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Managing biodiversity rich hay meadows in the EU: a comparison of Swedish and Romanian grasslands

THEMATIC SECTION
Biodiversity Governance in Central and Eastern Europe

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SUMMARY

Semi-natural hay meadows are among the most biodiversity-rich terrestrial ecosystems, and are managed for conservation purposes in most of Europe, including Sweden. Romania has some of Europe's largest areas of grasslands still managed with traditional methods. Through interviews and field studies, current management practices were investigated in two Romanian villages, and compared with CAP-generated grassland management in Swedish hay meadows and historical Swedish management of grasslands. The study evaluated the effect of the eligibility criteria within both countries' National Rural Development Programmes (NRDPs) on different ecologically important components of hay meadow management. The success of Swedish management was measured by assessing population trends for 25 grassland plant species. Current management proved to be considerably more diverse in Romania than in Sweden, but historical Swedish management was similar to management in Romania. Both countries' NRDPs provide support for some management components, but create barriers against other components. The Romanian NRDP contained more barriers than the Swedish NRDP, yet Swedish management showed little success in preserving grassland plants. NRDPs should nourish the use of local and traditional knowledge in order to preserve biodiversity in semi-natural grasslands. There are major limitations in both countries' NRDPs.

Keywords: agri-environment payment, grassland biodiversity, hay meadows, Romania, Sweden, traditional management

INTRODUCTION

The implementation of European Union (EU) environmental policies in new Central and Eastern European member states implies large challenges for the EU and structural changes for the member states. The process has mainly been a one-way transfer of expertise, institutions and experiences from Western to Eastern EU states, yet multi-directional exchange of practices and knowledge may promote the use of local knowledge that sometimes is more environmentally friendly than imported knowledge (Holzinger & Knöppfel 2000; Vandeveer & Carmin 2004). Engagement with non-governmental organizations (NGOs) and local actors is needed (Vandeveer & Carmin 2004) to help conserve biodiversity (Kluvánková-Oravská *et al*. 2009). Here, we investigate how local traditional farming practices are treated when national agricultural policies are transformed to meet the requirements of the EU common agricultural policy (CAP). We focus on one aspect of farming in which local traditions and engagement are particularly important, namely the management of biodiversity-rich semi-natural grasslands.

Semi-natural grasslands, defined as unfertilized grassland formed by land use but colonized mainly by wild species, are among the most biodiversity-rich ecosystems in Europe (see for example Veen *et al*. 2009). Before industrialization, semi-natural grassland comprised the nutrient base for farming and food production in most of Europe. Pastures and hay meadows provided fodder for the livestock, which in turn transformed the grass into food products and manure, the latter being the major nutrient source for cultivation on arable land (Emanuelsson 1988, 2009). Biodiversity-rich grassland habitats are thus formed by a long history of locally adapted land use (Kuster & Keenleyside 2009), and the continued use or reintroduction of traditional management practices can therefore be expected to be important for the preservation of the grassland ecosystems and their biological and cultural values.

In most of Western Europe, semi-natural grasslands have lost their indispensable function in the production chain due to the introduction of cultivated fodder and artificial fertilizers (Emanuelsson 2009) and their area has decreased greatly; for example, in Sweden, 99.7 % of the semi-natural hay meadows was lost between 1870 and 2010 (Swedish Board of Agriculture 2011). Grassland biodiversity is also threatened by sub-optimal habitat conditions in the remaining patches, caused, for example, by insufficient management methods and eutrophication (Stanners & Bourdeau 1995).

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Western European grasslands are managed mainly for conservation of biodiversity, cultural heritage and other values connected to grassland ecosystems and their use (Hasund & Helldin 2007). Such management is strongly affected by the regulations for agri-environment payment within the CAP, which aims at securing continuation of management in the remaining fragments of biodiversity-rich grassland, at obtaining sufficient management quality in ecological terms, and at restoring grassland and landscapes in order to counteract habitat fragmentation (EU Commission 2009). However, few studies have evaluated how successful CAP-driven management has been in achieving its conservation aims in Sweden (Government of Sweden 2009).

In contrast to Western European conditions, semi-natural grasslands are still fairly abundant in several of the new EU member states in Central and Eastern Europe (CEE). In many CEE regions, the grassland use is still based on local needs, traditions and knowledge, largely in subsistence farming. The Romanian Carpathian mountain regions contain some of Europe's largest areas of traditionally managed grasslands, in particular hay meadows (Emanuelsson 2009). These grasslands comprise biodiversity-rich habitats and are used as fodder source for livestock (Brinkmann *et al.* 2009).

Along with the economic development of Romanian agriculture and local societies, the present use of the agricultural landscape can be expected to change. While the current landscape is controlled by self-subsistence, traditions and local consumption, these forces will be replaced by drivers related to the CAP and global markets. For grassland-based agriculture, agri-environment payments can be expected to become particularly important, since such agriculture has low productivity but is rich in biodiversity and other values.

In this study, we compare Romanian and Swedish hay meadow management, focusing on meadow types having high biological and cultural values. In Romania, semi-natural hay meadows are still abundant and still mainly managed for subsistence using local traditional practices. The study considers the extent to which the Romanian NRDP can be expected to support the persistence of existing practices. By contrast, in Sweden, very few semi-natural hay meadows are left and grassland management is driven by agri-environment payments, aimed at preserving and restoring biodiversity in the last grassland fragments. It is unclear to what extent the CAP-driven management succeeds in preserving grassland biodiversity and to what extent the Swedish NRDP can be expected to support the increased use of ecologically important traditional management practices.

The semi-natural hay meadows and pastures of the Romanian Carpathians are very similar to grasslands in Central and Southern Sweden, both ecologically and in terms of land-use history. For example, > 75 % of the species of vascular plants in Carpathian grasslands occur also in Swedish grassland habitats (Svensson *et al.* 2008). The average temperature in June–August is 19.5 °C in Baia Mare in the Maramureş region of Romania and 16.5 °C in Stockholm, Sweden; in December–February average temperatures are – 0.5 °C and – 2.0 °C, respectively.

