Evidence for the benefits of biodiversity management in marginal agricultural areas

Deliverable D22 (D3.6)

25 March 2024

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SHOWCASE

SHOWCASing synergies between agriculture, biodiversity and Ecosystem services to help farmers capitalising on native biodiversity

This project receives funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862480.

Prepared under contract from the European Commission

Grant agreement No. 862480
EU Horizon 2020 Research and Innovation action

Project acronym: **SHOWCASE**
Project full title: **SHOWCASing synergies between agriculture, biodiversity and Ecosystem services to help farmers capitalising on native biodiversity**
Start of the project: November 2020
Duration: 60 months
Project coordinator: Prof. David Kleijn
Wageningen University
Deliverable title: Evidence for the benefits of biodiversity management in marginal agricultural areas
Deliverable n°: D3.6
Nature of the deliverable: Report
Dissemination level: Public

WP responsible: WP3
Lead beneficiary: EMU

Citation: Kadulin, A., Bodea, F., Costache, C., Hempel, S., Herzog, F., Martinez, M., Melts, I.& Öckinger, E. (2023). *Evidence for the benefits of biodiversity management in marginal agricultural areas*. Deliverable D3.6 EU Horizon 2020 SHOWCASE Project, Grant agreement No 862480.

Due date of deliverable: Month n°
Actual submission date: Month n°

Deliverable status:

Version	Status	Date	Author(s)
1.0	Draft	24 January 2024	Kadulin, A., Bodea, F., Costache, C., Hempel, S., Herzog, F., Martinez, M., Melts, I.& Öckinger, E.
2.0	Draft	26 February 2024	Kadulin, A., Bodea, F., Costache, C., Hempel, S., Herzog, F., Martinez, M., Melts, I.& Öckinger, E.
3.0	Semi final	29 February 2024	Kadulin, A., Bodea, F., Costache, C., Hempel, S., Herzog, F., Martinez, M., Melts, I.& Öckinger, E.
4.0	Final	25 March 2024	Kadulin, A., Bodea, F., Costache, C., Hempel, S., Herzog, F., Martinez, M., Melts, I.& Öckinger, E.

Table of contents

Summary

In this task T3.6, we merge existing information and generate new findings to demonstrate the advantages of biodiversity-focused management of permanent grasslands in agriculturally marginalized areas that face the threat of abandonment. Our primary focus is on species-rich grasslands, which have developed over time under traditional mowing and grazing practices. We examine three key aspects: (i) existing biodiversity values, (ii) the impact of their abandonment and (iii) effects of conservation and restoration efforts (i.e. agri-environment climate schemes, nature conservation practices) on biodiversity.

This deliverable mainly relies on analyses of existing data and interviews with stakeholders in the four countries Estonia, Romania, Sweden and Switzerland. Our definition of marginal agricultural areas relates to agriculturally marginal grasslands, sometimes also called semi-natural grasslands. The term is slightly contextual and varies from region to region. Marginal grasslands host a vast amount of biodiversity and, in contrast to the usual understanding of how biodiversity should be enhanced, on marginal grasslands mild human intervention is the pre-requisite to maintaining their biodiversity.

Firstly, we conduct a quantitative review of existing literature to establish the most up-to-date evidence related to the above-mentioned points (i) to (iii). We found that abandonment of agriculturally marginal grasslands has a high predicted probability of decreasing diversity of plants and lichen and a lower predicted probability of decreasing diversity of invertebrates and vertebrates. Restoration of abandoned agriculturally marginal grasslands has a high predicted probability of increasing the diversity of plants and lichen. Conservation of extensively managed grasslands has a high predicted probability of stabilising or increasing the diversity of invertebrates and vertebrates.

Secondly, we explore if existing data on vascular plants and key animal species representing various trophic and functional groups from four case study countries (Estonia, Romania, Sweden, Switzerland) can inform about effects of abandoned grasslands as compared to grasslands under active conservation management. We used these four countries as case studies in order to make sure we have a variety of marginal grasslands. However, the original plan to pool the data from the four countries proved to be not feasible. We explored data of two different monitoring programs from Sweden and Switzerland. The lack of management information prevented us from including those data sets in the analysis. For Romania and Estonia, there was no pre-existing data available, but the SHOWCASE experimental biodiversity areas (EBA) examine conservation and management practices on marginal grasslands. Those data will be analysed in Task 3.2, and it was decided not to further pursue the analysis in the current task.

Lastly, we identify the factors contributing to the abandonment of these areas by conducting reviews of both published and grey literature. Additionally, we conduct interviews with relevant experts in the four countries. In the past, abandonment of agriculturally marginal grasslands has been in most cases inevitable because of the shift to intensification in agriculture and urbanisation. Current main drivers are low profitability of managing those grasslands and reasons related to accessibility. Being high in priority politically and encouraged by CAP payments, easily accessible marginal grasslands are currently managed. Every additional hectare to be restored comes with a higher price to society.

List of abbreviations

EU	European Union
CAP	Common Agricultural Policy
RDP	Rural Development Programmes

EBA	Experimental Biodiversity Aera
AES	Agri-environmental schemes (SE)
HNV	High Nature Value (RO)
UAA	Utilized agricultural area (all farmland, excluding summer pastures and woods) (CH)
EFA	Ecological Focus Areas (CH)
LU	Livestock unit

Introduction

Agriculturally marginal land has very diverse definitions because it can include very different types of land and the use of the term may vary by country, by local conditions (Dale et al. 2010) and can be defined also by the issue to be studied (Csikós and Tóth 2023). Marginal land can be identified by adverse climate, excessive wetness, low soil fertility, poor rooting conditions, adverse terrain and chemical conditions (Elbersen et al. 2019). These ecological conditions make them environmentally fragile and different environmental risks may rise (Kang et al. 2013). Sometimes synonyms used for marginal land are fallow land, set-aside land, degraded land, wasteland, abandoned and surplus land (Gerwin et al. 2018). The term marginal land is used also as an umbrella to cover all these types of land because the types intersect and resemble by measuring their productivity and need for land restoration (Dauber et al. 2012). But more accurately, marginal land is an economic term. It designates land that is not suitable for conventional high productive agriculture and where cost-effective production is not possible under given site conditions (Gerwin et al. 2018, Wiegmann et al. 2008). Such sites can often be used for alternative agricultural practices like bioenergy production (Csikós and Tóth 2023, Dauber et al. 2012). On the other hand, marginal land is important and remarkable due to providing ecosystem services, preserving biodiversity and offering spiritual and cultural values. Therefore, environmental issues like ecosystem services and sustainability have been widely raised over the use of marginal land (Kang et al. 2013). For example, marginal grasslands/semi-natural grasslands are ecologically valuable lands, and their traditional management helps to preserve cultural heritage as well as biodiversity and diverse ecosystem services (Herzon et al. 2022).

Agricultural abandonment is one of the dominant land use change processes in Europe. While the current extent of abandonment is unknown (Pointereau et al., 2008), European agricultural statistics and land cover maps show a clear decrease of agricultural areas in the past decades, especially for extensive and small-scale agricultural systems (Pinto Correia 1993; Renwick et al., 2013; Fuchs et al., 2015) and modelling studies predict significant levels of agricultural abandonment in Europe over the next 20–30 years (Renwick et al., 2013; Verburg and Overmars, 2009). Recent studies on agricultural abandonment in Europe show that it primarily occurs in less productive areas, remote and mountainous regions and areas with soil erosion or unfavourable climatic conditions for agriculture (Rey Benayas et al., 2007; Keenleyside and Tucker, 2010). Secondary drivers of agricultural abandonment include rural depopulation and regional specific factors regarding land ownership and tax regimes (Rey Benayas et al., 2007; Keenleyside and Tucker 2010; MacDonald et al., 2000). An important regional event which triggered agricultural abandonment in Eastern Europe was the collapse of the Soviet Union in the 1980s. This was to a large extent due to poorly established property rights and problems with land ownership (Kuemmerle et al., 2008; Hartvigsen, 2014). Agricultural policies also play an important role, as abandonment often occurs in areas where the land productivity does not provide an adequate income for farmers. Even with the support of subsidies such as the Less Favored Areas support and agri-environmental payments, which are part of the rural development pillar of the Common Agricultural Policy (CAP), agriculture in these areas is often not competitive (Renwick et al., 2013).

