared woodland or drained marshland, or to natural climax grasslands modified by human activity but which still retain a predominance of native species and remain relatively ‘unimproved’ in agricultural terms. It is a broader term than ‘High Nature Value’ (HNV) grassland (the subject of other presentations in this workshop) but is more specific than ‘permanent grassland’ which is a more general category that includes long-term but often agriculturally improved land lacking in environmental value. However, for SNG generally, and HNV grassland in particular, there are important linkages between the grassland habitat and the farming systems which maintain them.

Until the mid-20th century (and more recently in some areas) European grassland agriculture was generally of low intensity, enabling habitat diversity to co-exist with food production. Semi-natural grassland could be considered as both an input to, and a product of, pastoral farming. In the decades since the 1940s there has been a drastic decline in the extent and connectivity of SNG as a consequence of the intensification of agriculture. International recognition of the negative impacts of habitat loss and other environmental damage has led to the adoption of successive measures to incorporate nature and landscape conservation within EU farm policy, with similar arrangements in some non-EU states. In many countries, protection of biodiversity within agricultural habitats also became a commitment under the terms of the Convention on Biological Diversity in 1992.

The CAP is now increasingly aimed at delivering benefits to wider society, including environmental protection and the conservation of nature and landscapes. This is not just seen as meeting environmental preferences, but as essential for developing the long-term socio-economic potential of rural areas, encapsulated in the Killarney Declaration and the Malahide Commitments of 2004, and the 2010 targets of the European Biodiversity Strategy. There is also increasing recognition of the wider contribution of grasslands, and SNG in particular, to ecosystem services, including the protection of soils, regulation of water and its quality, and carbon storage. The present structures imply a long-term commitment to maintaining biodiversity objectives within the farmed environment and carry an increased urgency in an era of global climate change, population growth and concerns about security of resources. In the context of maintaining SNG this poses a number of challenges in terms of how these objectives can be met within the context of profitable and sustainable farming that delivers quality food production and wider ecosystem and socio-economic benefits. Nevertheless, the remaining areas of SNG in Europe face many threats and are vulnerable to the effects of land-use change from both intensification and reduced management or abandonment.

[1] Alan Hopkins, GES Consulting, Dunsford, Exeter, EX6 7JJ, UK and Honorary Research Associate, Centre for Rural Policy Research, Department of Politics, University of Exeter, EX4 4RJ, UK, a.hopkins@exeter.ac.uk

The objective of this paper is to present an overview of the relevance and functions of semi-natural grasslands in Europe at the present time, and to consider, in the context of policy changes and other drivers of change, the prospective for these grasslands in the future.

The status quo

Extent of semi-natural grassland in Europe

How extensive are SNG in Europe today? Statistics on the areas occupied by SNG are limited by the lack of precise definitions and different approaches followed in different countries which reflect differences in interest and concern for SNG as a habitat. The EEA (1994) report estimated that 15-25% of the European countryside supported farmland of high nature value, (mostly grassland) based on the EU15 countries. A more recent review (Emanuelsson, 2008) has considered regional differences and noted the serious losses of SNG in north-western Europe (Norway, Benelux, Denmark) and problems elsewhere due to the lack of grazing systems for maintaining SNG (notably in parts of Germany, UK and Sweden). The situation in eastern and central Europe is somewhat mixed: Romania is identified as the country that probably has the greatest well-managed SNG in Europe, but elsewhere contractions in the agricultural sector and uncertainties about land ownership have resulted in large areas of SNG now becoming unmanaged. In southern Europe the situation is also mixed, and there are many areas of remaining SNG and considerable interest in transhumance systems such as the Iberian dehesa and montado areas (Olea and San Miguel-Ayanz, 2006). In alpine regions SNG is often associated with tourism, and in many places it has a traditional link to niche food products (e.g. speciality cheeses) characterized by livestock feeding of forage (hay and grazing) of SNG mountain pastures and meadows (Lombardi et al., 2008). This concept of valorization of SNG through high-value products has gained attention in recent years and is being seen as an opportunity to improve the socio-economic value of farmland that has high conservation value (considered further in this paper).

The productivity and forage value of semi-natural grasslands

Herbage production potential, as well as its seasonal distribution, feeding value and the suitability of swards either for grazing or mowing are of paramount importance for farmers utilizing SNG. Factors affecting herbage production are primarily environmental: soil water, nutrient status, temperature and length of growing season. But these also affect sward botanical composition with the more productive grass species dominating under favourable conditions. Today, SNG is mainly to be found in areas of low growth potential such as mountain pastures, drought-prone shallow soils, coastal salt-marsh, heathlands etc., though there are some exceptions. Examples include lowland peaty areas and also situations where, for reasons of policy or land ownership, potentially productive grassland sites have survived with SNG under traditional low-input management. The evidence from both empiral studies and field surveys suggests that herbage production from SNG is generally low, especially when botanical diversity is high, and is typically less than half that which may be obtained from agriculturally improved grassland in the same localities (Peeters and Janssens, 1998). Most of the evidence is from cutting experiments and there are few comparisons under grazing due to the difficulties with determining herbage production under grazing. In a review of lowland experiments, Tallowin and Jefferson (1999) reported found that dry matter production (as hay) of unfertilized species-rich SNG was 0.2-0.8 of the production that might be expected from agriculturally improved and intensively managed grassland. However, it is important to recognize that comparisons need to be on a like-for-like basis and in most studies reported in the literature agriculturally 'improved' grassland is managed with at least moderate inputs of fertilizers. Studies comparing low-input SNG with similarly managed grassland based on sown species have usually shown much smaller differences, and in some cases their production may even exceed that of sown swards (Hopkins et al., 1990), for instance if the SNG contains species such as N-fixing legumes, or grasses and forbs that have seasonal advantages, e.g. deep-rooting species during dry periods.

These effects will often be greater in grazed grassland than in meadows because of the need of grazers to maintain adequate herbage over a longer growing season. There is also evidence from experiments with sown multi-species swards under nil or low nutrient inputs that herbage production can exceed that from swards composed of single species (Hector et al., 1999; Tilman et al., 2001). Based on multi-site European experiments, Hector et al. (1999) found that 29 of 71 common species had significant effects on productivity, with one species, *Trifolium pratense*, having the greatest effect. Thus, increased productivity with species richness as noted in this case is not a simple one of species numbers - since productivity can saturate at a relatively low number - but of functional groups, of which the presence of legumes, long recognized by grassland agronomists as essential components for production, is a key feature.

Herbage production is only a partial measure of forage value. How does the feeding value of herbage from SNG compare with other grassland herbage? There has been relatively little scientific investigation of the chemical composition of the herbage from SNG, and for individual plant species, especially non-legume forbs, compared with the main species of sown grassland. A review of factors affecting forage digestibility from SNG (Bruinenberg et al., 2002) concluded that digestibility is usually lower than in forages from grasslands used in intensive production.

Greater variation in forage digestibility in SNG swards is attributed to there being greater variation in heading dates and growth stages, and the presence of more forbs whose effects can be either positive or negative, depending on leaf : stem ratio. Bruinenberg et al. (2002) also urge caution on methodical approaches, noting that in-vivo predictions based on those for *Lolium perenne* can be inaccurate when applied to other species.