This study addresses three main questions.

(1) Does hay meadow management based on subsistence agriculture in Romania use more traditional management practices than conservation-based management in Sweden, and, if so, does management complexity found in Romania correspond to management practices that have been lost in Sweden?
(2) How may the performance of hay meadow management be affected by the National Rural Development Programmes of Romania and Sweden, in particular with respect to management complexity and the use of ecologically important management components?
(3) Biodiversity conservation is a major aim for Sweden's National Rural Development Programme, but how well has the NRDP succeeded in preserving hay meadow biodiversity?

METHODS

Research methods

We investigated current hay meadow management in Romania through interviews and mapping in the field, and current meadow use in Sweden by monitoring the management practices over 20 years; we investigated historical management through detailed examination of farmers diaries and cadastral maps. The significance for biodiversity of management practices, identified in Sweden and Romania, was derived from the literature (Emanuelsson 2009; Gustavsson *et al.* 2011; Gustawsson 1976). We evaluated EU policies for sustainable grassland management by comparing information on current and historical hay meadow management in Romania and Sweden with the eligibility criteria and requirements for agri-environment payment in the NRDPs. We assessed the conservation success of Swedish grassland management by monitoring vascular plant populations in hay meadows.

Interviews in Romania

In 2010, we interviewed 10 farmers per village in the villages of Botiza and Şurdeşti, located in the Maramureş region in the northern part of the Romanian Carpathians. We selected interviewees from active family farms comprising several generations, thus capturing traditional knowledge from both active farmers and other generations within their household. The interviewees were asked general questions about the farm and household (such as farming area, crops, livestock and selling of products), and more specific questions about management activities in hay meadows (see Tables 1 and 2) and the spatiotemporal organization of mowing. We conducted the interviews as free discussions around defined questions. This enabled us firstly to find out what different activities were used in hay meadow management, and secondly to evaluate the

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Table 1 Characteristics of the farms of Romanian interviewees in two villages (ten farms per village).

Characteristic	*Şurdeşti Range (average)*	*Botiza Range (average)*
Area of agricultural land (ha)	1–10 ha (3.9 ha)	2–8 ha (3.6 ha)
Land parcels (n)	1–10 (5.8)	6–11 (7.5)
Hay meadow parcels (n)	1–8 (4.7)	5–11 (6.5)
Cows (n)	0–6 (3.3)	0–4 (2.5)
Horses (n)	0–5 (0.5)	0–2 (0.6)
Sheep and goats (n)	0–7 (0.8)	0–77 (11.8)
Pigs(n)	0–4 (1.4)	0–2 (0.5)

Table 2 Management activities in hay meadows in Romania (2010), Sweden (1990–2010), and in Sweden historically. Notes: [1]frequent, common and rare refer to the number of farms that apply the practice (see text); [2]see Table 3 for explanation of meadow types; [3]see Fig. 2 for more details.

Management activity	*Romania 2010* [1]	*Sweden 1990–2010*	*Sweden historically*
Spring raking (removal of old grass, leaves and branches)	Frequent, every year	In two out of five meadows	Yes
Clearing of bushes, trees and other unwanted plants	Common, when needed, usually every year	In all meadows, occasional, when needed	Yes
Other maintenance: clearing of stones, ant hills, repairing fences	Frequent, when needed	No	Yes
Fertilising	Common, manure in some meadows and in combination w. temporary cultivation (meadow types 1, 2, 3A)[2]	No	Normally not
Drying and storage of hay	Frequent. On the ground and on rack. Storage mainly in stacks or small barns in the meadows.	No	On the ground and on rack, storing mainly in barns, but also in stacks
Aftermath grazing	Frequent, not all meadows. In autumn or spring	In one out of five meadows. Autumn grazing	Yes
Burning of old vegetation	Rare, occasional, especially in meadow type 4[2]	No	No information
Temporary cultivation	Frequent, in meadow types 1, 2, 3A[2]	No	Yes
Management interruptions	Common, occasional, especially in meadow types 1 and 4[2]	No	Yes
Mowing time, start[3]	Mid–June	Late July	Beginning of July
Mowing time, end[3]	August–September	Late July	August – September
Mowing technique	Scythe in Botiza, motorized single–axle mower and scythe in Şurdeşti	Scythe or single–axle mower	Until early 20th century only scythe, then later horse driven mowers also on flat meadows

importance and abundance of those management activities. The prevalence of different management activities was estimated according to the proportion of the farmers that mentioned and used them: 1–4 out of 20 answers (rare); 5–15 out of 20 answers (common); > 15 out of 20 answers (frequent).

Mapping of grassland use and area in Romania

In addition to the interviews, we mapped mowing time and presence of cultivation in one 100 ha grassland area in Botiza, using photographs. In Şurdeşti, we mapped a 75 ha grassland area in order to estimate the size of the land parcels, using aerial photographs taken in March 2011.

Analysing historical hay meadow management in Sweden

We investigated the pre-industrial use of hay meadows by consulting farmers' diaries from two villages, Strandmora and Hyttbäcken, in the county of Dalarna (available from the Nordiska museet, Stockholm).

As in Romania, the grasslands were the base for agriculture and animal breeding. The diaries we studied covered the period 1840–1850 (Hyttbäcken) and 1850–1855 (Strandmora). Diaries were written on the farmers' own initiative and can be considered working journals. The farmers recorded, on a daily basis, the type and location of work performed, such as work on arable land and in the forest, mowing and related activities. Diaries are a highly valued historical source in research, often used for studying work

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patterns, social contacts and travels (see for example Myrdal 1991; Pearson 1992).