Despite the widespread use of agri-environmental payments aimed at mitigating biodiversity decline in agricultural lands, their effectiveness remains questionable, particularly in extensively managed grasslands. Often, these payments have led to only modest improvements in the richness or abundance of common species in intensively used areas, and in some instances, have inadvertently increased land-use intensity, resulting in habitat and species loss. This has sparked criticism of past and current agricultural policies, prompting calls for innovative conservation strategies, especially for biodiversity-rich semi-natural grasslands. Acknowledging these concerns, the post-2020 CAP seeks to enhance natural

resource management and biodiversity conservation within agricultural systems. Simultaneously, the European Union emphasizes the preservation of semi-natural habitats and environmentally sustainable rural practices, allocating a significant portion of its budget to the agricultural sector through CAP, with Rural Development Programmes encouraging economically and environmentally sustainable farming practices. These programmes, which form a crucial part of the CAP's second pillar, include agri-environmental payments to encourage conservation-friendly farming practices and offer compensation for traditional farming in economically challenging areas, aiming to prevent land abandonment and the loss of semi-natural grasslands (Napoleone et al. 2022).

Projections of farmland abandonment should be taken carefully, as they are limited by available information, the uncertainty of political decision-making and future socio-economic development. Models assume that landowners give a prompt response to external incentives, especially economic ones. However, reality often shows that farmers consider social and cultural concerns (Swart et al., 2023), which lead them to cultivate land, although it is not a profitable activity; at other times, they maintain agriculture despite being anti-economic, as an income support (Lasanta et al., 2017). The modelled projections about abandonment do, however, need to be considered with caution, as they are constrained by available data, lags in policy assumptions and uncertainty over future socioeconomic developments and policy decisions. In particular, the projections of very high levels of abandonment may be exaggerated because their scenarios assume levels of market liberalisation and weak environmental regulation that are probably unrealistic (Keenleyside, Tucker 2010).

European semi-natural grasslands rank among the most species-diverse ecosystems on a global scale (Napoleone et al 2022). Such grasslands are crucial for both conservation and aiding in food production. The significance of grasslands extends far beyond local concerns of biodiversity preservation and food production; they play a role in ecological processes at various levels – including pollination at the landscape level, water regulation and recreation regionally, and climate regulation on a global scale (Bengtsson et al 2019).

Semi-natural grasslands have developed in Europe under human influence about 7500-6800 years ago (since the Neolithic Age). These communities are mostly grasslands which have emerged from cleared woodland and shrubland to manage them as hayfields or pasturelands (Herzon et al. 202, Isselstein et al. 2005). Semi-natural grasslands are areas that have been influenced by human activity, their biological diversity is dependent on human activity (i.e. mowing and grazing). These grasslands are typically found in areas that have been grazed or mown for centuries and are characterized by a complex mosaic of different plant species and microhabitats. Continuous traditional agricultural activities have created remarkable species-rich communities which hold great conservation value and will last only through ongoing moderate human impact like grazing, mowing, burning, removal of trees and shrubs (Herzon et al. 2021).

According to Bengtsson et al. (2019) semi-natural grasslands are crucial for biodiversity due to their high species richness and the essential ecosystem services they provide. These grasslands, shaped by extensive human management like livestock grazing or hay-cutting, are diverse habitats that support a wide range of flora and fauna. They play a significant role in maintaining biodiversity, both in terms of species richness and ecosystem functionality. The biodiversity in semi-natural grasslands contributes to crucial ecosystem services such as pollination, pest control, and carbon sequestration, making them valuable not only for their inherent biological diversity but also for the essential ecological functions they support. Despite the rising demand for animal products driven by a growing population and higher per capita consumption, the need for more meat and dairy production isn't resulting in expanded grazing of marginal grasslands. Instead, it's being addressed through fodder production on croplands and improved grasslands. Consequently, there is an emphasis on food production and security in both scientific and policy discussions, often focusing on sustainable intensification, which

involves increasing food output on existing croplands, but this frequently overlooks the importance of semi-natural grasslands in this context.

Marginal grasslands are typically found in areas that are more remote or inaccessible than other semi-natural grasslands and may have more extreme environmental conditions or topographical constraints. Therefore, marginal grasslands are often less intensively managed than other semi-natural grasslands, but this can also differ significantly between regions.

Marginal grasslands face threats from both the complete stop of farming activities and the shift to more intensive agricultural practices, both of which can disrupt the delicate balance of these ecosystems. In this report we try to explore the ecological impacts, clarify the conservation and management strategies to address this issue.

This deliverable is divided into three main sections, according to the three approaches we have used:

Firstly, a systematic literature review was conducted to synthesize information on the value of maintaining permanent grasslands in agriculturally marginal areas. In this section we describe existing biodiversity values of marginal grasslands, the impact of their abandonment or intensification and the effects of conservation and restoration efforts.

Secondly, we search existing empirical data from four case study countries – Estonia, Romania, Sweden, and Switzerland. Due to lack of existing data sets about the impact of abandonment in marginal grasslands in this part we excluded Estonia and Romania.

Thirdly, a grey literature review in combination with expert interviews were carried out in order to identify drivers of abandonment in the four countries.

In this task we define marginal grasslands as a subset of semi-natural grasslands, i.e. semi-natural grasslands that are situated in agriculturally marginal areas. Our focus is grasslands in agriculturally marginal areas and not for example grassy margins next to crop fields.

1 Systematic literature review

1.1 Methods

We conducted a systematic literature review, in which we aggregated information from scientific studies about the consequences of land-use change on the biodiversity of different classes of organisms in agriculturally marginal grasslands across the European continent. We focused on the impact of abandonment, but also explored the effects of conservation and restoration efforts in those biodiversity-rich semi-natural grasslands. We searched the literature using the Web of Science Core Collection and Elsevier Scopus databases with a combination of keywords according to the Population, Intervention, Comparison and Outcome (PICO) framework. Potentially relevant studies were screened using a checklist based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. We extracted qualitative information on the effect of land use change on biodiversity and considered two categories: positive/neutral or negative/neutral outcome for biodiversity upon land use change. We modelled the change in biodiversity using generalised linear mixed effect models with a binomial distribution.

1.2 Effects of abandonment on biodiversity values

In our systematic literature review, we screened the scientific literature for information about the consequences of abandonment on the biodiversity values of plants and lichen, as well as invertebrates and vertebrates in European agriculturally marginal grasslands. With this approach we aimed to answer the following questions: 1) What is the effect of abandonment on the biodiversity of agriculturally marginal grasslands? 2) Is this effect different between

different classes of organisms? 3) Are certain types of agriculturally marginal grassland differently affected by abandonment? The number of studies reporting the consequence of abandonment of agriculturally marginal grasslands was highest in plants and invertebrates, with much less studies focusing on the consequences of abandonment on vertebrate biodiversity (Figure 1, left column).

The statistical model based on the extracted information predicted a high probability of a decrease in plant biodiversity upon abandonment. The high probability of observing a decrease in plant biodiversity is predominantly prevalent in mountain and calcareous grasslands. According to our analysis, plant diversity of dry, wet and other semi-natural grasslands is not significantly decreased by abandonment. The effect of abandonment on grassland biodiversity is predicted to be significantly worse for plants than for invertebrates and vertebrates. Invertebrates and vertebrates do not show a decrease in biodiversity upon abandonment in our model. This effect can probably be attributed to two factors. Firstly, a great variability of taxonomic groups within the class of invertebrates and vertebrates, may result in diverse responses to land-use changes due to differences in, amongst others, mobility, habitat range, feeding and nesting behaviours. Secondly, species on higher trophic levels, such as herbivores and predators, may exhibit a delayed response to changes in the diversity of lower trophic levels, such as plants.