The most meaningful information on the feeding value of SNG forage is that based on animal performance. Findings reviewed in Bruinenberg et al. (2008) and Huyghe et al. (2008) indicate there is potential for feeding SNG forage in beef and sheep systems, where such forage will require a longer period to reach target weights, as well as for dairy heifers and even for lactating dairy cows. A number of studies have indicated that animal performance on SNG is better than might be expected from forage analysis and many research challenges remain to address this. In swards of diverse botanical composition livestock may be presented with an array of choices of species and plants at different growth stages, reflecting differences in content of carbohydrate, N, fibre, and possibly also minerals, condensed tannins and other secondary metabolites. The implications for grazing preferences and intake rates are considerable, especially for intake and feeding preference of non-legume forbs. Studies have shown that intake of fodder-based rations increases as the proportion of grasses declines relative to that of legumes and fine herbs (Jans, 1982; Lehmann and Schneeberger, 1988). The consequences of this effect show up in milk yield of dairy cows, with a reported 40% greater milk production potential from a green fodder diet with a grass : herbs+legume ratio of 40:60 compared with a ratio of 90:10. Plant morphological characteristics and sward responses to environmental stress can limit intake on some types of biodiverse pastures. On a cattle-grazed Cirsio-Molinietum fen meadow, low animal growth rates, low herbage energy value, and mineral imbalances and deficiencies were identified and these increased from summer to autumn (Tallowin et al., 2002). Thus, we can identify situations where SNG pastures provide resources for high intake of nutritionally adequate forage and others where this is not the case.

Intake of SNG forage will depend on the characteristics of the plants species present and their growth stage. Many grassland species have evolved adaptations as potential defence strategies against herbivory, including secondary metabolites, spines, toughened leaves etc. and adaptive growth forms such as basal rosettes and lignified stems (Herms and Mattson, 1992). In some cases there is an inference that herbivory, and thus intake of some forb species, will be lower than for grasses and forage legumes, especially under continuous grazing (but in other cases intake of forbs may be higher). The issue is further complicated by the consideration that some plant secondary metabolites may have evolved for other plant survival strategies (e.g. to attract pollinators) and thus not necessarily deter herbivory. Other metabolites are frequently found in the forb species of SNG (Rychnovska et al., 1994) and contribute to the grazing animals' nutrient requirements, including supplying fibre needed for rumen function.

Although measures of digestibility, and to a lesser extent protein concentration, are usually the main farm-scale indicators of feed value, other components of chemical composition of forage influence the quality of ruminant products and thus the potential output value of the grassland. A number of recent studies have highlighted positive benefits for feed derived from SNG for meat quality in terms of nutritionally beneficial fatty acids, vitamin E, skatol, carotenes and terpenes. There is also evidence that the milk from cows fed on forb-rich permanent grassland has higher contents of omega-3 and conjugated linoleic acids compared with milk from temporary grassland (Wyss and Collomb, 2008). These finding may also provide a scientific basis for the concept of 'terroir' which links locally produced foods to particular locations (Whittington, 2006; Wood et al., 2007). Cheese sensory characteristics are also affected by the production system, of which botanical composition of forages is one part of the 'terroir' effect (Martin et al. 2005; Moloney et al., 2008).

Semi-natural grasslands and biodiversity

Biodiversity protection has emerged as a key driver in environmental policy particularly since the1992 Rio de Janeiro Convention on Biological Conservation. Biodiversity protection is an issue of regional and global security. Grasslands are particularly important sources of biodiversity as hosts not only to a vast number of plant species but also to vertebrate and invertebrate fauna (Hopkins and Holz, 2006). Recent EU regulations promote the protection of key habitats and species and individual countries have targets which in some cases aim to increase the area of different types of SNG. The year 2010 was set for halting the loss in biodiversity loss and a point for reviewing progress in meeting targets (http://www.countdown2010.net/?id=35). The term biodiversity, however, extends beyond species, and issues of provenance have focused attention on the role of existing SNG as donor sites of seed for habitat creation or diversity enhancement based on native seed that respects the genetic diversity of SNG as well as diversity at the species and habitat levels. This is a potential new economic benefit for land managers of donor sites where the value of agricultural production might otherwise be low. In many areas adequate supplies of seed of native ecotypes are seldom available.

Other ecosystem services associated with semi-natural grassland

The concept of 'ecosystem services' emerged in the late 1990s and was incorporated into the Millennium Ecosystem Assessment (2005) which classifies ecosystem services into four main groups summarized below. The examples listed within each group indicate some of the existing and future functions that can be associated with SNG in Europe:

1) **Provisioning services:** products of ecosystems such as food (e.g. meat, dairy products, herbs, honey), genetic material (e.g. for new forage accessions and seed for habitat restoration projects), fresh water.

2) **Supporting services:** those that underpin other services, e.g. soil formation, carbon fixation through photosynthesis, nutrient cycling, water cycling.

3) **Regulating services:** stability to the natural environment, e.g. through regulating air quality (mitigating Greenhouse Gas emissions - CO_2 sequestration and CH4 capture), water quality, soil erosion (stabilization

on slopes), water run-off (water retention and stem flow regulation).

4) **Cultural services:** non-material benefits that can affect health and well-being, e.g through recreational opportunities (including agro-tourism) and aesthetic experiences (including the aspects of 'terroir' food products that add a cultural experience beyond food as a provision).

Future prospective

The preceding sections have emphasized the important role of SNG in contributing to agriculture, rural livelihoods and the wider rural environment. Losses of SNG have occurred, and continue to occur, as a result of agricultural intensification, abandonment and other land-use changes. What is the future for SNG in Europe and can its functions be developed further? Although outcomes cannot be predicted it is relevant to examine the drivers of change that are impacting on land use and determining rural land-use policy and to consider these in terms of the relevance of SNG.

Global population growth, declining resources and food security

The role of technology combined with public policy has enabled European farming to raise food production that matches or even exceeds present demand, and the development of agri-environmental policies since the 1980s can be seen as an 'environmental dividend' of that success. If global population growth continues to the 15 billion projected to occur this century will it be possible to reconcile environmental and food production objectives? Opportunities for agricultural intensification are, however, likely to be limited by declining stocks of resources that are part of the food production chain, notably oil, water (EEA, 2009) and phosphorus for fertilizer (EcoSanRes, 2008), and this strengthens the argument for retaining a sustainable management of low-input SNG as part of a multiple role rural land use. There are clearly many policy and research challenges for determining how SNG can contribute to these multiple goals.

Climate change

Projected changes in global climate change, attributed, at least in part, to increased atmospheric emissions of Greenhouse Gases (GHG : CO_2, CH_4 and N_2O) are widely considered to pose threats and uncertainties for land use management in the decades ahead. Key features of climate change scenarios for Europe indicate higher temperatures in summer and winter, increased winter rainfall in most regions and more frequent extremes of weather (Hopkins and Del Prado, 2007). Impacts are considered likely to be greatest for grasslands in southern Europe (droughts and increased fires leading to desertification), northern Europe (drying of tundra), coastal areas affected by rising sea levels (inundation of salt marsh etc) and alpine areas (reduced water from snow melt). Seasonal drying of wet grasslands is a particular threat. Enhanced CO_2 also has implications for photosynthesis and in leading to shifts in species composition of diverse swards.

Although livestock farming is often seen as a contributor to GHG emissions, extensive grassland including SNG probably has the greatest potential to contribute to mitigating this, through net CO_2 sequestration into herbage and soil and possibly also through CH_4 capture (reviewed in Hopkins and Lobley, 2009). (However, against this there is the issue that the longer periods required for grazing livestock to reach maturity on extensive grassland means CH_4 emissions are greater per unit of product, though not per hectare.) There is also a potential for SNG to be managed to help in regulating the overall impacts of climate change, e.g. through water retention and reduced surface run off from slopes following intense rainfall, as well as through the functions of soil structure relative to soil on cropland, and the benefits of having species that can be adapted to seasonal changes, such as deep-rooting plants in dry periods.

Land use changes and bio-energy

One consequence of both declining energy supplies and of measures to reduce GHG emissions is the emergence of biofuel cropping as an alternative land use. High prices for food commodities are likely to deter the conversion of arable and improved grassland to biofuels, and this leaves the option of SNG and other low output grasslands to be used for biomass. There may be potential on some sites suited to machinery access for the harvesting of SNG as a fuel for combustion or as a feedstock for biodigestors, but there is also a threat to SNG habitats that this might adversely affect their other environmental values (Stein and Krug, 2008). There is clearly a need to identify managements that can satisfy both nature and bio-energy requirements.