We analysed the prevalence of temporary cultivation of semi-natural hay meadows for a third village (Örbäck) from the same region, using cadastral maps and protocols dating from 1844 (cadastral map: Lantmäterimyndigheternas arkiv. 19-kar-88, Örbäck, Norberg, available from The Archive of Swedish Land Survey). The Swedish cadastral maps contain information about land-use types (arable, hay meadow, pasture, ley or forest) and their use, as a basis for taxation or reallocation of land between the different farms (Kain & Baigent 1992).

To complement the diaries and cadastral maps concerning information about management components in hay meadows, we used the literature reviews of Gustawsson (1976) and Gustavsson *et al*. (2011), which were mainly based on ethnological work from the 18th century onwards and recent work on pre-industrial agrarian land-use.

Monitoring of management and plant populations in Swedish semi-natural hay meadows

Current management procedures for Swedish meadows were monitored annually for five hay meadows during 1990–2010; management methods, timing of procedures and the presence of specific measures for maintenance were recorded.

During the same period, in these five hay meadows, we monitored the abundance of 23 vascular plant species annually; for most species we used fixed 0.5–1 m transects, but for some species we recorded entire populations. Two of the meadows contained all 23 species, one meadow contained 21 of the species, and two meadows contained 17 species. The population trend for each species was calculated by dividing the average population size during 2000–2010 by the average population size during 1990–1999. A value of 1 thus indicated a stable population, values >1 indicated population increases and values <1 indicated population decreases.

Evaluation of eligibility criteria and requirements for agri-environment payment in the Romanian and Swedish NRDPs

We extracted all explicit information about eligibility criteria and specific requirements for agri-environment payment that may affect biologically significant management components from the Romanian and Swedish National Rural Development Programmes (Government of Romania 2008; Swedish Ministry of Agriculture 2008). We identified the biological significance of the management components found in interviews, by field mapping and in historical sources through literature reviews (Emanuelsson 2009; Gustavsson *et al*. 2011; Gustawsson 1976).

We analysed the potential qualitative effects of eligibility criteria on components of hay meadow management by presupposing that eligibility criteria are followed when agri-environment payment schemes are implemented. The criteria have the potential to change, support, limit or prevent the use of different management activities, either directly or indirectly. We estimated whether the criteria would favour or disfavour the use of each management component, and whether there was a likely but not immediate effect. For some eligibility criteria the effect was obvious and direct, since those criteria were specifically designed to affect specific management components (for example regulations for fertilization or grass removal, or forbidding ploughing). Other criteria were expected to affect management components indirectly, and we estimated the likely effects. Other criteria may have had effects that were dependent on their interpretation by farmers and controllers; we usually excluded such criteria from the results because of their uncertain effects.

Research areas

Romania

Botiza is situated in Iza Valley in the 'historical Maramureş' ethnographic area and had 2964 inhabitants in 2002 (Romanian Statistical Yearbook 2010). Şurdeşti is located in the ethnographic region of Chioar, and had a population of 1270 in 2002.

The villages differ in topography. Botiza is situated in a valley with comparably steep hills, and therefore contains defined zones, with houses and gardens in the valley bottom along the riverside, arable land just above the houses and hay meadows and pastures further uphill. The village centre of Şurdeşti is situated in flatter terrain, allowing a scattered distribution of houses, gardens, arable land and hay meadows scattered over a larger area. Outside this area, slightly uphill, lie hay meadows and pastures.

The main occupation in both studied villages is agriculture and animal breeding, the latter mainly based on extensive areas of semi-natural hay meadows. Agriculture is small scale, and most products stay within the family (Government of Romania 2008).

Sweden

The three villages studied in the historical analyses, as well as the hay meadows subject to field monitoring, are situated in central Sweden in the provinces of Dalarna, Västmanland and Uppland. Historically, agriculture was based on livestock production and grassland use, while arable production was of less importance. As in Sweden in general, the use of semi-natural grassland has been replaced by cultivated fodder on arable land, leaving few hay meadows still in use. The five monitored hay meadows ranged from 0.2 ha to 3.8 ha. All meadows were dry-mesic and dominated by vegetation types similar to those in the Romanian villages in the study.

RESULTS

Current hay meadow management in Romania and Sweden, and historical management in Sweden

Hay meadow types

In Romania, nine out of 20 interviewees were aged in their 60s; five were $>$ 69 years old and six were $<$ 60 years old. The interviewees also represented a younger generation of farmers, because 17 of the 20 spokesmen lived in households

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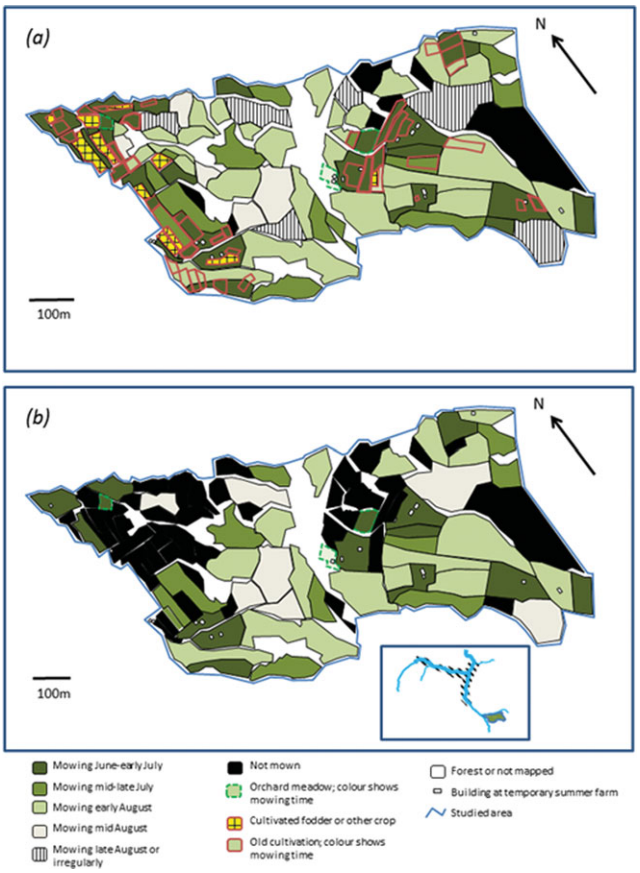

Figure 1 Mowing time and presence of temporary cultivation in land parcels in a meadow area in Botiza, Romania (*a*) The situation in 2005 according to field mapping and (*b*) the possible situation after full implementation of the agri-environment schemes, see text for explanation. The inset shows the main river in Botiza (blue) the village (dashed area) and the study area (the green field in the bottom right corner).

with at least two generations. The farms conducted a range of management activities (Table 2).