1.3 Effects of conservation and restoration efforts on biodiversity values

Apart from the effects of abandonment, we further synthesised existing information from the scientific literature about the consequences of conservation or restoration efforts on the biodiversity of different classes of organisms in agriculturally marginal grasslands across the European continent. We aimed to answer the following questions: 1) What are the effects of conservation and restoration on the biodiversity of agriculturally marginal grasslands? 2) Are these effects different between different classes of organisms? Studies analysing the effect of conservation or restoration efforts were underrepresented in all three classes of organisms as compared to studies dealing with the effect of abandonment on grassland biodiversity (Figure 1, middle and right column).

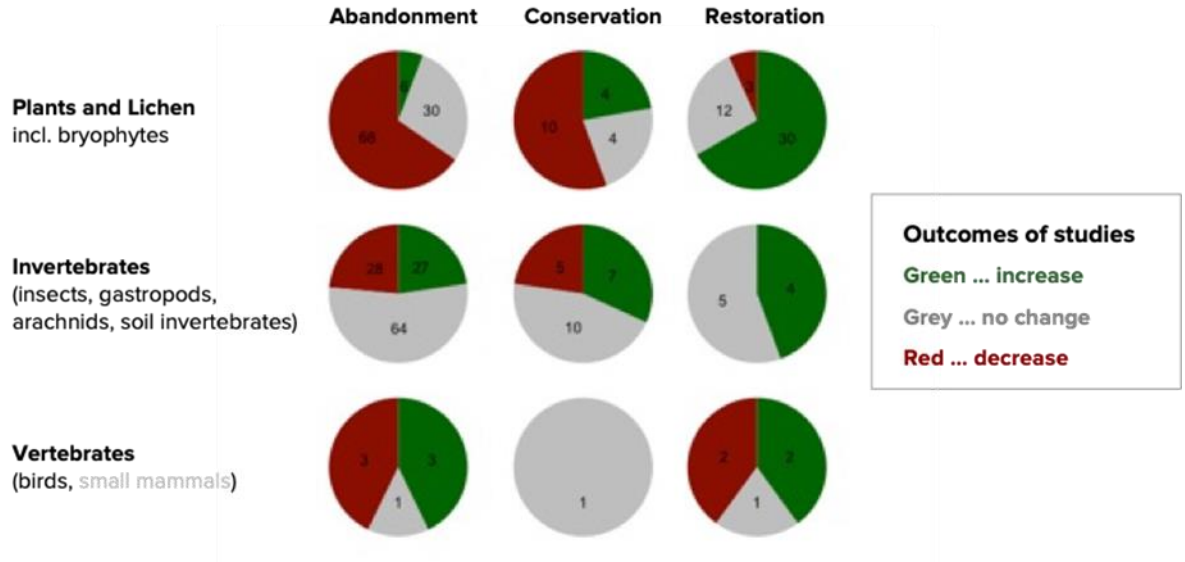

Figure 1 *Number and outcomes of studies that report an effect of abandonment (left column), conservation (middle column) or restoration (right column) of agriculturally marginal grasslands on biodiversity values of different classes of organisms.*

The conservation efforts in the studies we investigated for this systematic literature review included: traditional meadow irrigation, burning, mechanical turf disturbance, mulching, alternative low-intensity mowing regimes, grazing with low stocking rate, sowing, and leaving uncut refuges. According to our model, conservation of extensively managed agriculturally marginal grasslands has no significant effect on plant diversity, but it has a significantly beneficial effect on the biodiversity of invertebrates and vertebrates. This implies that the studied conservation efforts might not be sufficient to maintain the high floral diversity of agriculturally marginal grasslands as compared to traditional management, like regular extensive mowing or grazing regimes.

The restoration of abandoned agriculturally marginal grasslands in the studies we analysed was predominantly achieved by the reintroduction of extensive grazing or mowing, or shrub clearing, and is predicted to have a positive effect on biodiversity of plants according to our model. We further find that the diversity of invertebrates and vertebrates in previously abandoned grasslands is not significantly affected by restoration, but it did not show a decline due to abandonment in the first place.

2 Analysis of existing data

The second part of Task T3.6 aimed at an overarching analysis of data sets from Estonia, Romania, Sweden and Switzerland. The goal was the investigation of the effects of abandonment and conservation/restoration management on biodiversity of vascular plants and iconic key animal taxa representing different trophic and functional groups in agriculturally marginal areas. To fulfil this task, the data sets from the 4 countries needed to meet the following requirements:

- Comparison of abandoned agriculturally marginal grasslands to traditionally/extensively managed agriculturally marginal grasslands to demonstrate the consequence of abandonment and the effect of conservation efforts (hereby defined as continuous traditional or low intensive agricultural practices), and
- Comparison of abandoned agriculturally marginal grasslands to formerly abandoned agriculturally marginal grasslands that were restored to show the effect of restoration efforts.

We identified existing data sets from systematic monitoring programmes in Sweden and Switzerland. Data sets from Estonia and Romania, that were at first promised while developing the task, were eventually missing or identified as unsuitable for this task. Data collected within the SHOWCASE project from Estonia and Romania could be used as their Experimental Biodiversity Area (EBA) are grasslands, but we decided not to use those data sets because they are analysed in other deliverables.

Both Sweden and Switzerland contributed vegetation data from their national landscape monitoring schemes, namely NILS and ALL EMA, respectively.
The National Inventory of Landscapes in Sweden (NILS) takes place in 631 plots of 1km^2 each covering the entire country of Sweden. Plots are monitored in 5-year cycles, the first cycle took place from 2006 to 2010, the second cycle from 2011 to 2015. Within each 1km^2 plot, presence of vascular plants, bryophytes and lichen are surveyed in small circular subplots of 0.25 m^2 (with a radius of 0.28 m), whereas shrub cover is surveyed in larger circular plots of 314 m^2 (radius = 10 m) (Figure 2) encompassing three to nine small subplots. Agricultural marginality of the plots is not indicated, though, and there is no direct information about the

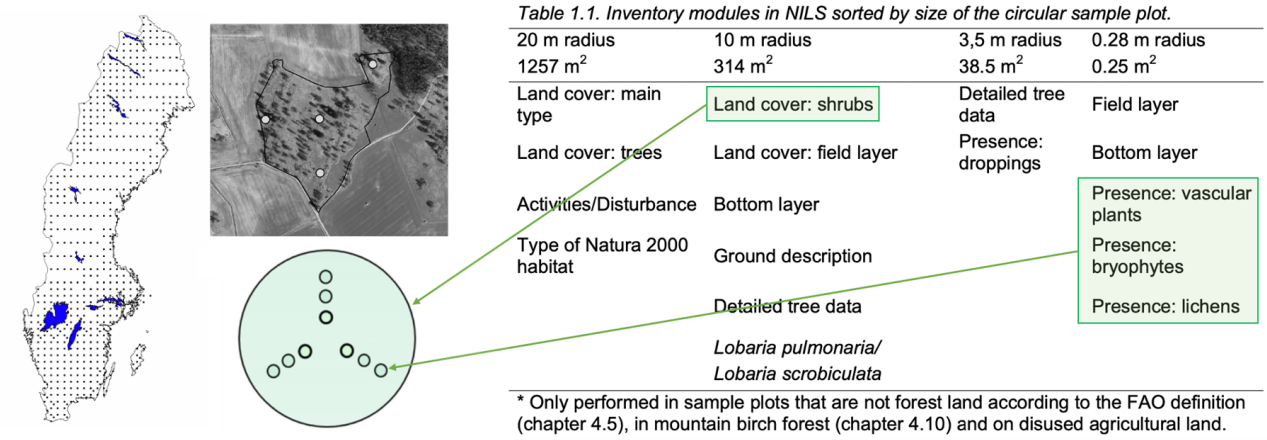

Table 1.1. Inventory modules in NILS sorted by size of the circular sample plot.