Socio-economic benefits of semi-natural grassland

The previous paragraphs have highlighted the roles of SNG in contributing to agricultural production and the potential for high-value products linked to the SNG environment or production system. This assumes greater importance as the links between livestock diets and the balance of fatty acids, and their human health implications, suggest that by some measures SNG forage can be regarded as of superior economic value. But SNG also provides other benefits to society beyond the immediate rural locale, including potential benefits for future use, as well as existence values of nature and landscapes (Lehman and Hediger, 2004). One further example is the future potential for carbon trading which offers the prospect to support the funding of surplus or abandoned land to be restored to appropriate management.

Multifunctionality: a unifying concept for policy makers to maximize the relevance of semi-natural grassland?

The concept of multifunctionality has been developed by academics and policy makers over the past decade as a concept for linking economic, social and environmental aspects of land use against a background of post-productivist agriculture (Wilson, 2007). There is scope to develop this concept around the future roles of SNG, identifying the particular strengths where there are good overlaps. For instance, situations where SNG enables the production of foodstuffs of high nutritional or gastronomic value which are able to raise living standards and well being of farmers an associated rural businesses, while at the same time maintaining rural communities and halting land abandonment and also delivering strong environmental goods such as biodiversity protection and regulating ecosystem services. This concept also enables the identification of situations where there inherent weaknesses in functions that SNG delivers: how can we maintain SNG entirely on the basis of its biodiversity or other environmental values, or when its economic or social values are low how these can be raised, for instance through training and rural development programmes. However, in a world with increased market liberalization there is a threat that environmental support payments linked to multifunctional land use may also be challenged as an opportunity for subsidizing agriculture within the framework of European rural policy (Potter and Tilzey, 2007).

Conclusions

Semi-natural grassland has many important roles in contributing to a multifunctional rural land use. Although its agricultural value in terms of forage production and feed value is low compared with more intensive grasslands, there is a clear potential for SNG to contribute to livestock production, particularly for niche products, linked to environmental and social values. Many uncertainties remain concerning the future for SNG and for future rural land-use policy in general. Security is now emerging as a new leitmotiv in rural policy development amid concerns about global food supplies, water, energy and other inputs, as well as the impacts of climate change, and this focuses on the need to identify resilience and weaknesses in land-use systems. The future prospective for SNG lies in strengthening the overlapping values of economic production, environmental deliverables and social benefits to rural communities and beyond.

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High Nature Value Farmland as an European evaluation indicator - definition, function and status quo -

Andreas Bartel[1]

Agriculture is still one of the main drivers of biodiversity loss in landscapes of Europe. This because of growing intensification on one hand, on the other hand land abandonement and the loss of traditional farming practices, which have often generated species rich habitats. Thus agriculture loses on both ends, which led to the idea, that farming styles, which favour biodiversity rich landscapes, should be valued for that „service“.

The High Nature Value farming concept was established in the early 1990s and describes those types of farming activity and farmland that, because of their characteristics, can be expected to support high levels of biodiversity or species and habitats of conservation concern (Baldock et al., 1993; Beaufoy et al., 1994; Bignal and McCracken, 2000).

The IRENA operations by the European Environment agency first led to a concept of an indicator named „high nature value farming“. The definition given by Andersen (2003) is still agreed on:

„HNV farmland comprises those areas in Europe where agriculture is a major (usually the dominant) land use and where that agriculture supports, or is associated with, either a **high species and habitat diversity** or the **presence of species of European**, and/or national, and/or regional **conservation** concern, or both“.

Hence HNV Farmland is characterised through three criteria:

1. **Low intensity farming characteristics** - biodiversity is usually higher on farmland that is managed at a low intensity. The more intensive use of machinery, fertilisers and pesticides and/or the presence of high densities of grazing livestock, greatly reduces the number and abundance of species on cropped and grazed land.
2. **Presence of semi-natural vegetation** - the biodiversity value of semi-natural vegetation, such as unimproved grazing land and traditional hay meadows, is significantly higher than intensively managed agricultural land. In addition, the presence of natural and semi-natural farmland features such as mature trees, shrubs, uncultivated patches, ponds and rocky outcrops, or linear habitats such as streams, banks, field margins and hedges, greatly increases the number of ecological niches in which wildlife can coexist alongside farming activities.
3. **Diversity of land cover** - biodiversity is significantly higher when there is a „mosaic“ of land cover and land use, including low intensity cropland, fallow land, semi-natural vegetation and farmland features. Mosaic agricultural habitats are made up of different land uses, including parcels of farmland with different crops, patches of grassland, orchards, areas of woodland and scrub. This creates a wider variety of habitats and food sources for wildlife and therefore supports a much more complex ecology than the simplified landscapes associated with intensive agriculture.

First, HNV was developed in an „area approach“, which tried to mark certain areas as HNV. Further Studies for the European Commission, DG Agriculture and thus in the framework of Evaluation of rural development programmes, stated, that it is clearly not the objective to delineate or designate particular areas as HNV, but rather to use rural development measures to preserve and develop HNV farming and forestry systems. (IEEP 2007a, 2008). This sets an important emphasis on the systemic view of farming practices, together with landscape and habitat characteristics.

The result of these works is a guideline, which gives a concept to the memberstates, how to develop a reportable set of indicators, which depict the status, trends in quantity and quality, and - as the final goal - the impact of RD-measures on the resource of „High nature value farmland“.

Summary of the guideline

Token from the 2nd newsletter of the European Evaluation Network for Rural Development (2009):

The High Nature Value (HNV) Impact Indicator is one of seven indicators provided by the Common Monitoring and Evaluation Framework (CMEF) to assess the impacts of the 2007-2013 rural development programmes. Along with the Farmland Birds Indicator, the HNV indicator is intended to contribute to assessing the impact of programmes on biodiversity.

Indicators for HNV farming and forestry are in their infancy, and this HNV Guidance Document is intended to assist Member States in developing a workable HNV monitoring framework. The document is developed from, and replaces, a draft HNV Guidance Document that has been in circulation since 2007. Both documents build on a study carried out for DG Agriculture of the European Commission in 2007 (IEEP, 2007).

The challenge for Member States is to devise a set of indicators that will provide meaningful information on changes in the extent and in the condition of HNV farming and forestry, during the seven years of the rural development programmes.

[1] Dipl.Biol. Andreas Bartel, Umweltbundesamt, Federal environmental agency, Spittelauer Lände 5, A-1090 Wien, andreas.bartel@umweltbundesamt.at

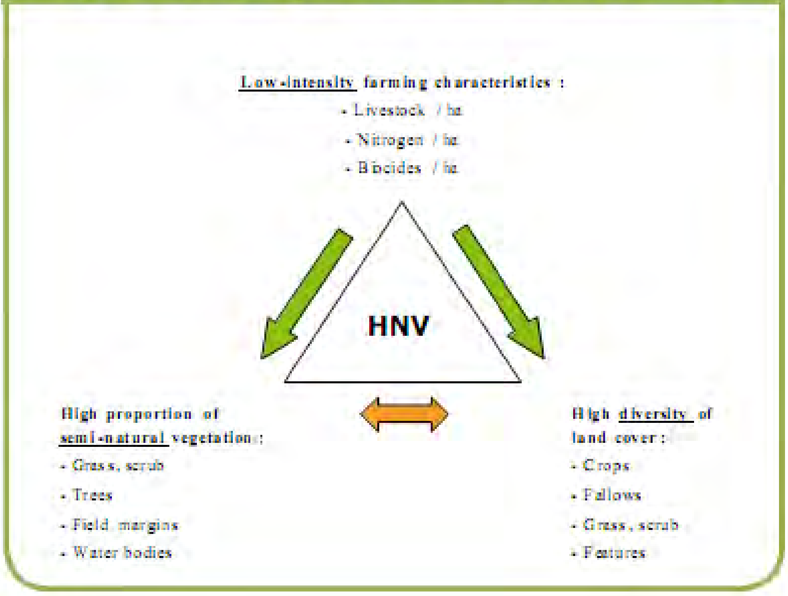
Logically, the first step is for each Member State to assess the baseline situation against which the changes can be measured. This means estimating the extent of HNV farming and forestry, and gathering information on its condition in terms of farming practices and associated wildlife species and habitats.