All Romanian hay meadows are situated on mesic to dry soil. They can be assigned to four main land-use types and one subtype, occurring in small parcels, each parcel usually having different landowners (Table 3, Fig. 1). In the village centre, shifting cultivation is practised, producing meadows/fields with cultivated fodder (type 1, Table 3) and meadows/fields with ley (type 2). There are also meadows close to the village that are mainly semi-natural (type 3), but with frequent traces of earlier temporary cultivation (type 3*a*). The semi-natural meadows situated further from the village are mown later in the season, and not every year (type 4).

The five studied Swedish hay meadows are semi-natural and correspond to meadow type 3 in the Romanian villages. The meadows are no longer an integrated part of the farming, but mown only for conservation purposes based on agri-environment payments. Historically, the Swedish farms had meadow types corresponding to all four of the Romanian meadow types.

Hay meadow management

A number of management components of the hay meadow use were identified which may be ecologically important (Table 2). The Romanian mowing period is extended over most of the growing season (Fig. 2), from the second half of May to late October if all meadow types are included, and between the second half of June and late October if only semi-natural meadows are considered. The Romanian landowners do not apply a general sequence for the mowing of individual parcels within each meadow type. The beginning, end and length of the mowing period vary to some extent between landowners, but with no systematic difference between the villages (Fig. 2). The spatiotemporal variation in mowing time between parcels includes single years without mowing, in particular in meadow types 1 and 4.

In the studied Swedish meadows, the current mowing is performed during one, occasionally two, day(s) around 25 July (Fig. 2). A somewhat later mowing, around 1–5 August, occurred two and three times, respectively, in two of the meadows. Historical records for the two Swedish farms, Hyttbäcken and Strandmora, showed that the mowing of non-cultivated semi-natural grassland historically started around 15–20 July and continued until around 10 August (Fig. 2). In some years, the last meadows were mown in mid- or late September. The leys were mown before semi-natural meadows, with an average starting date of 5 July.

In Romania, the mown grass is first dried for one day on the ground and turned 1–3 times during the process. The hay is either dried further on temporary hayracks, *sărcieri*, before storage, or stored directly in haystacks in the field or in small wooden barns. In the studied Swedish meadows, no current practices for drying of the hay were observed, but the grass was removed directly after cutting. Historically, the Swedish hay was dried and stored in the same way as in Romania, using hayracks and small barns (Table 2).

In both Romania and Sweden, scythes and single-axle motorized mowers are currently used, and in both countries the scythe was the traditional tool.

In Romania, both current temporary cultivation and traces of earlier cultivation occur mainly close to the villages or close to temporary summer farms (Fig 1). In Sweden, no temporary cultivation of meadows currently occurs, but such practices were common historically in many regions. In Örbäck, *c*. 15% of the meadows were considered leys in 1835, thus showing the minimum abundance of temporary cultivation in semi-natural meadows.

In all Romanian meadows, several maintenance activities are conducted, such as removal of anthills, bush clearing, and grazing with sheep in the spring or autumn (Table 2). Burning of old grass in the spring is used mainly in type 4 meadows in order to maintain the meadow in the absence of annual mowing. In Sweden, current mowing procedures included no other management activities above the mowing itself and some bush clearing (Table 2). Gustavsson *et al.* (2011) and Gustawsson (1976) found that most of the management components occurring in Romanian meadows

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Table 3 Characteristics of hay meadow types in two Romanian villages, Botiza and Şurdeşti.

Characteristic	*Type 1, cultivated meadow*	*Type 2, fertilized semi-natural meadow and ley*	*Type 3, semi-natural meadow close to settlements*	*Type 3A, as Type 3 with temporary cultivation*	*Type 4, semi-natural meadow further from settlements*
Order in the village's mowing sequence	First	Second (1st cut) and fourth (2nd cut)	Third	Third	Fifth
Fodder type / vegetation	Alfalfa (*Medicago sativa*) or clover (*Trifolium spp*)	Successional semi–natural, with nitrophilic species	Species–rich semi–natural	As Type 3 but with more successional spp.	Species–rich semi–natural
Cultivation	Shifting cultivation with other crops	Most meadows are leys	No cultivation	Traces of earlier cultivation	No cultivation
Location in village	Village centre	Village centre	Close to the village	Close to the village	Further away from the village
Fertilization	Manure and sometimes a mineral fertilizer, *polochim*	Manure	Not regularly fertilized	Not regularly fertilized	Not regularly fertilized
Number of cuts	2–3	2	1 (rarely 2)	1 (rarely 2)	0–1 (some meadows constitute a reserve)
Beginning of mowing	1st cut: Mid or late May.Repeatedly cut throughout the summer	1st cut: Second half of June to early July.2nd cut: mid–August	1st cut: Mid July.(2nd cut: September–October)	1st cut: Mid July.(2nd cut: September–October)	End of July
End of mowing	October or snowfall	2nd cut: October or snowfall	1st cut: End of July 2nd cut: October or snowfall	1st cut: End of July 2nd cut: October or snowfall	Late September