20 m radius 1257 m^2	10 m radius 314 m^2	3,5 m radius 38.5 m^2	0.28 m radius 0.25 m^2
Land cover: main type	Land cover: shrubs	Detailed tree data	Field layer
Land cover: trees	Land cover: field layer	Presence: droppings	Bottom layer
Activities/Disturbance	Bottom layer		Presence: vascular plants
Type of Natura 2000 habitat	Ground description		Presence: bryophytes
	Detailed tree data		Presence: lichens
	Lobaria pulmonaria/ Lobaria scrobiculata		

* Only performed in sample plots that are not forest land according to the FAO definition (chapter 4.5), in mountain birch forest (chapter 4.10) and on disused agricultural land.

Figure 2 *Overview of the National Inventory of Landscapes in Sweden (figure modified from Milberg et al. 2020 and Stahl et al. 2011)*

management intensity of the plots (abandonment *vs.* extensive/traditional management, or abandonment *vs.* restoration).

We discussed to infer indirect information regarding management intensity from the difference in shrub cover between the cycles, but faced the following hindrances: first, there was no correlation between species richness of plants and lichen and shrub cover in neither of the two cycles (Figure 3A); second, the difference in shrub cover between the two cycles was rather small, and only few plots showed an appreciable difference of more than 25% (Figure 3B). There was no correlation between differences in shrub cover to species richness of plants and lichen: neither within the 29 plots that showed an increase of more than 25% shrub cover, nor within the 18 plots that showed a decrease of more than 25% shrub cover.

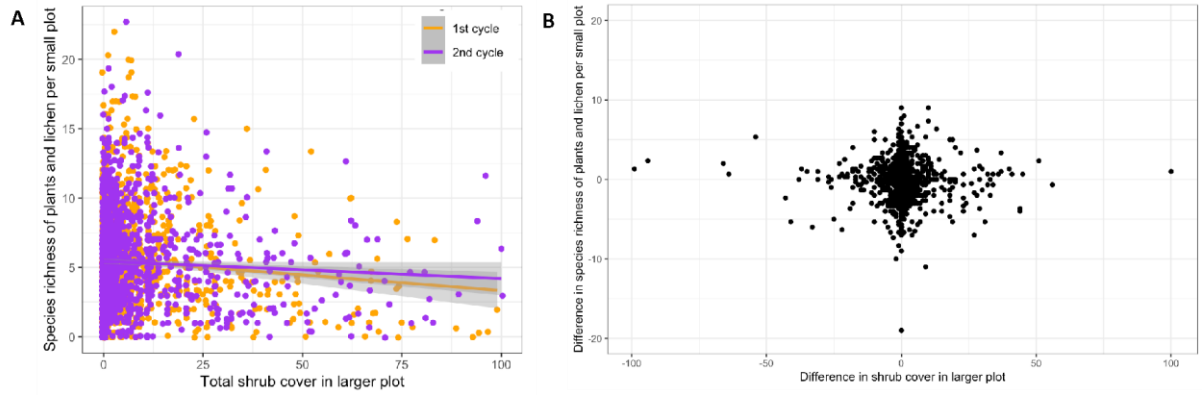

Figure 3 *(A) Relationship of species number of plants and lichen to shrub cover in plots from NILS. Values from the first cycle are indicated in orange, values from the second cycle are indicated in purple. grey represents the 95% Confidence Interval. (B) Relationship of difference in species richness of plants and lichen to difference of shrub cover in plots from NILS after 5 years.*

As it was not possible to correlate the biodiversity values from NILS-plots to management practices that occurred in those plots, the use of this dataset to answer the questions from Task 3.6 was not meaningful, and the NILS data was not considered in the final analysis.

Switzerland also contributed vegetation data from their Agricultural Species and Habitats monitoring program ("Arten und Lebenraueme Landwirtschaft – Espèces mileux agricoles", ALL EMA), which takes place in 170 quadrats of 1 km^2 plots each covering the entire agricultural landscape of Switzerland. Like the Swedish monitoring data, ALL EMA plots are surveyed in a 5-year cycle with the first cycle lasting from 2015 to 2019. The second cycle started in 2020 and will finish in 2024. In each 1 km^2 quadrat, plant species and shrub cover are surveyed in 10 m^2 plots randomly stratified across the habitat types within each 1km^2 quadrat (Figure 4).

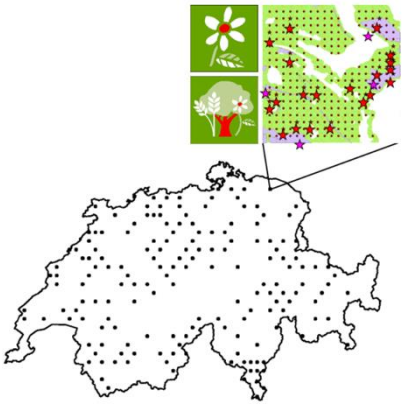

Figure 4 *Overview of 170 quadrats of 1km2 each covering the Swiss agricultural landscape (lower part of the figure) with sampling plots and 10m2 sampling plots within one of those 1km2 quadrats (upper right corner). Figure adapted from Meier et al. (2021).*

Based on topography and agricultural marginality, Swiss agricultural fields are grouped into five different zones, namely the Valley zone, Hill zone, Lower mountain zone, Upper mountain zone and the Summering area (figure 5). In the Hill zone and in the mountain zones, agriculture is confronted with increasingly difficult production and living conditions. Management intensity is highest in the Valley zone and lowest in the Summering area. Agriculturally marginal areas, as defined within this Task 3.6, are located in the Summering area, which is covered by surveys of 47 ALL EMA quadrats (Figure 5).

Agricultural zone	Main use	Number of 1 km ²
Valley zone	Crop rotation areas, Meadows and pastures, Orchards	35
Hill zone	Meadows and pastures, Orchards, Crop rotation areas	22
Lower mountain zone	Meadows and pastures	37
Upper mountain zone	Meadows and pastures	29
Summering area	Alpine farming	47

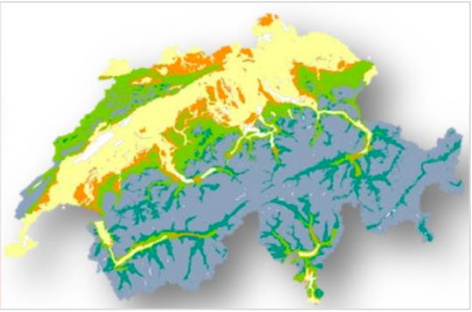

Figure 5 *Agricultural zones of Switzerland. Adapted from Meier et al. (2021).*

Like the Swedish monitoring data set, there is no direct information about management and management intensity (abandonment *vs.* extensive/traditional management, or abandonment *vs.* restoration) in the Swiss ALL EMA data set. Indirect information about management intensity could be inferred from the shrub cover. Although there is a weak negative correlation between plant species richness and shrub cover in ALL EMA plots in the Summering area in both cycles (Figure 6A), the difference in shrub cover between the cycles is only prevalent in

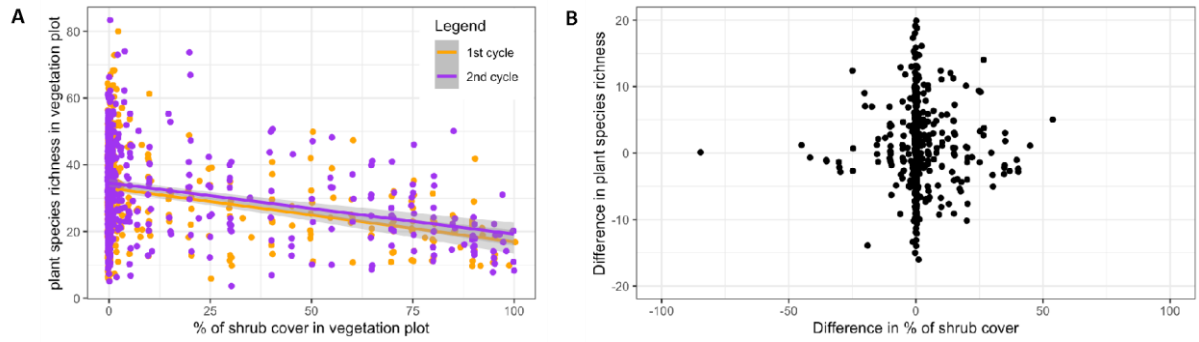

Figure 6 (A) *(A) Relationship of species number of plants and lichen to shrub cover in ALL EMA plots located in the Summering area. Values from the first cycle are indicated in orange, values from the second cycle are indicated in purple. Grey represents the 95% Confidence Interval. (B) Relationship of difference in plant species richness to difference of shrub cover in ALL EMA plots located in the Summering area after 5 years.*

11 plots that show more than 25% less shrub cover, and in 21 plots that show 25% more shrub cover (Figure 6B).