The HNV Guidance Document emphasises that the objective is not to delineate or designate particular areas as HNV. The policy priority for HNV as set out in the Community's Strategic Guidelines for rural development is to use measures to preserve HNV farming and forestry systems. The idea is to contribute to nature conservation by supporting the broad types of farming and forestry that favour biodiversity, not to designate particular areas as HNV.

So what are these HNV farming and forestry systems, and what indicators can be used to monitor changes in their extent and condition? In simple terms, they are types of farming and forestry that, because of their characteristics, can be expected to be high in „nature value", meaning biodiversity generally, or particular species of conservation concern.

The HNV Guidance Document explains the broad land-use characteristics that are known to be critical for supporting nature value, and which then provide the basis for designing indicators for HNV farming and forestry. *Figure 1* summarises these characteristics.

Figure 1: Three Key Characteristics of HNV Farming



As the diagram illustrates, high nature value results when certain patterns of land cover (those with a high proportion of semi-natural vegetation and a diversity of types) are managed for production in a particular way (under low intensity systems). This situation occurs most frequently with low-intensity livestock farming. This type of farming is unique in harbouring numerous habitat types from Annex 1 of the EU Habitats Directive, ranging from hay meadows to wood pastures and heaths, which depend on the continuation of low-intensity grazing and/or late mowing for their conservation.

Most arable farming is too intensive to be HNV, but there are some areas where this is not the case, especially in southern and eastern Europe. These are usually low-yielding, low-input dryland systems retaining a signifcant proportion of fallow and semi-natural vegetation. Traditional orchards and olive groves can be of high nature value. Key characteristics are large old trees, a semi-natural understorey - which is often grazed by livestock - and no or minimal use of nitrogen fertilisers, biocides or broad spectrum insecticides.

Semi-natural features such as hedges, copses and ponds, are signifcant for some types of HNV farmland, especially low-intensity cropping and bocage landscapes. Where semi-natural features survive on intensively managed farmland they conserve vestiges of biodiversity in landscapes that otherwise are of limited nature value.

The HNV Guidance Document explores these key characteristics in more detail, and explains how they can form the basis for the design of indicators to monitor trends in HNV farming and forestry. A four-step approach is presented, with suffcient fexibility to be adapted to the conditions of different Member States, which can be summarised as follows:

Step 1 - *Describing and characterising the main types of HNV farming and forestry in the Member State*

The first step is to gather information on existing types of HNV farming and forestry, and particularly on aspects that can provide the basis for designing HNV indicators:

- The predominant land cover associated with each HNV system, such as the types of seminatural vegetationand of cropped land, highlighting features that make a signifcant contribution to nature value.
- Farming/forestry characteristics and practices, i.e. how the land cover is managed, the grazing and mowing regimes, cropping patterns, livestock densities, nitrogen inputs.
- The nature value associated with these types of land cover and farming/forestry practices, especially species and habitats of conservation concern.

Step 2 - *Developing indicators of the extent of HNV farming and forestry systems*

The HNV Guidance Document proposes using a basket of indicators for estimating the extent of HNV farming and forestry, drawing on a range of data sources, such as land cover data, farming statistics, or the distribution of wildlife species. For example, an indicator of the extent of HNV livestock farming could be the total area of semi-natural vegetation used for grazing or mowing. Another could be the total area of forage declared by holdings with a livestock density between thresholds that are associated with HNV. These would be defined on the basis of information gathered in *Step 1*. Similarly, data on the extent of arable land with a proportion of fallow within defined thresholds can provide one indication of the extent of arable land that is likely to be HNV.

Existing data sources on land cover and farming characteristics are far from perfect, and will afford only an approximate picture of the extent of HNV farming and forestry. Data showing the distribution of wildlife species on farmland can provide a complementary picture.

Step 3 - *Developing indicators for monitoring changes in the extent and condition of HNV farming and forestry*

Changes in the extent of HNV farming and forestry can be monitored by means of the indicators developed in *Step 2*. Changes in condition are more difficult to assess, as the baseline situation cannot be defined so clearly. The HNV Guidance Document proposes using sample surveys to assess trends in the most relevant farming practices. Changes observed in suites of species associated with different types of HNV farming and forestry will provide another indication of trends in HNV condition.

Step 4 – *Applying the indicators to assess changes in HNV farming and forestry in the context of the rural development programmes*

Assessing the impact of rural development programmes on HNV farming and forestry is not a simple exercise, and cannot depend on indicators alone, given that development of these is at an early stage. Also, there are inherent difficulties in evaluating what proportion of the changes observed may be attributed to the programmes themselves.

A considerable input of expert analysis will be needed, with the information gathered in *Step 1* providing an essential background.

To conclude, the HNV concept has come a long way since the early 1990s (some of the reports that have marked this progress are listed below). Nevertheless, these are still early days in HNV monitoring. The new HNV Guidance Document is not the end of the story, rather it is part of an evolving process. Effective monitoring of HNV farming and forestry will require further adaptation and development of existing data bases. Ground-truthing of indicators through local case studies will be important.

By investing in appropriate data collection and monitoring schemes now, we can build a true picture over time of the biodiversity benefits and impacts of rural development programmes.

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„Natura 2000 as a practicable tool for the protection of semi natural grassland in styria“

Gerda Gubisch[1]

Nature conservation - human resources:

- Land using and land administrating people (matter of cross section)
- Regional capital Graz/regional authority: 30 officials (lawyers, experts of authority, administrators, secretaries…)
- District authoritys: 8 experts of authority
- 10 Natura 2000-regional managers (some part-time)
- NGO´s, freelance-experts

41 styrian Natura 2000-sites:

617.763 acres (ca. 15% of total styrian area)

(Natura 2000 sites ca 252.000 ha; total area of Styria ca. 1,46 Mio ha)

- Bird Directive (SPA): 5 sites
- FFH Directive (SAC): 23 sites
- FFH/Bird Directive: 13 sites

Habitat Directive Annex 1 (habitats): 53

Habitat Directive Annex 2 (animal and plant species): 65

Bird Directive Annex 1 (bird species): 35

Habitat Directive Annex 1: Styria: 10 Natural and semi-natural grassland formations (Austria: 15 formations)

61. Natural grasslands

*6110 Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi* / Lückige basophile oder Kalk-Pionierrasen (*Alysso-Sedion albi*)

6130 Calaminarian grasslands of the *Violetalia calaminariae* / Schwermetallrasen (*Violion calaminariae*)

6150 Siliceous alpine and boreal grassland / Boreo-alpines Grassland auf Silikatsubstraten

6170 Alpine and subalpine calcareous grasslands / Alpine und subalpine Kalkrasen

62. Semi-natural dry grasslands and scrubland facies

*6210 Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometalia) (*important orchid sites) / Naturnahe Kalk-Trockenrasen und deren Verbuschungsstadien (Festuco-Brometalia) (*besondere Bestände mit bemerkenswerten Orchideen)

*6230 Species-rich Nardus grassland on siliceous substrates in mountain areas and submountain areas in continental Europe / Artenreiche montane Borstgrasrasen (und submontan auf dem europäischen Festland) auf Silikatböden