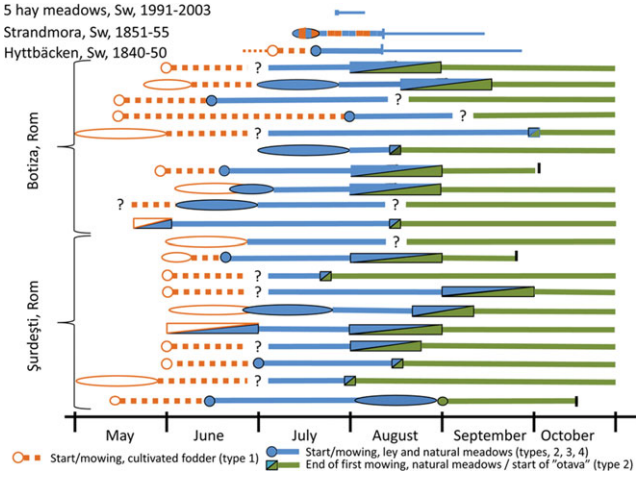

Figure 2 Present and historical mowing times in Swedish (Sw) and Romanian (Rom) villages.

were also present in the historical management of Swedish hay meadows (Table 2).

NRDP eligibility criteria in relation to management components in Romanian and Swedish hay meadows

General requirements

The NRDPs consist of four axes; support for grassland management is part of Axis 2, 'Improving the environment and the countryside'. For support, farmers are first obliged to pursue farming for at least five years, and to respect good agricultural and environmental conditions (GAEC) on the farm as a whole. Second, for open grassland, only parcels ≥ 0.3 ha in Romania and ≥ 0.1 ha in Sweden are eligible for support. For orchard grasslands, vineyards and some other types of production, the Romanian area limit is ≥ 0.1 ha. Romanian farms and parcels that fulfil these requirements can apply for support for mountain areas of € 50 ha^{-1} (Government of Romania 2008, Annex 4A; €1 = US$ 1.30, November 2012). For Sweden, similar regional support exists, but was not applicable to the villages in this study.

Additional agri-environment payment for the use of semi-natural grassland is available, provided that a set of special requirements (Fig. 3) are fulfilled. The Romanian agri-environment payment consists of four packages, of which the two first are relevant here: Package 1 HNV (high nature value) grasslands (€ 124 ha^{-1}) and Package 2 Traditional farming (€ 58 ha^{-1}, only available for land committed to Package 1; Government of Romania 2008, pp. 263–267). In Sweden, there is a base payment for grasslands of € 121 ha^{-1} and an extra payment of € 275–385 ha^{-1} for particularly valuable grasslands. Scythe-mowing, pollarding and aftermath grazing merit extra payment.

Eligibility criteria

The Romanian eligibility criteria can be expected to have large effects on future grassland use and biodiversity. In the studied area in Botiza, about half of the parcels fell outside of the 0.3 ha area criterion, implying a loss of *c*. 25 % of the meadow area if the agri-environment scheme becomes fully implemented

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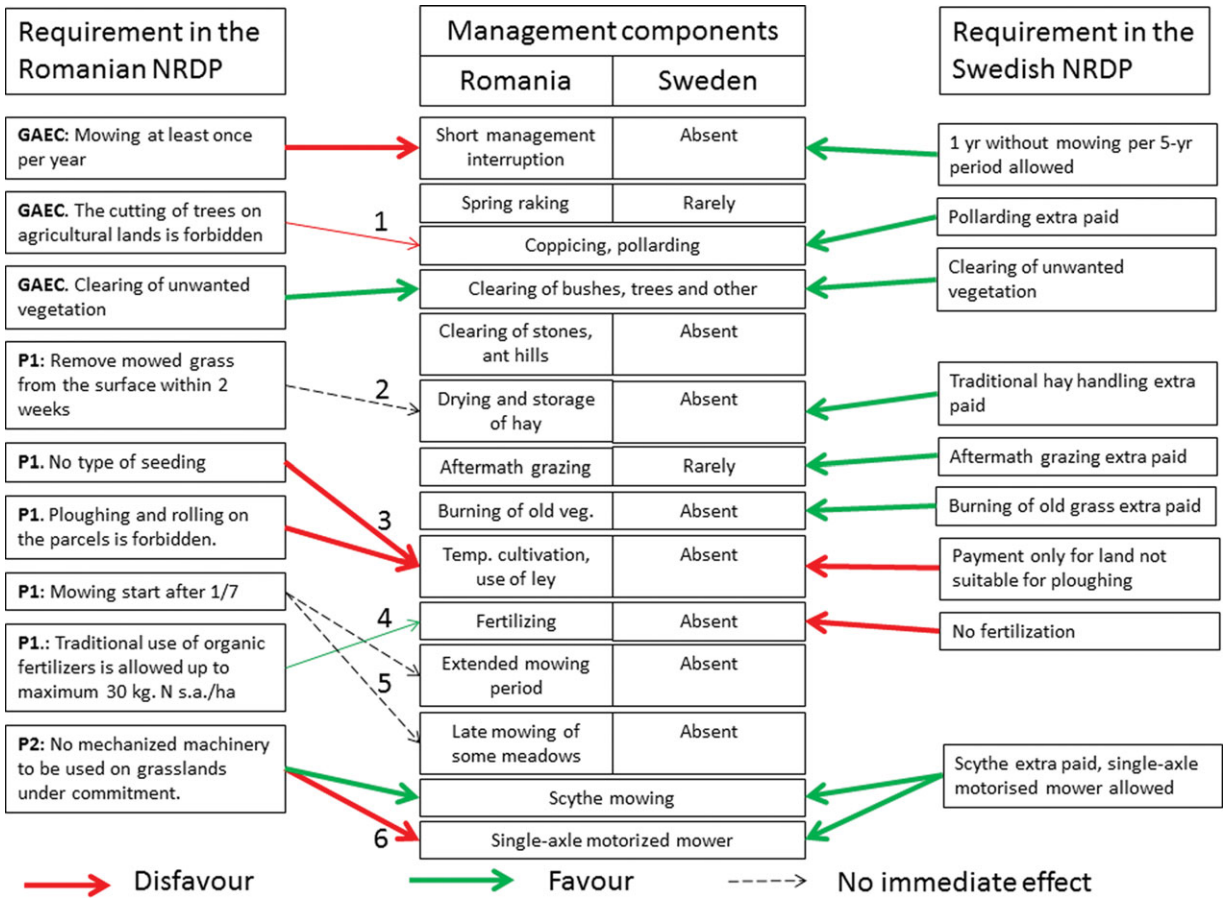