There was no correlation between the difference in shrub cover and the difference in plant species richness within plots that showed a greater than 25% increase or decrease in shrub cover.

As it was not possible to relate the biodiversity values from ALL EMA plots to management practices and intensities that occurred in those plots, and the number of plots in which an appreciable change in shrub cover occurred was too small for statistical analyses, the use of this dataset to answer the questions from Task 3.6 was not meaningful, and the ALL EMA data was not considered in the final analysis.

3 Drivers of abandonment

3.1 Introduction

We address the issue of abandonment and its driving factors more closely by conducting a review of grey literature and by interviews with national experts. The literature review allowed us to capture the current situation and the level of study in both academic writings and at the national levels of the four participating countries. We revised academic literature if there was any and also literature in national languages, mainly published by governmental organisations. By this we could assess the existing knowledge, trends, and future perspectives.

3.2 Materials and methods

For the review of the grey literature, the partners of the four countries analyzed reports on topics related to biodiversity, management and abandonment of marginal and semi-natural grasslands from the past ten years that had been published in national languages. Most reports stemmed from government organisations. For each country, we wrote a summary report in English to convey the most important findings on the status of marginal grasslands in the respective country, and about driving factors. The findings are synthesized in this section of the Deliverable 3.6.

To gather the most up-to-date insights into how grassland abandonment is perceived and managed in each country, we conducted a series of structured interviews. Aiming for a comprehensive understanding across different contexts, we conducted a minimum of three

interviews in each participating country: Estonia (4 interviews), Sweden (3 interviews), Switzerland (3 interviews), and Romania (1 questionnaire). The selection of interviewees was based on recommendations from our partner institutions, ensuring that each participant had substantial expertise and confidence in their respective fields related to our study.

Our interview methodology was designed to capture both general and local-specific issues concerning abandonment. To achieve this, the interview questions were divided into two distinct parts:

- Compulsory questions. A set of standardized questions to all interviewees, regardless of their country. This segment aimed to establish a baseline understanding of abandonment and the general effectiveness of existing conservation and restoration efforts.
- Country-specific questions. Because of challenges and contextual specifics of each country, we also asked country-specific questions. For instance, in Estonia, we added a question specifically addressing the role of protected areas, while in Switzerland, we explored the impact of increasing wolf populations. This customized approach enabled us to capture detailed, localized insights that might otherwise be overlooked in a more uniform questionnaire.

- We made an exception for Romania, where conducting interviews proved not to be possible because stakeholders were not willing to participate. Therefore, instead we elaborated questions in written form (questionnaire). The questions were the same as in the interviews, but without any regional specific questions, and they were answered by the Romanian SHOWCASE partner.

Before each interview, confirmation was obtained to ensure the interviewee was comfortable and acknowledged as an expert. This preliminary step was crucial for establishing a foundation of trust and reliability for the information shared during the interviews. We chose interviews as our preferred methodological approach due to capacity to facilitate in-depth analyse of local perspectives.

3.3 Overview over the situation of marginal grasslands in Estonia, Sweden, Switzerland and Romania

Throughout the world the area of semi-natural grasslands has decreased considerably during the last century as a result of land use changes (e.g. Poschlod and Wallis De Vries 2002, Sammul et al. 2008, Squires et al. 2018). Changes in land use and management practices (e.g. agricultural intensification, abandonment etc.) have led to afforestation and loss of biodiversity (Olsson et al 2000, King 2010, Melts et al. 2018). A high decline in species richness of grasslands has been recorded, especially in the last 60 years as many grasslands were abandoned or intensified (Hejcman et al. 2013). In Estonia the area of semi-natural grasslands decreased almost tenfold last century from (Figure 7). They had maintained about 300,000 ha in 1981 (Aug and Kokk 1983) and in the beginning of this century the area of semi-natural grasslands was estimated to cover more than 3% of land territory of Estonia (Kukk and Sammul 2006). In 2020 approximately 41,000 ha of species-rich semi-natural grasslands were under maintenance and restoration (Pärandniitude tegevuskava 2021). These grasslands are mainly located and maintained in the western and southwestern parts of Estonia.

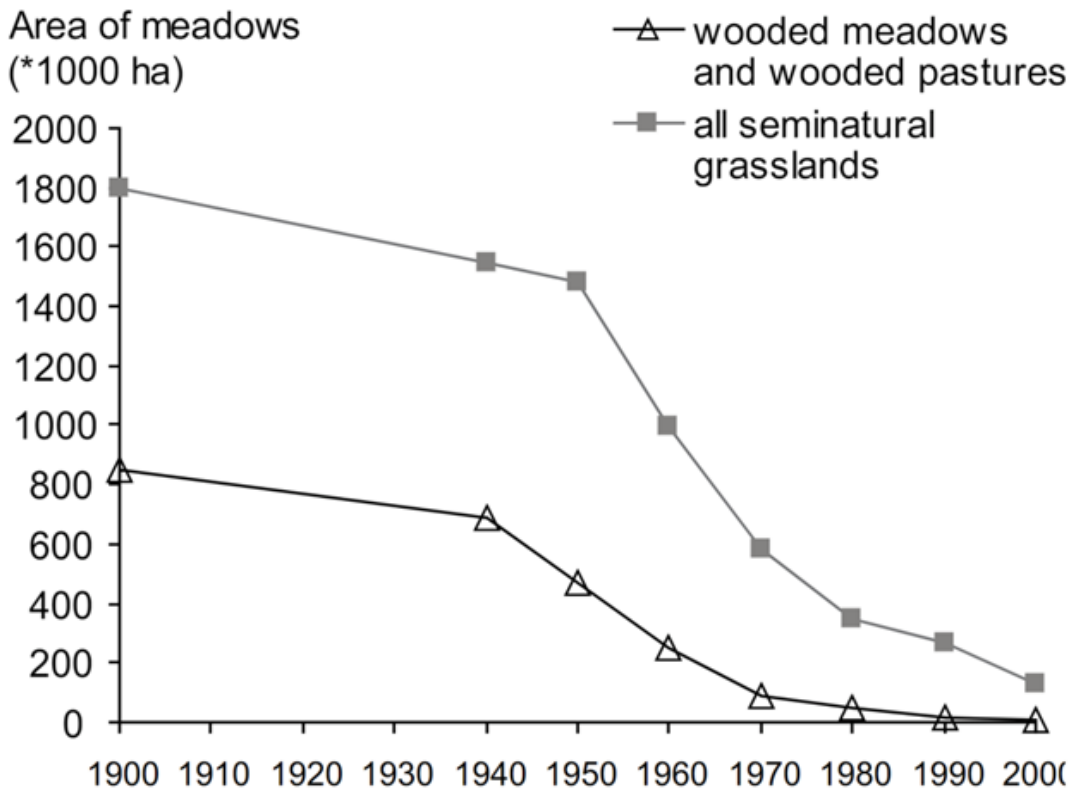

Figure 7 *Dynamics of semi-natural grasslands in Estonia last century (Sammul et al. 2008)*

The area of semi-natural grasslands in Sweden reached its maximum extent around 1800 – 1850. The remaining grassland area is only a few percent (on average 3 % in a study by Dahlström (Blom 2009), but with variation from 0 to 14% depending on the region). The number of agricultural enterprises (“farms”) has declined from 155,000 in 1970 to 53,000 in 2016 (SCB 2019). The number of farms with cattle decreased from 86,000 in 1975 to 15,000 in 2022. The total area of managed grasslands in Sweden is approximately 450,000 ha (SCB 2019), or about 1 % of the total land area, excluding alpine grasslands above the treeline. However, this number includes much more grassland area than those that can be defined as “marginal”, and most of these are in fact cultivated grasslands or permanent grassland on former arable land. Swedish semi-natural grasslands are extremely species-rich, and also harbour large numbers of rare and threatened species. Despite covering less than 1% of the land area in Sweden, semi-natural grasslands are the habitat of 27% of the species on the Swedish national Red list (Eide et al. 2020). Abandonment of species-rich grasslands was identified (together with forest clear-cutting) as one of the two most frequent threats against nationally red-listed species in Sweden (Eide et al. 2020).