64. Semi-natural tall-herb humid meadows

6410 Molinia meadows on calcareous, peaty or clayey-siltladen soils (*Molinion caeruleae*) / Pfeifengraswiesen auf kalkreichem Boden, torfigen und tonig-schluffigen Böden (*Molinion caeruleae*)

6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels / Feuchte Hochstaudenfluren der planaren und montanen bis alpinen Stufe

65. Mesophile grasslands

6510 Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) / Magere Flachland-Mähwiesen (*Alopecurus pratensis*, *Sanguisorba officinalis*)

6520 Mountain hay meadows / Berg-Mähwiesen

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xxx…no or small importance in connection with grassland mowing/pasturing

xxx…increased importance in connection with grassland mowing/pasturing

xxx…high importance in connection with grassland mowing/pasturing

Natura 2000-goals:

- Conservation and developement of habitat types, plant and animal-species (directives)
- Drafting of management plans for Natura 2000 sites
- Realisation of planned targets
- Cooperation with land users / Information
- Funding nature conservation measures:
  - EAFRD European Agricultural Fund for Rural Development - EU-cofinanced
  - National financing

Nature conservation grassland-funds in styria:

Areas funded by contracting programs:

- EAFRD: M 214 - ÖPUL 2008: 3.044 contract-partner, 8.734 ha, Mio € 4,58

[1] Gerda Gubisch, Federal government of styria, Department for nature conservation, FA13C, A-8020 Graz, www.naturschutz.steiermark.at

- BEP 2008 - national financed: 740 contract-partner, 1.000 ha, € 328.456,-
- 5 other national financed site-specific programs 2008: € 277.003,-

Projects funded:

- EAFRD (cofinanced EU/national) 2007-2013:
  - M 213 Payments Natura 2000 and agriculture
  - M 323a Rural development - Nature Conservation projects: ca. € 2 Mio p.a. (6% Leader)

Semi-natural grasslands **seed production** *within Natura 2000 sites*

Following aspects have to be considered:

- Cooperation with regional managers of the respective natura 2000 site / FA13C
- Consideration of site-targets and parcel-targets
- Implementation of a GIS-based register
- Documentation of seed-harvesting (when, where, who, …GIS)
- Optionally adjustment to altered specifications (related to species/habitats)
- Monitoring of the croped parcels
- Possibly adjustments of existing contracts.

Experiences with the collection and harvest of diasporas from semi-natural grassland: A Creative conservation viewpoint

Richard Scott[1]

Landlife is an environmental charity (NGO) of some 34 years standing. After being a pioneer champion in ecological landscapes, as part of a sustainable operation it became one of the first wildflower seed producers in the UK, which paralleled an objective of creating new opportunities for nature and enabling people to enjoy them.

In the UK Landlife has become a catalyst for practical activity and advice and in September 2000 opened the National Wildflower Centre, one of a very few landmark environmental projects established for the new Millennium.

Landlife's experience ranges from the diverse fields of seed collection from the wild, and all the inherent experience of scaling up seed production from collected samples, to delivery of our own projects in challenging social circumstances in places where ecological landscapes are demanded as a matter of environmental justice.

Experience from both growing, harvesting, cleaning seed selecting seed mixtures and delivering ecological landscapes, gives a exceptional insight into the best practical means of delivering the best potential for nature in many scenarios. This is creative conservation, which relies on good scientific method, innovative land practice, creative thinking and practical delivery.

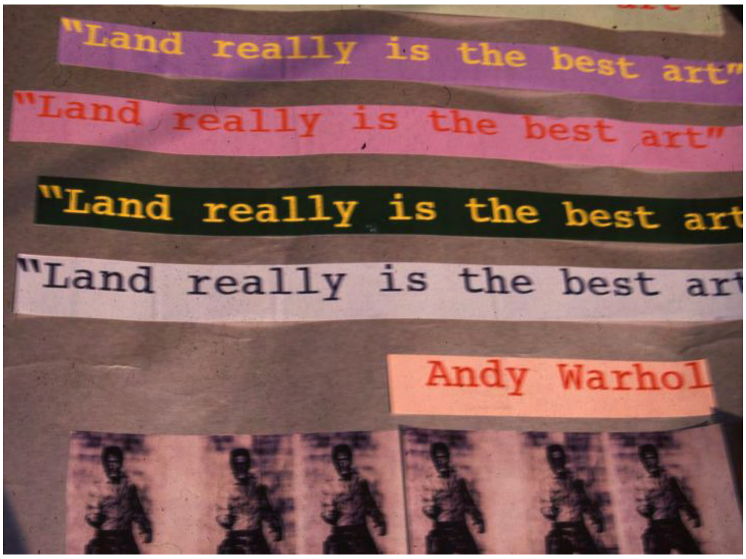
Landlife organised the first UK conference on climate change and its implications for conservation policy in May 2000, and continue to challenge traditional ways of working. Landlife enables other organisations and communities to deliver ecologically especially in areas with low ecological potential and low aspirations of ecological landscape delivery.

Woolfall Heath, Huyton. Sustainable landscape delivery on Merseyside

[1] Richard Scott, Landlife, National Wildflower Centre, Court Hey Park, Liverpool, L16 3NA, rscott@landlife.org.uk

Seeds represent potential and their resource should be used wisely, the starting point of projects is therefore critical.

What awaits us? As the world becomes increasingly urbanised, aspirations for landscape practice need to be raised as a matter of urgency.



Semi- natural landscapes demand a link to culture and society, ecological networks are often abstracted from communities and social networks this need not be so.

The oldest grassland experiment in the world. What secrets does it hold for semi- natural grassland project work?

This presentation will demonstrate Landlife's experience in the realm of the semi-natural grassland delivery, and illustrate the important concept of creativity in response to a changing world and considerable environmental and social need. The opportunity of nature is reflected in the potential of seed and how it is used. This takes on board the Parable of the Leaning Tower of Pisa and the Accidental Rainforest, and lessons from the world's oldest grassland experiment.

Recommendations for the production and use of wild flower seeds adapted to local ecological conditions in Switzerland

Sibylla Rometsch[1]

Since nearly 20 years, promotion of ecological aspects, including diversity of plants and animals, has been one of the important tasks of Swiss agriculture. The federal administration supports this plan by direct payments.

Measures are diverse; one of those is to set aside 7% of farmland as ecological compensation area. This area can include

(1) border strips of a crop without weed control, sometimes sown with a mixture of (rare) indigenous weeds,

(2) wild flower strips sown with indigenous species normally remaining no longer than six years at the same place,

(3) rotational fallows with indigenous species integrated in crop rotations;

(4) extensively managed meadows and pastures,

(5) ruderal areas,

(6) dry stone walls,

(7) orchards with high-stem trees and so on.

The farmer can obtain more financial support if the compensation area is of particularly high quality, for example an extensively managed meadow with a characteristic and high biodiversity. This high quality can also be obtained by sawing appropriate seeds for restoring a high biodiversity.

The Swiss Commission of Wild Plant Conservation, CPS, has noticed already in 1992 that only a small part of the wild flowers sown was of Swiss origin. However, we know that the introduction of non-native seed can lead to erosion of native genetic variation by crossing between native and introduced plants. Helping to remedy this problem, the CPS set up „Recommendations for the production and use of seeds adapted to local ecological conditions“. These are not only helpful for agriculture but also for wild flower seed used along streets and railways, in gardens and parks, for restoration of grasslands on ski runs, and so on.

The most important guidelines of the recommendations are based on the bio-geographical classification, which is in relation with distribution of the indigenous flora and fauna. We distinguish 6 main regions and 11 subregions. According to the conservation status of the species the requirement for the seed origin is more or less strict. Seed of relatively frequent wild flower species has to come from the same main region in which it will be used; seed of rare or geographically disjunct species has to come from the same subregion. The use of endangered species can only take place in collaboration with the Cantonal Office of Nature Conservation. Furthermore, we recommend that altitude and soil conditions have to be taken into consideration.