Figure 3 The expected effects of the requirements for agri-environment payment in Romania (left column) and Sweden (right column) on ecologically important management components (centre columns). The requirements are set by the respective National Rural Development Programmes (NRDP). Bold arrows indicate a clear effect, thin arrows an uncertain effect. GAEC indicates regulations related to good agricultural and environmental conditions, P1 = regulations in package 1 (high nature value grassland) and P2 = regulations in package 2 (traditional farming) for agri-environment payments. Explanation of numbers: (1) The banning of tree cutting on agricultural land may have a negative effect on coppicing, if coppicing is classified as tree cutting in this context. (2) Probably no effect since the normal handling of hay includes removal of hay within two weeks. (3) and (4) Effects depend on complicated relations between ploughing, seeding and fertilizing. The ban on seeding and ploughing will obviously have a negative effect on this practice in hay meadows. Permission to fertilize, but not plough, may result in increased fertilization of meadows that are normally nutrient poor, inducing a reduction in biodiversity. (4) The normal level of hay meadow fertilization is unknown to us and therefore we do not know whether the decided limit entails a change. (5) Mowing times will probably not be affected, since semi-natural hay meadows are normally not mown before 1 July. (6) See Discussion for an analysis of the effects of mechanized machinery.

(Fig. 1). In Şurdeşti, *c.* 60 % of the meadows were orchard grasslands for which the eligibility criterion is 0.1 ha. Of the remaining, non-wooded meadows, cultivations and temporary cultivations, < 10 % of parcels in both number and area qualify for the agri-environment payment at the 0.3 ha criterion. In Sweden, the smallest area eligible for payments is 0.1 ha, which admits most semi-natural hay meadows. However, a limit on the number of trees allowed per hectare has caused many wooded meadows to lose agri-environment payments.

The GAEC contributes to maintaining the use of farmland in general in both countries, but may also have some negative effects on future use of traditional management components. In particular, management interruptions of 1–2 years, which commonly occur in Romanian grassland use at present, may become rare in the future because annual management is a Romanian GAEC requirement. In Sweden, one one-year interruption per five-year commitment period is allowed subject to governmental approval (Fig. 3).

The ban against ploughing in the Romanian NRDP can be expected to decrease the use of temporary cultivation in semi-natural meadows, as well as the abundance of species-rich leys. A similar regulation exists in the Swedish NRDP, which impedes the reintroduction of semi-natural ley in grasslands (Fig. 3).

The Romanian ban against cutting of trees may lead to cessation of coppicing, albeit depending on how the regulation is interpreted. In Sweden, traditional pollarding merits an extra per-tree payment.

The Romanian requirement that mowing must not start before 1 July can be expected to impede early mowing, but

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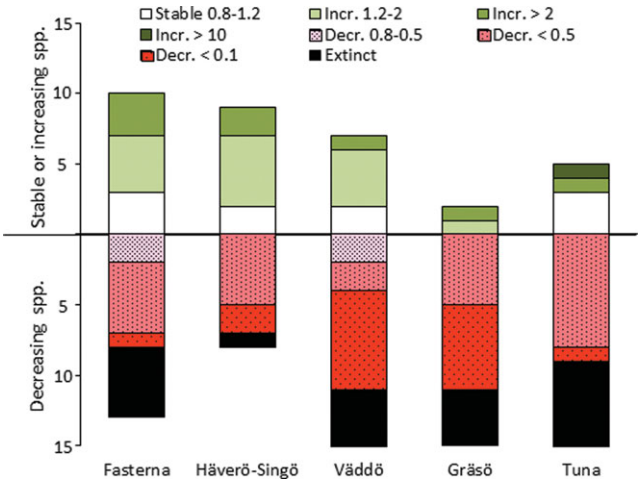

Figure 4 Number of species, showing population increases (bars above horizontal line), and population decreases (bars below horizontal line), identified over a period of 20 years mowing in five meadows in Sweden. Figures in the legend refer to population changes, for example, < 0.5 indicates the population has decreased by more than a factor 0.5; 1 indicates a stable population; and > 2 indicates the population has more than doubled.

without encouraging occasional late mowing and an extended mowing period (Fig. 3). A similar criterion exists in the Swedish NRDP.

Biodiversity effects of the Swedish hay meadow management

In all but one of the five studied Swedish hay meadows, the number of species that decreased or became locally extinct was greater than the number of species showing stable or increasing trends during the 20-year study period (Fig. 4).

Eight of the studied vascular plant species became locally extinct in one or more of the meadows (*Trifolium montanum* extinct in 3 out of 4 meadows, *Gentianella campestris* extinct in 3 out of 5 meadows, *Crepis praemorsa* extinct in 2 out of 4 meadows, *Hypochaeris maculata* extinct in 2 out of 5 meadows, *Succisa pratensis* extinct in 2 out of 4 meadows, *Serratula tinctoria* extinct in 4 out of 5 meadows, *Melampyrum cristatum* extinct in 3 out of 3 meadows, and *Seseli libanotis* extinct in 3 out of 4 meadows). Five species (*Briza media, Antennaria dioica*, *Campanula persicifolia*, *Ranunculus polyanthemos* and *Dianthus deltoides*) decreased in all meadows in which they occurred, and three species (*Galium verum*, *Linum catharticum* and *Euphrasia stricta*) decreased in all but one meadow. Four species (*Primula veris*, *Platenthera bifolia*, *Bistorta viviparum* and *Chrysanthemum leucanthemum*) increased in all meadows in which they occurred. Three species varied strongly between the meadows (*Polygala vulgaris* increased in three meadows and decreased in one, *Melampyrum nemorosum* increased in two and decreased in two, and *Crepis praemorsa* increased in two and became extinct in two meadows).