The total area of Switzerland is 41,000 km2 and 10,000 km2 are utilized agricultural area (UAA = all farmland, excluding summer pastures and woods), including 6,000 km2 of natural grassland (BLW, 2020). In addition, there are 5,000 km2 of alpine pastures in the Swiss Alps and in the Jura mountains (BFS, 2021). In total, therefore, there are currently 11,000 km2 of “permanent grassland”, including meadows and pastures in the lowlands and in the summer pasturing alpine zone. Grassland Ecological Focus Areas (EFA) make up about 80% of the total EFA area on Swiss farmland. In the lowlands they contribute to mitigate the loss of farmland biodiversity, whereas in the mountain regions, they contribute to the maintenance of traditional farming practices and thus to the conservation of biodiversity, which is still comparatively intact in mountain regions as compared to the lowlands (Weyermann et al., 2006; Kampmann et al., 2012; Riedel et al., 2019; Meier et al., 2021). Dry meadows and

pastures in Switzerland are particularly species rich and – at the same time – less productive than mesic grasslands and therefore threatened by abandonment. Those species rich grasslands have been inventoried and are now protected at national or cantonal level. The national inventory comprises almost 4,000 “objects” (grassland fragments) with altogether 300 km^2, protected by article 18a of the National Law for Nature Protection (Bundesrat, 2022b). The Ordinance About the Protection of Dry Meadows and Pastures of National Importance (Bundesrat 2021b) aims at the protection and promotion of those grasslands. Switzerland attaches to the maintenance of marginal grasslands, mainly because of their landscape and biodiversity values. Switzerland is not a member country of the European Union. Therefore, it does not participate in the Common Agricultural Policy of the EU but has its own agricultural policy. As Switzerland conducts its agricultural policy independently of the CAP of the EU, cross compliance was already introduced in the early 2000s (Aviron et al., 2009) to require minimum ecological standards in agriculture.

In Romania the biodiversity of Transylvania grasslands has been reduced through afforestation or conversion of the land into vineyard terraces. This was mostly because the productive value of this dry grasslands is low, and they were repurposed. Maintaining the health of dry grasslands is crucial for farmers to qualify for European Union agri-environment payments. However, various factors, such as overgrazing by sheep, invasion by scrub, uncontrolled burning, weeds and invasive neophytes, and excessive soil erosion, negatively impact these habitats, especially on steep, sunny slopes. Overgrazing by sheep has particularly affected the Sighișoara-Târnava Mare area, causing degradation of over 94% of dry steppic grasslands. Scrub invasion, decline in farming activity, uncontrolled burning, and invasion by weeds further contribute to the challenges, impacting biodiversity and soil stability in the Saxon Villages region. In Romania there is financial aid for farmers so that they maintain the grassland as it is. Since 2008, farmers have received rewards for preserving High Nature Value (HNV) grasslands through practices that safeguard flora and fauna. European Union agri-environment measures permit grazing and mowing but impose restrictions on natural and chemical fertilizers, excessive grazing, and early-season mowing. Management requirements emphasize traditional practices, including the use of natural fertilizers, avoiding over-grazing (with low stocking rates), delaying mowing to support plant seeding and wildlife, and promoting lighter machinery or scythe use to prevent soil damage and harm to young animals (Rákosy 2012; Akeroyd 2013; Crișan and Rákosy 2020; Integrated Management… 2016)

3.4 List of drivers

In this study we categorize drivers as a first step of the analysis. In general, land-use change is mainly affected by the following main groups of drivers: physical, political and social-economical (includes demographic issues), and also separately technological (Figure 8). All of those drivers have also contributed significantly to the land use changes of marginal agricultural areas (Figure 9).