What is the situation today? What are the results or effects of these recommendations? Are they followed? Which problems occur?

Today, nearly all wild flower seed used in agriculture are of native Swiss origin and also multiplied in Switzerland. Only some species of Poaceae are still from foreign origin. However, recommendations of the CPS concerning the biogeographical regions are still difficult to put in practice and are in general not considered.

Today, we can say, that thanks to an intensive communication work, awareness about the importance of using regional adapted seed has globally risen considerably. Cities like Geneva or Berne, organised their own seed production in collaboration with some specialised firms; a Website - www.wildpflanzen.ch - promotes knowledge over the use of indigenous wild flowers and certain companies can provide suitable material if there is enough request.

But the largest part of wild flower seed used in agriculture does not respect the regional origin recommended by the CPS. Why? Are the recommendations too strict and not applicable? What are the consequences? What could help to have the recommendations respected?

In the beginning, a large effort of the producing companies was needed for understanding the biology, germination and growth conditions of species in question. Multiplication of some species was very difficult and requested special techniques to be developed. The question of the bio-geographic origin was not a priority. Most of the companies today offer up to 300 and 400 species (Switzerland counts about 2600 indigenous taxa) and their seed mixtures contain often 40 and more species. The firms offer also different seed mixtures for the different environmental conditions (soil pH, humidity, elevation, etc.). Diversity of the offer is such, that it is very difficult to organize the same kind of offer multiplied by the number of bio-geographical regions.

Some negative consequences of an indiscriminate use of wild flower mixtures are already visible. For example,

[1] Sibylla Rometsch, Swiss Commission for Wild Plant Conservation, Domaine de Changins, CP 1012, CH-1260 NYON 1
sibylla.rometsch@acw.admin.ch, www.cps-skew.ch

Anthemis tinctoria, a species with a disjunct natural distribution in Switzerland, is widespread today. Some rare and endangered „weed“ species like *Nigella arvensis* or *Agrostemma githago* can be found today in areas where they never occurred before. Other consequences are supposed, such as crossing between native and introduced plants.

Regarding these problems, the CPS is determined to find solutions together with the companies producing wild flower seed and with persons in charge of agriculture policies.

Several proposals are promising, like reducing the number of species in seed mixtures, using only species according to main bio-geographical regions and stopping the use of rare and endangered species. Technologies using wild flower seed have to promote the natural, local flora by using low seed quantities and density. With less species in a mixture, it should be possible to follow the recommendations.

For compensating the loss of profit for the companies, it is very important to encourage also the adapted use of indigenous wild flowers in gardens and parks.

All these efforts will, hopefully, preserve the biodiversity of our indigenous flora.

Establishment of semi-natural litter meadows at a Natura 2000 site in the Enns valley

Bernhard Krautzer and Wilhelm Graiss[1]

Introduction

Nature-conservation areas of high-value (High Nature Value Farmland - HNVF) are valuable capital for the maintenance and promotion of biodiversity. About 15 to 25% of the areas used for agriculture in Europe are to be counted within this category (Planta Europa 2008). But only a small share of these HNVF areas are also designated as protected (EEA 2007). The maintenance and at least local (re-)spreading, of such areas is therefore seen as being of great political importance.

Extensive fields and meadows are grassland areas dominated by grasses or herbs, which compared to intensively used agricultural areas are characterised by a lack of nutrition and the implementation of extensive care or cultivation measures (e.g. annual or biannual mowing). The substrate conditions in such areas generally lie in the damp to wet or dry to very dry sphere. The nature-conservation value of these areas is given on the one hand by their rarity in an area of nature, but also by the biodiversity within the area as well as the occurrence of rare or protected species of animals or plants.

The objective of the creation of high-quality nature-conservation grassland areas lies in the establishment of ecologically valuable plant societies of site-specific origin (Blaschka, Krautzer and Graiss, 2007). Suitable and usable restoration procedures are of great importance for the maintenance and safeguarding of the genetic diversity through the transfer of local species and plant societies as well as geographical breeds, subspecies and small species. An essential prerequisite lies in the careful selection of suitable donor areas of the greatest possible ecological value.

AREC Raumberg-Gumpenstein has been active for more than 15 years in the development of differing restoration techniques for the establishment and maintenance of high-quality nature-conservation areas of grassland. Differing problems concerning the winning, reproduction and use of diaspore material, and for the establishment of the resulting growth of vegetation from semi-dry grassland to the damp valley floor of the Enns Valley's characteristic litter meadows (so-called iris meadows), were a part of the research work in recent years undertaken by the Department of Vegetation Management in the Alps (ÖAG 2000, Graiss 2004, Krautzer et al., 2006, Krautzer, Blaschka and Graiss, 2007).

Prevailing in the German- and English-speaking world is a Babylonian confusion of tongues (Zerbe et al., 2009) in respect of terms and definitions (e.g. near natural, semi-natural, site-specific, native, local, regional, indigenous …), for which reason some of the terms used in this presentation are defined as follows:

Ecological restoration: this is the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed. (SER, 2004)

Non-local provenance: wild species which are not found on open terrain in the area concerned or which have not been found there for more than 100 years (Kirmer and Tischew, 2006)

Natural area: an area that is uniform and individual in its overall physical character (geology, climate, vegetation), which can be demarcated against and differentiated from the neighbouring areas (Kirmer and Tischew, 2006).

Site-specific vegetation (ÖAG, 2000): A plant society is site-specific when it is generally and permanently self-supporting or self-stabilising following extensive use, or non-use, and when among such plant societies agricultural production is not in the foreground. With the exception of production or development cultivation, or possible further extensive use, this vegetation requires no further cultivation measures. Further differentiation is given in respect of site specificity. Vegetation created by humans is then site-specific in a stricter sense when the three following criteria are fulfilled:

1) The ecological amplitudes (the 'needs') of the plant species applied are appropriate to the characteristics of the site.
2) The plant species used are considered 'indigenous' because in the geographic region (e.g. the Inn Valley, Hohe Tauern) in which restoration measures take place, but at least in the same natural area, they exist or have existed in relevant uncultivated sites within nature.
3) On the one hand seeds or plant material are used that originate from the immediate vicinity of the project area, and on the other are won in habitats appropriate in their essential site parameters for the type of vegetation to be produced. This means that not only value is placed on the use of proper, well-established and site-specific matching species during restoration, but local ecological types and small families of the respective plant species are also used.

Creation of litter meadows in the central Enns Valley

The project running from 2007 to 2010, as introduced in the following, is a rare but good example of what was finally

[1] Bernhard Krautzer and Wilhelm Graiss, AREC Raumberg-Gumpenstein, Raumberg 38, 8953 Irdning, Austria, bernhard.krautzer@raumberg-gumpenstein.at

the successful linking of the interests of nature-conservation activists and the recreation industry.

The Enns Valley is seen as one of the few still intact hatching areas of the corn crake (*Crex crex*), a species of bird threatened with extinction in Austria and the numbers of which are considered endangered worldwide. The Rosswiesen corn crake conservation area is on the edge of a golf course. A prolonged conflict between the golf-course operators and nature-conservation experts took place during an extension of the golf terrain from a nine-hole to an 18-hole course. After many years fraught with discussion to find an acceptable balance to meet all interests and optimum protection for the corn crake, a compromise acknowledged by all sides was found in 2006. The Enns Valley GLC was obligated to reinstate about five hectares of area previously used as fairways to create a cultural landscape suitable for the corn crake. As a countermove the operators were offered the possibility of extending the golf course to a modern 18-hole course through leasing in nearby areas. All of the measures within the sphere of reconstruction were given expert support by AREC Raumberg-Gumpenstein. Through research- and monitoring undertaken for many years, well-founded evidence was gained concerning the technique of harvesting donor areas, the preparation of seed, the application technique and necessary preparation of the recipient areas and the development of the vegetation created from these seed mixtures, but also a tolerable nature-conservation solution to any problems arising through the appearance of undesired, but dominant plants.