DISCUSSION

The present hay meadow management based on subsistence agriculture in Romania uses more of the traditional management methods compared to the management for conservation purposes in Sweden, thus forming a more complex and diverse grassland management. Historical sources show that Swedish hay meadow management has lost a number of management components that are still present in Romania. The eligibility criteria for agri-environment payments in the NRDPs of Romania and Sweden will strongly influence the grassland management practices if implemented. Some aspects of the traditional management can be expected to be favoured, but the NRDPs may also become a barrier for the continuation of traditional grassland use in Romania, and for the reintroduction of traditional practices in Sweden. The Swedish NRDP supports more traditional management components, and smaller hay meadow parcels than the Romanian NRDP. In spite of this, Swedish hay meadow management for conservation has only limited success in preserving grassland plants.

Traditional management practices and the National Rural Development Programmes

Agricultural policies and socioeconomics drive the maintenance of traditional grassland use, and governance of grassland biodiversity in general, in Europe (Zarzycki & Misztal 2010; Kristensen *et al.* 2004) and elsewhere (see for example Banks *et al.* 2003; Fauna and Flora International 2009; Fu *et al.* 2012).

In Sweden, the main drivers for hay meadow management are nature conservation and agri-environment payments in the CAP. In Romania's mountainous regions, semi-natural hay meadows are used mainly because they constitute the major fodder source for agriculture. Grassland-based agriculture persists because topography and lack of economical capital counteract a switch to production of fodder on arable fields, based on artificial fertilizers (Government of Romania 2008). However, the agri-environment payment connected to the NRDP is of growing importance in agriculture and grassland use. Thus the eligibility criteria and requirements for agri-environment payment will be crucial for the future of the Romanian semi-natural grasslands, their biodiversity and their value for agriculture and local communities (Schmitt & Rákosy 2007).

In Sweden, policies for grassland use aim at preserving what is left of grassland management and reintroducing some of what is lost. In Romania, the challenge is to preserve and develop the Romanian grassland landscapes and their biodiversity for the future within the CAP, by improving economic viability of the agricultural systems on which the grasslands rely. The subsistence agriculture needs to develop in terms of techniques, ownership structure and products in order to increase economic power and attract new generations of farmers. For governance of biodiversity, the new ways of using the grasslands need to be, in ecological terms, as

similar as possible to the traditional land use that has formed the grassland ecosystems. New techniques need to have a similar impact on vegetation and species as traditional tools (Römermann *et al*. 2009).

Romanian NRDP

For achieving economic and ecological sustainability, two aspects of the NRDP are likely to be particularly important, namely how the NRDP acknowledges and economically supports grassland landscapes and their use by small farms and how eligibility criteria for agri-environment payments are designed in relation to regional cultural, socioeconomic and ecological conditions. How will the NRDP affect further use of those local traditional practices that have formed the grassland ecosystems?

Firstly, the Romanian grassland resource, its biological and cultural values and its use in agriculture are not unambiguously recognized in the NRDP. Grassland biodiversity related to subsistence farming in the mountains is acknowledged, but small farms are also described as reducing the aggregate agricultural performance, and as lacking incentives or capacity to observe European standards, including those on environmental quality, animal welfare and food safety (Government of Romania 2008, pp. 22 and 32). The NRDP risks not giving priority to the local development of subsistence farming because areas characterized by such farming are generally considered a problem.

Secondly, the present requirements for agri-environment measures support some traditional practices, but disfavour others, which may contribute to reducing the present complexity and varieties of hay meadow management, and hence landscape heterogeneity. In order to qualify for agri-environment payment, it is necessary for the farmer to stop or change several traditional management practices which may be ecologically important, examples including temporary cultivation and short periods without mowing (Table 2, Fig. 3).

Such management changes will reduce the spatial variation in the landscape. The eligibility criteria restricting agri-environment payment to parcels of, $<$ 0.3 ha will contribute to reducing grassland mosaics and the total area of mown meadows. In Botiza, about half of the parcels and 75 % of the meadow area qualified for payment according to the area criteria (Fig. 1). If fusion of parcels is possible, area may remain approximately the same, but variation will be lost. In Şurdeşti, $<$ 10 % of the number and area of open meadows qualified for agri-environment payment according to the 0.3 ha criterion. Reduction of area may, in turn, generate other land-use changes that may negatively affect biodiversity; for example, if each landowner manages fewer hectares, the mowing period may be shorter and late-mown meadows may be lost. Landscape homogenization has reduced biodiversity in grassland biomes elsewhere (see Brockett *et al*. 2001; Fuhlendorf & Engle 2004; Butaye *et al*. 2005).

The eligibility criteria for traditional farming include regulations for mowing techniques. Scythes and animal-driven mowers are allowed, but not single-axle motorized mowers. In Şurdeşti, motorized mowers prevail at present, implying that most of the grassland is not eligible for payment for traditional farming. Although a shift to horse-driven mowers is technically possible in the flat Şurdeşti meadows, it is probably economically impossible for most farmers. In Botiza, the scythe is the prevailing tool and most meadows thus qualify for traditional farming payments for mowing. However, if this labour-intensive manual mowing needs to be replaced by more rational techniques, only motorized single-axle mowers, and not horse-drawn machinery, would function due to the local topography. The disqualification of motorized single-axle mowers may thus impede economic and technical development of grassland use in both Şurdeşti and Botiza.