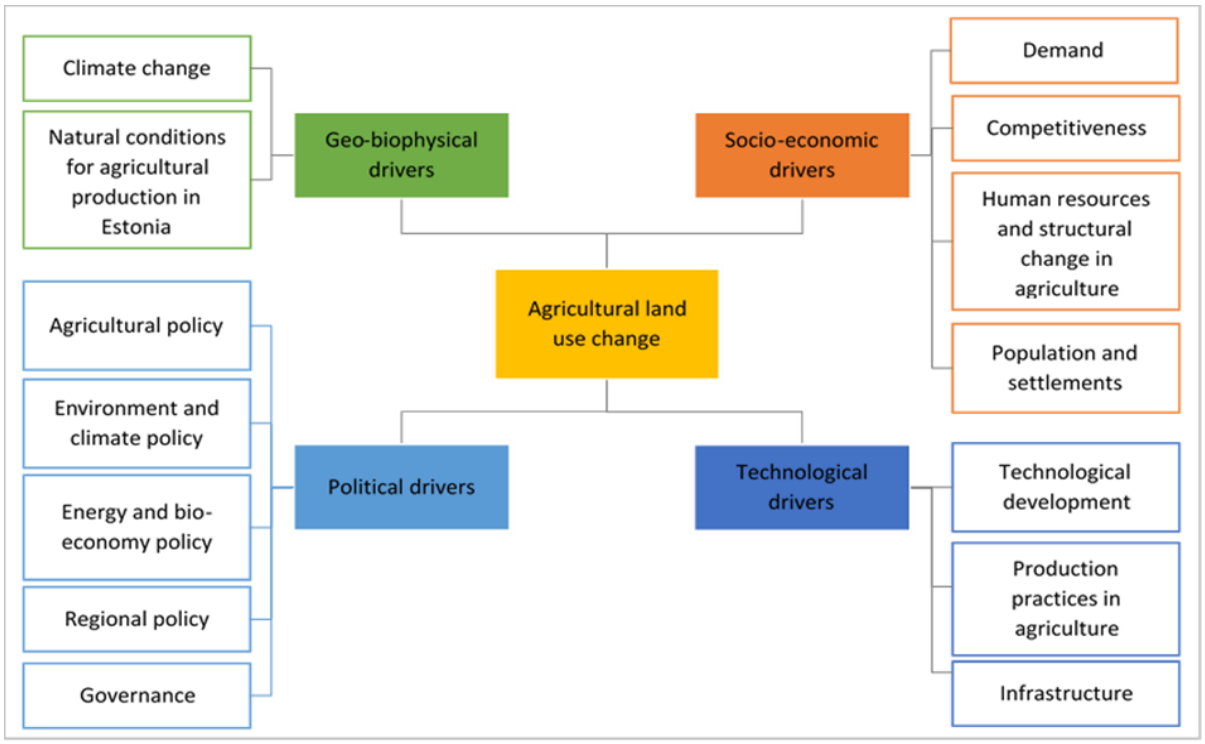

Figure 8 *Drivers of agricultural land use changes (Viira et al. 2022)*

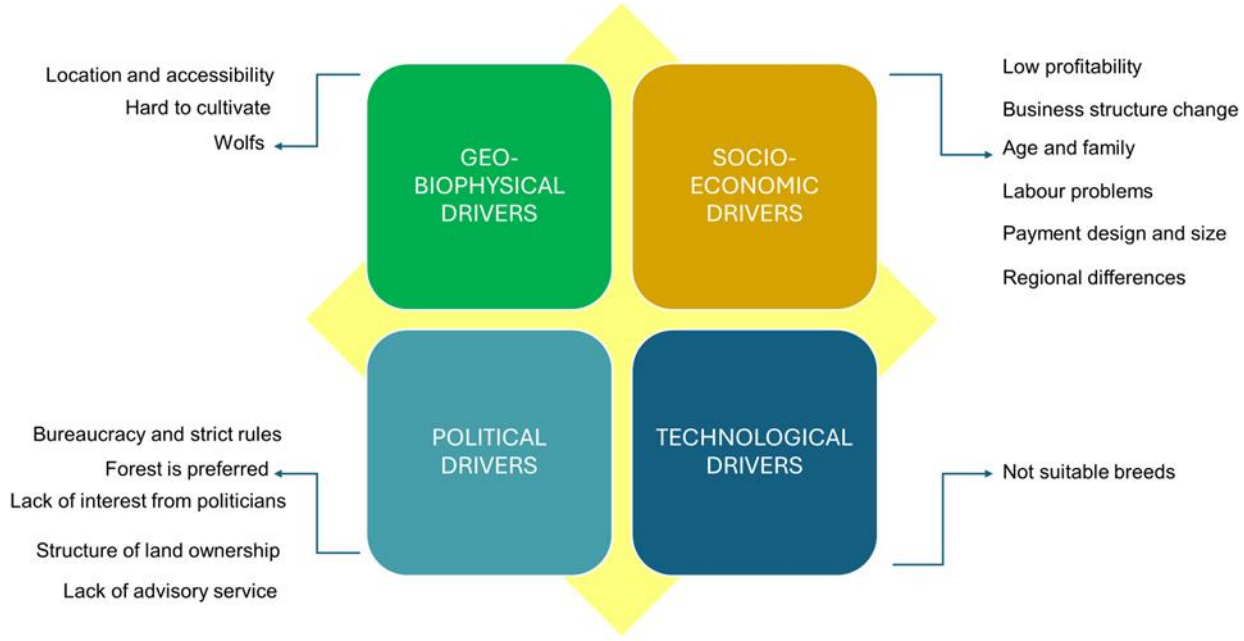

Figure 9 *Drivers of abandonment based on interviews carried out with experts on Estonia, Sweden, Switzerland and Romania.*

In one interview question we asked participants to list three most important drivers of abandonment of semi-natural grasslands. Across answers a clear pattern emerges. Geophysical barriers and socio-economic pressures are common threads in the narrative of abandonment, yet each country has unique concerns. In Estonia, experts pointed out that important reasons are related to farmers' age and perspectives of succession. In, Sweden

experts highlighted structural and market-driven challenges, and in Switzerland the wolves and ecological realities of mountain landscapes were highlighted. In Romania farmers struggle with unclear and confusing rules. This intricate web of drivers shows the importance of regionally tailored strategies that address both universal and localized aspects of abandonment. It also highlights the complexity of translating conservation priorities into action.

In Estonia, respondents identified the lack of accessibility in fragmented land holdings, emotional and historical connections to the land, and environmental conditions such as excessive moisture on grassland, as key factors. Additional concerns include a decrease in small-scale livestock keepers, the inadequacy of support payments, and bureaucratic inefficiencies. Land leasing issues, strict support requirements, and the physical and mental toll on maintainers were also brought out.

In Sweden, responses showed that the economic viability of maintaining semi-natural grasslands was the main issue. There is a shift in land use from traditional mowing to more profitable ventures like intensive farming. Notably, the Swedish perspective also pointed out the growing interest to have the land as forest as it is seen as preferred type of land-use over semi-natural grasslands. Those tendencies are visible elsewhere too, but in Swedish interviews it came out more dominantly.

The Swiss focus on topographical challenges, such as remoteness of grasslands and also manpower decline in agriculture. Impact of predators like wolves are also critical.

The Romanian expert pointed out that payment system is not clear, measures are complicated to implement, and farmers are complaining that they cannot have the needed information and advice.

“Location and accessibility” and “Low profitability” are the most frequently cited reasons for land abandonment, indicating significant barriers. These suggest that remote locations and financial non-viability are the primary challenges regarding semi-natural grasslands. Those most mentioned drivers were pointed out in all four countries as the most important. Drivers that were named only once were usually also listed as less important.

3.5 Avoidance of abandonment

Across Estonia, Sweden, Switzerland and Romania, several strategies have been implemented to prevent the abandonment of semi-natural grasslands. These strategies include direct payments, which provide financial incentives to farmers for maintaining traditional agricultural practices that support biodiversity. Management-based payments reward the application of specific farming techniques that contribute to the ecological value of the land. Result-based payments focus on the outcomes for biodiversity, offering incentives for demonstrable conservation results. In addition to monetary incentives, non-monetary measures are also in place. These may be advisory services, training in sustainable agricultural practices, and the promotion of local biodiversity-related projects that aim to raise awareness and encourage active participation in conservation efforts.

3.5.1 Direct payments

In Estonia, the payment system for farmers managing semi-natural grasslands has been reformed during the new CAP period to prioritize user-friendliness, flexibility, and a supportive approach for land managers. With a modest increase in support levels, the system now offers greater differentiation to various farming needs. Farmers have the liberty to select from multiple concurrent support options, including Basic Income Support, Area Based Support, and Organic Farming Support, thereby ensuring a more tailored financial framework. Additionally, the system encourages voluntary participation in activities beneficial to environmental conservation. For a one-year commitment, farmers are compensated for engaging in manual mowing, maintaining islets and small islands, supporting special bird areas, and enhancing habitats. This approach reflects a shift towards integrating conservation

efforts with farming incentives, ensuring that economic activities contribute positively to environmental stewardship. The Environmental Board is evaluating and monitoring the implementation of these activities.

In Sweden, there is an agri-environmental payment scheme for managing grasslands through mowing or grazing. Grasslands are categorized into two classes - “regular” and “high value”, mainly depending on their biodiversity. The level of the payment depends on this classification, with larger compensation for managing “high value” grasslands. Approximately 420 000 ha of grasslands are in total covered by these AES. Due to EU definitions of “farmland”, not all grasslands qualify for the Single Farm payment (i.e. grasslands with high tree cover or high cover of rocky outcrops), but farmers are compensated for this by receiving a sum corresponding to the Single Farm payment for these grassland types as well. One problem is that the rules and regulations for qualifying for the grassland AES has changed frequently, often with changes between each CAP period. Jamieson & Hessle (2021) estimated that, for a farmer specializing in meat production of cattle or sheep, the income consist of up to approximately 10% of targeted agri-environmental payments for grasslands, while other types of (CAP) support accounts for 30-45% of the income, and 45-60 % come from selling the products. According to a survey among farmers, 16% of respondents would completely stop grazing their grasslands if they did not receive the agri-environmental payments targeted to grasslands, and another 28 % would stop grazing at least 1/3 of their grassland area (survey by Landja, referred to in a talk by Lisa Karlsson, 2023-11-21).

Switzerland, although not an EU member, has implemented similar initiatives to enhance biodiversity in semi-natural habitats and maintain open rural landscapes. These payments are generally aimed at promoting balanced grazing, which is known to boost biodiversity and ecosystem functions. Substantial funding is directed towards farm-level grazing plans that consider local biodiversity and site-specific conditions. At the same time, several policy instruments were put in place to support the management of marginal farmland – grassland in particular (BLW, 2021):

- Basic area payments for agricultural management, with increasing contributions from the hilly to the upper mountain zones.
- Direct payments for farmland in the hilly and mountain zones of Switzerland, with increasing contributions per hectare. The land must be managed in a way that there is no forest encroachment.
- Direct payments for the management of grasslands with inclinations of 18% and more.
- Direct payments of particularly steep grassland with inclinations of 30% or more, with increasing contributions depending on the steepness.
- Direct payments for farms that send their cattle, sheep or goats to alpine summer pastures. This payment is calculated per livestock unit (LU), depending on the category of the animal.

Those payments are all subject to ecological cross compliance, which means that farmers can only claim the direct payments if their records show that they fulfil the “proof of ecological performance”. As part of the “proof of ecological performance”, farmers must manage at least 7% of their farmland as “biodiversity promotion areas” or ecological focus areas (EFA), according to the CAP terminology (maximum share 50%, average share currently around 12%). Farmers are free to choose among different EFA types if they reach the required minimum of 7% of their UAA. The large majority of Swiss farmers complies with those requirements, as the direct payments make up a substantial part of their income. The relative importance of direct payments is highest for farmers in marginal mountain regions, it decreases towards the more fertile lowlands, which are also easier to manage. This shows that one of the objectives of the direct payments is to maintain the management of marginal farmland – and of grassland.