An initial mutual plan of measures was drawn up by the golf-course operators, nature-conservation experts and HBLFA Raumberg-Gumpenstein restoration experts. Based on the research results of the last 15 years, the successful creation of high-quality nature-conservation litter meadows of differing botanical characteristics could be subsequently demonstrated. One prerequisite was the availability of suitable donor areas. These Natura 2000 areas could be harvested in agreement with the responsible specialised department of the Province of Styria and consideration given to the existing cultivation stipulations. The material thus won (hay thresh) showed very good quality. The share of clean seed in roughly cleaned threshed material was between 26 and 79%.

The numerous frost germinators (e.g. Siberian iris) contained in the site in late autumn enabled sufficient stimulation despite an extremely warm winter. Seeding was undertaken with hung-out sowing tubes and then lightly brushed in. Due to the already beginning winter, re-stabilisation of the soil was unnecessary. A relatively slight amount of seed (3g/m² thresh material) is useful for making sufficient space available to the slowly developing seedlings. Germination of the seed took place in the following spring. In 2008, the areas already showed a satisfying vegetation cover in the autumn of the first vegetation year, containing a high number of target species from the hay threshing used. Due to the quality of the typical seedling index species from the donor area (e.g. *Molinia* sp., *Iris sibirica*), the success of the diaspore transfer could already be shown.

A special problem, which is no wonder on areas previously used as maize fields or grassland, was the scattered, explosive spreading of undesired plants, such as *Cirsium arvense*, *Rorippa sylvestris* and *Rumex obstusifolius*. Control with herbicides was neither ecologically justifiable nor useful due to their unspecific effect. A cleansing cut at the beginning of June already caused clear decline of the creeping thistle. Due to previous experience, it can be assumed that under the given site- and exploitation conditions (no further fertilisation, annual cutting at the end of August/beginning of September) the weeds that were dominant in the first year will play a secondary role in two to three years.

Together with the above-described weeds many typical grassland species, such as *Plantago lanceolata*, *Ranunculus acris* or *Trifolium hybridum*, also still have a large share. But especially on the lean, partially damp areas, the typical species of the herb-rich litter meadows will become dominant within a few years. On the better nutrition-supplied drier areas, on which maize was previously cultivated, this process will take longer. But is can also be deduced here from older, artificially created litter meadows that these areas will be seen as little different from old semi-natural meadows in 10-15 years.

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Ecological restoration of semi-natural grassland from agricultural fields Status quo and future prospects

Rudy van Diggelen[1]

Introduction

Semi-natural grasslands in Europe produce important ecosystem goods and services such as live-stock products (milk, meat, wool, leather), biodiversity, storage of carbon (35% of the global stock as compared to 39% in woodlands), protection against soil erosion, tourism and recreation. This is increasingly acknowledged at the European level and the conservation of high value farmland is stimulated with financial instruments. Nevertheless the area of used agricultural area decereased by over 15% in almost all EU countries between 1990 and 2003. Much less information is available on changes in the quality but the data that do exist show a sharp decrease in species richness and diversity. Major causes are the abandonment of management in less optimal conditions, intensification of use in mild climates, at good soils and close to large markets, and in some countries changes in land use such as afforestation or conversion to arable fields play also an important role.

To counteract these unwanted developments there is an increasing demand for the restoration of species-rich grasslands. The present paper attempts to give an overview of the present status quo and possible future trends.

Mowing and grazing

In the case of restoring species-rich grasslands from intensified patures nutrient availability is normally too high for the establishment of many target species and communities. The first management goal is therefore, normally the reduction of site fertility. This target has been pursued in several countries by stopping fertilisation and (re)installing traditional management regimes such as mowing and grazing. The basic idea behind this option is to remove nutrients with the hay and the fodder and deplete the soil nutrient stocks in this way.

Nitrogen budget studies have shown that mowing indeed does remove nutrients from the site. Its effect, however, depends largely on the overal landscape setting. If the site is situated in an area with high atmospheric nitrogen deposition rates such as the southern Netherlands, northern Belgium and certain parts of Germany, where deposition may be as high as 50-60 kg N * ha^{-1} * yr^{-1} the net removal may be close to zero or there may be even an increase in nitrogen. On the other hand, however, nitrate and ammonia easily leach from the soil and can be reduced to gaseous N_2 and leave the system that way. A good understanding of the nitrogen balance is therefore essential to assess the effectiveness of mowing as a tool to lower nitrogen availability.

The situation is different with respect to phosphorus. Except for the coastal region where P is supplied through the sea, phosphorus in grasslands originates mainly from antropogenic activities and the level is determined almost entirely by the fertilisation intensity. This implies, after stopping fertilisation, mowing indeed leads to a net removal of phosphorus from the system. It is not surprising that the productivity in many grassland systems that have been mown for many decades or even centuries is regulated by P-availability. Under such conditions a net P-removal immediately leads to a lowered productivity and more open vegetation. Unfortunately this is not normally the case in sites that were used agriculturally until recently. In the intensively used agricultural grasslands of NW Europe P-fertilisation was normally so high that large surplusses are stored in the soil. Bakker and Olff (1995) devised a conceptual model for the time needed to remove surplus nutrients as function of the number of years under intensive management (*Figure 1*).

Originally they devised their model for nitrogen but it is probably even better applicable for phosphorus because of the conservative behaviour of this element.

The effect of grazing under moderate stocking densities differs from that of mowing not only in its heterogeneous nature, leading to a mosaic of highly grazed patches and ungrazed sites (Mouissie et al. 2008b, Mouissie et al. 2008a),

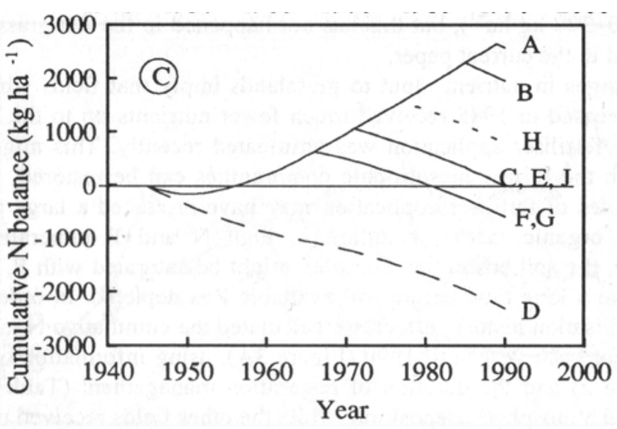

Figure 1: **Cumulative nutrient balance over time since 1945. Fields taken out of intensive agricultural use later must be subject to impoverishment schemes longer before the level of 1945 can be attained (Bakker and Olff 1995).**

[1] Prof. Dr. Rudy van Diggelen, Ecosystem Management Research Group, Department of Biology, University of Antwerp, Universiteitsplein 1c, B-2610 Antwerpen, ruurd.vandiggelen@ua.ac.be

but also in its nutrient removal rates. Budget studies have shown that the net removal of nutrients through grazing herbivores is low. They mainly redistribute the nutrients over their feeding area, especially when they have latrines like horses. Most studies were carried out on husbandry animals in fenced areas, such as cows and sheep in meadows. The situation maybe somewhat different in the case of herded animals, especially when they defeacate mainly during the night. In that case there might be a net transport of nutrients from the fields to the stable.

It can be concluded that under certain conditions mowing and/or grazing can be suitable tool for the removal of excess nutrients. However, the net removal rate is low and tends to decrease under present day conditions.