Swedish NRDP

The Swedish agri-environment payment supports continued management of the last fragments of hay meadows (SLU 2007). The criteria for agri-environment payment reflect the fact that most of the meadow area and its ecological variation are already lost. The criteria encourage reintroduction of traditional management components, such as hay handling, aftermath grazing, coppicing and pollarding. Meadows of $\geq$ 0.1 ha are eligible, a considerably lower area limit than in Romania. Scythes and single-axle motorized mowers are considered equal and both merit extra payment. Some traditional management components are however overlooked, for example temporary cultivation is not allowed, and a variable mowing date is allowed but not economically encouraged. Management interruptions and burning are allowed after approval, but do not merit extra payment.

The Swedish eligibility criteria will thus theoretically favour most of the traditional management components believed to be potentially important for hay meadow biodiversity. Since very few of the components are present in reality (Fig. 3, Table 2), the criteria seem to have partly failed in reintroducing traditional management practices and more varied hay meadow management in general. Possible explanations for this include lack of resources to administer the variety of payments and eligibility criteria, and lack of local traditional knowledge of management practices (SLU 2007).

Traditional management practices and biodiversity in Sweden

In the studied Swedish semi-natural hay meadows, a number of grassland plants have shown negative trends during 20 years of management within the CAP framework. The Swedish mowing during the study period consisted of cutting and instant removal of the grass, performed at more or less the same date every year. This practice stands in clear contrast to the historical use of Swedish hay meadows, which included a palette of harvest and maintenance activities, an extended mowing period, and considerable variation of management between years and meadows (Table 2). It is likely that these differences between present and historical management conditions in Swedish hay meadows are large enough to cause population decline of some species, especially when combined

with eutrophication and other habitat variables (Lennartsson 1997; Poschlod & Wallis de Vries 2002). Several of the management components lost from Swedish management affect plant populations directly. For example, traditional late mowing, later than the Swedish late-July mowing, is crucial for the seed production of many grassland plant species (Lennartsson *et al*. 2012) and for the reproduction of phytophagous insects (Dahlström *et al*. 2008). To our knowledge, this study is the most extensive (in terms of time span and number of monitored species) evaluation of how CAP-driven hay meadow management in Sweden affects biodiversity.

Comparing historical and present management practices

A growing body of international literature stresses the need to use historical-ecological knowledge when designing new land-use methods and developing sustainable land-use in general (see Battershill & Gilg 1996; Cubit 1996; Berkes *et al*. 2000; Bignal & McCracken 2000; Poschlod & Wallis de Vries 2002; Sheehy *et al*. 2006). This study further highlights the need to preserve traditional land use where it persists.

Complexity and variation are lost from Swedish grassland management, but still survive in the Romanian farmers' use of their semi-natural meadows, including a variety of management components. Although Romanian grassland use has changed in some respects, it is likely that many of these management components represent traditional practices. One important cause of land-use change in Romania is collectivization during the communist period, and the subsequent return to private ownership (Iordachhi & Dobrincu 2009).

The correspondence between pre-industrial meadow use in Sweden and the current use in Romania is striking. Even when taking into account climate and other differences, Romanian practices may provide insights into Swedish historical practices. For example, the effects of between-year variation in mowing time can be studied even if the exact mowing dates cannot be transferred to Swedish conditions. Temporary cultivation in grasslands was formerly common in Sweden, and its general impact on vegetation succession can be studied in Romania even if the species assemblages are somewhat different.

CONCLUSIONS AND POLICY ADVICE

This study of semi-natural hay meadows offers a number of messages for governance of grassland biodiversity in Europe and similar grassland types in temperate regions elsewhere (Grigg 1974).

First, once the habitat area has become seriously reduced and fragmented, it is difficult to design and implement ecologically sufficient management regimes, for example in terms of dynamics and variation. Thus the requirements and eligibility criteria for agri-environment payment should aim to counteract habitat loss and fragmentation.

Second, new management practices, which are needed to develop agriculture socioeconomically, need to be ecologically similar to the historical land use that has formed the habitats and landscapes. Requirements and eligibility criteria for agri-environment payment should be designed to encourage the use of living traditional management practices, and develop those practices for modernized agriculture without losing their ecological function. Countries like Romania, which contain large areas of biodiversity-rich grassland based on traditional farming, need to adopt existing agri-environment schemes with caution. Most schemes mainly deal with the Western European need to preserve habitat fragments (not large non-fragmented areas) and to restore biodiversity and traditional knowledge (not preserve functional ecosystems under traditional land use).

Third, it is impossible to design management for conservation that is as diverse, flexible and adaptive as use by local farmers. Requirements and eligibility criteria should thus be designed to maintain those categories of farm units (in Romania mainly subsistence farms) that function to maintain biodiversity-rich grasslands, and to facilitate their continued use of the grasslands.

Fourth, the loss of management complexity, habitat area and habitat connectivity in Sweden has been accompanied by loss of biodiversity (Government of Sweden 2009). This may inform future practices in countries that are in the process of developing their agriculture within the CAP framework.

Fifth, development of Romanian subsistence agriculture needs to be built on local traditional knowledge and existing local practices, rather than on science and technical expertise (Wolchik 1991). Ecological knowledge can indicate which aspects of traditional knowledge are most important for biodiversity. In Western Europe, the maintenance and restoration of valuable agricultural landscapes has been compromised by the loss of local traditional agricultural knowledge and local agricultural societies. In the Romanian villages, such knowledge and societies have survived. Landscapes in active use by local communities constitute invaluable European capital of both biodiversity and traditional knowledge. Both the EU and the Romanian agricultural policies would be strengthened if knowledge and experiences from Romanian traditional agriculture could reach and influence policymakers in Brussels, Bucharest and Stockholm.

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