Topsoil removal

Removal of the entire top layer through sod-cutting is a technique that has been used for centuries in heathlands and resulted in an extreme nutrient poverty (De Smidt 1979). Inspired by this approach nature conservation managers experimented with this method from the last decades of the 20th century onwards in an attempt to speed up nutrient removal rates and create the necessary nutrient poor conditions that are essential for the establishment and survival of the target communities.

This technique has been mainly applied in sites where the parent material underneath the cultivated layer is nutrient-poor by nature, such as sandy or calcareous soils (Verhagen et al. 2001, Van Diggelen and Marrs 2003). There are also differences in removal depth. Because there is a linear relationship between the amount of soil removed and costs, nature managers remove often only part of the cultivated layer, assuming that the great majority of the nutrients is situated in the upper layer. Soil chemical analyses showed that nitrogen and phosphorus behaved differently. Nitrogen is almost exclusively present in organic matter and, since organic matter content decreases with depth, removal of only the upper layer indeed does result in lowered nitrogen availability. Phosphorous is mainly present in inorganic form, adsorbed to soil minerals. Available P moves downward with infiltrating rainwater until free binding places are encountered. In general, therefore, P-containing soils can be seperated into two layers: an upper layer that is (almost) saturated and a layer where there is hardly any P. Unless the top soil is removed up to a depth below this P-front, there are no differences in P-availability between sites with and without topsoil removal (*Figure 2*).

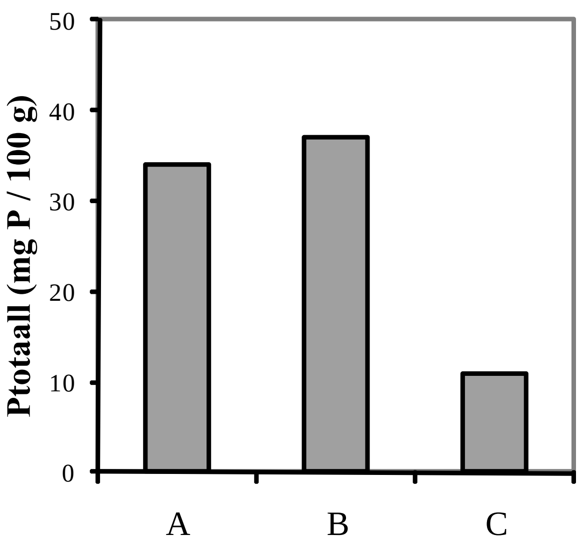

Figure 2: **Total P-content in the soil at site Eexterveld (NL) at different removal depths.**
A = before top soil removal
B = Shallow removal (ca. 15 cm)
D = Deeper removal (> 30 cm)

The productivity in the majority of ecosystems on nutrient-poor soil types is limited by the amount of available nitrogen and such systems react very sensitive to changes in air-borne nitrogen deposition, especially when other nutrients are not in short supply. Additional removal of nutrients through mowing or grazing is essential under such conditions. Ecoystems with P-limitation, either because they have a calcareous and/or iron-rich soil or because all P has been stripped away through topsoil removal, are much less sensitive in this respect.

It can be concluded that topsoil removal is a fast way to remove nutrients if it is carried out well, that is, if all nutrients have been stripped away.

Species addition

In sites where abiotic conditions had been restored and optimised for certain target plant communities species number indeed began to increase spontaneously. However, the number of species was rarely the same as from older, not restored sites with these vegetation types. The so-called saturation index (Wolters et al. 2005), a measure for the degree of similarity between the actual vegetation and an optimal developed version, typically is relatively low, thus showing that many species are lacking in the restored site. Analyses of the buried soil seedbank showed that many target species are no longer present after many years of intensive agricultural exploitation of a site. Based on measured or estimated seed longevity, compiled in Thompson et al. (1997), the fraction of target species that are likely to still have viable seeds after a certain period of exploitation can be assessed. In van Diggelen (1998) such calculations were done for wet meadows (*Table 1*) showing that many species are already lacking after a relatively short period of intensive exploitation. Especially the rarer species were no longer present. Introduction experiments (Strykstra et al. 2002) showed that lacking species often did establish on such sites, implying that the abiotic conditions are suitable for these species and that dispersal barriers prevented their actual appearance.

Large-scale experiments were then carried out (Hoelzel and Otte 2003) targeted at optimising species transfer rates, e.g. by mowing at times when most target species contain ripe seeds, in sites where they are most common, etc. etc.. They showed that under optimal conditions it was possible to transfer as much as 90% of the desired species from the donor to the receptor site. If the transfer is part of the normal mowing management, that is not optimised for species transfer rate but for agricultural efficiency, transfer rates are considerably lower but still significant (*Table 2*).

Table 1: **Seed bank characteristics of selected wetland communities**

Alliance[1]	Number of characteristic vascular plant species >4 records on seed longevity	Seed longevity at least several years[2]	Seed longevity probably several with decades[3]
Junco-Molinion	22	12	8
Calthion palustris	27	14	4
Cynosurion cristatae	19	11	7
Arrhenatherion elatioris	26	16	10
Alopecurion pratensis	13	8	3
Average	**21.4**	**12.2**	**6.4**

[1] names and species composition after Schaminée et al. (1995, 1996)
[2] longevity index cf. Bekker et al. (1998) > 0.49 or recorded seed longevity > 4 years or n (records) indicating persistent seeds > 4
[3] longevity index cf. Bekker et al. (1998) > 0.79 or recorded seed longevity > 19 years

Table 2: **Transfer efficiency of species with hay under a normal mowing management regime**

Alliance[1]	*Calthion palustris*	*Caricetum aquatilis*	Flooded *Calthion palustris*	*Nardo-Galion*	*Caricion curto-nigrae*	*Cynosurion cristatae*	*Allopecurion pratensis*
species in donor vegetation	23	18	32	14	27	27	40
species also present in hay	14	9	9	6	9	19	14
Transfer efficiency (%)	61	50	28	43	33	70	35

Another bottle neck is species establishment. When compared to the number of species with viable seeds that are transferred only about half of them actually do establish. This probably has to do partly with competition for light from other, faster growing, species (Kotowski and van Diggelen 2004) but it occurred even in sites where there were still many open gaps that could be colonised. Obviously there are also other factors that prevent establishment, even when viable seeds are present on the spot.

It can be concluded that species transfer is a technique that significantly enhances the likelihood that a target species gets established at a restored site.

Comparison of techniques

Klimkowska et al. (2007) performed a meta-analaysis on the effectiveness of several alternative techniques to restore wet grasslands, based on published results of 92 cases where different restoration techniques were applied. Interestingly they found that when only single techniques were applied topsoil removal and addition of propagules gave significantly larger increase in saturation index than rewetting. Nevertheless, rewetting is by far the most applied method and known to give sometimes very spectacular results. The authors discuss the effects that rewetting has on increasing nutrient availability in formerly fertilized meadows, thus counteracting the effects of improved hydrological conditions by degrading nutrient status.

In practical applications a combination of two or more techniques is often used. Again, combinations including topsoil removal gave the best results, especially in the case of deeper removal, where all degraded layers were certainly removed as well as all seeds of non-target species.

The largest increase in saturation index was reached under the combination of all three techniques, although the results were not significantly different from a combination of topsoil removal and propagules addition. However, the much larger deviation in the latter case indicates that the results are much less predictable than when all three techniques are applied.

Conclusions

The results presented here show that species richness does increase over time under a regime of biomass removal but, unfortunately the increase rate decreases with time since ecosystem degradation. Increase rate also decreases with increasing species richness. These results imply that it takes a long time to restore species-rich grasslands this way.

Techniques such as topsoil removal or propagule addition can potentially increase the restoration speed significantly but there are considerable differences in effects between these. Topsoil removal and addition of propagules are slightly more effective than just manipulation of abiotic conditions but especially the combination of techniques appeared most effective. In this way restoration can be reasonably fast and reasonably well-developed communities can be attained within a few years.

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