Management based and result-based payments
Both payment schemes are used in agricultural policy to balance the need for environmental conservation with the economic viability of farming. While management-based payments provide certainty in terms of actions taken, result-based payments align financial incentives with actual environmental benefits, potentially leading to more effective conservation efforts. Management based payments are made to farmers for carrying out specific management actions or following predefined practices that are believed to be beneficial for the environment. The focus is on the process rather than the outcome. As long as the farmer does prescribed actions, they receive the payment, regardless of the actual environmental outcome. This approach is easier to monitor and enforce because it's clear what actions the farmer needs to take to receive payment. It is used because it can lead to immediate changes in farming practices and is relatively straightforward to implement. However, it does not guarantee environmental benefits since the effectiveness of the prescribed actions may vary. Result-based payments focus on the result. Farmers have the flexibility to choose how they manage their land to achieve the desired outcomes, and this encourages innovation and efficiency among farmers, who can tailor their practices to the specific conditions of their land. Result-based payments are more challenging to monitor, as it requires assessing the actual environmental benefits achieved, which can be influenced by factors beyond the farmer's control.

From the literature we know Swiss farmers have result-based direct payments, where grassland species composition is regularly monitored. (Napoleone et al 2022). Monitoring is done in every 8 years. In our study we had few questions designed for specific countries, so we asked comments from Estonian, Swedish, and Romanian experts about result based payments.

In Estonia there is pilot program under the LIFE IP framework. This program, involving 500 coastal areas, is notable for its educational component, developed in collaboration with the University of Tartu, which educates maintainers on evaluating natural values and is monitored by the Environmental Board. Currently there is no result-based payments in Estonia, except this above mentioned LIFE program. Estonia is aiming to provide result-based payments for farmers during the next CAP period.

In Sweden there are results-based payments available, which are currently being debated. It is acknowledged that they should complement, rather than replace, management-based measures, this idea was also pointed out by Estonian interviewees. The potential confusion and stress for farmers in the event of unmet outcomes and the attractiveness to those particularly dedicated to heritage conservation highlight the complexity of implementing such systems.

In Romania, regarding grasslands, there haven’t been any result-based payments yet, but pilots’ studies are foreseen.

3.5.2 Non-monetary measures
In Estonia according to interviews, the government and sectoral organizations are working together to prevent the abandonment of semi-natural grasslands. The State Forest Management Centre offers contracts on very favourable terms, ensuring that state owned lands are maintained. There are about 400 contract partners in this system. Additionally, various LIFE projects are running to introduce new advisory systems and recruit maintainers, with training provided through initiatives like Muhu LIFE, where six new advisors were trained. The restoration and preparation for the maintenance of heritage landscapes, especially wooded meadows, have been a focus, funded through structural funds or the state budget. An advisory system is also in place to help maintainers, including mandatory training under the CAP that occurs once every five years. Non-monetary support also includes community

measures such as volunteer work camps, which contribute to the restoration of wooded meadows by removing bushes and branches.

In Sweden, initiatives exist that connect landowners with conservation organizations, fostering collaborative projects that aim to manage and preserve semi-natural grasslands. Additionally, there is advice provided for farmers on various conservation methods, including general advice, specific farm guidance, and the organization of field trips and courses to encourage sustainable practices.

In Switzerland, while the data suggest that monetary payments remain a central component of support, there is an acknowledgment of the need for additional measures. However, specific non-monetary measures are not detailed in the responses that experts were naming. Advisory service for farmers is not nationally organised, but they are the responsibility of the 26 cantons. From the interviews it was recognisable that there are relatively big differences between cantons. According to grey literature the government measures for the maintenance of marginal grasslands, there are also private initiatives that support their management in Switzerland:

- Labels by retailers that support mountain farming (e.g., Pro Montagna) and summer farming (e.g., milk from alpine summer farms in the region of Bern, Alpleben).
- Foundations that support mountain farming and the upkeep of traditional grassland management (e.g., Bergwald Projekt).
- Local associations and clubs that maintain the tradition of mowing marginal mountain grasslands, often in particularly remote, steep and actually dangerous situations.

- Private initiatives by mountain farmers and associations that seek volunteers to engage in the mowing of marginal grasslands, which require a high amount of manual labour because they are too steep even for modern machinery (e.g., Bergheuet).

In Romania there is the Law on Grassland and by this it is prohibited to plough permanent grassland. In addition, there is an increasing demand for carbon certificates for land use and biodiversity. Romania has about 20% of its land designated as Natura 2000 sites, which includes habitats, species, and birds. Management plans are required for these sites, including for semi-natural grasslands.

3.6 Additional measures and considerations

Semi-natural grasslands are a national priority politically in Estonia, which is visible from the proportion of CAP payments dedicated to grassland. It is stated that semi-natural grasslands are important not only from a nature conservation perspective but also have socio-economic impacts as they serve as a significant livelihood source in rural areas. The maintenance of semi-natural grasslands diversifies rural life and ensures the diversity of agricultural practices and a varied food supply across Estonia. Supporting the restoration of semi-natural grasslands and the maintenance practices that ensure their preservation is considered as one of the most effective investments within the CAP for preserving the diversity and richness of agricultural landscapes in Estonia (Pärandniitude tegevuskava 2021). At the same time it is admitted that semi-natural grasslands restoration and maintenance rely on the willingness and interest of landowners and/or land managers. If landowners are not interested in maintaining semi-natural grasslands or renting out the areas, the regulations do not provide an option for the state to acquire those lands. Additionally, organizing work on the land without the landowner's consent is generally not advisable, as it may create resistance to achieving nature conservation objectives (Pärandniitude tegevuskava 2021). Non-local landowners, especially those not engaged in animal husbandry, typically show little interest in maintaining remote grasslands. Additionally, in some instances there are cultural preferences for forest preservation. Some grasslands are hard to access or too small, and lands that reverted to state ownership post-land reform are often entangled with private properties, making

permission for access complicated. Financial barriers also play a role—the cost of grassland restoration is high, often unaided by structural funds, which shifts the financial burden to the state budget. While there is a national goal to have 45 000 ha of semi-natural grasslands under maintenance by 2027, which aligns with the EU Habitat Directive and Natura commitments, it's acknowledged that smaller, fragmented areas with poor conditions may not find maintainers, making this goal ambitious.

Active policies to preserve remaining semi-natural grasslands have been considered successful in Sweden. Different forms of financial compensation to farmers for managing semi-natural grasslands since the 1980-s (both before and after Sweden joined EU in 1995) have halted the decline in the area of grasslands (Hasund 2017). Consequently, Sweden has larger remaining areas of semi-natural grasslands comparted to other countries in northern Europe (Emanuelsson 2009). Model estimates indicate that 98,000 ha of grasslands would already have been abandoned or converted to other land uses (mainly forestry) without the AES payments (Hasund et al. 2014). The total area of grasslands has remained relatively constant over the last decades (SCB 2019). Hence, at the national scale, the main problem is not a decrease in the total grassland area, but rather a decrease in the average quality. This is in turn partly a result of a loss of quality of existing grasslands (though non-optimal management). But, masked in the statistics, there is also a gradual loss due to a gradual abandonment of the most species-rich grasslands, which is partly balanced through conversion of arable fields to cultivated and species-poor grasslands. The result is that the total area of grasslands remains relatively constant, but there is a continuous decline of the associated biodiversity. This is because grasslands on former arable land typically are species-poor, and it might take several hundred years until their biodiversity reaches the same level as the remaining semi-natural grasslands (Schmid et al. 2017). There are about 90,000 ha of grassland habitats within the Natura 2000 network in Sweden. The majority of this area is on the two large islands in the Baltic Sea: Öland and Gotland. Of these 90,000 ha, about 30,000 ha do not receive any AES payment, or any other type of financial support (Naturvårdsverket 2018). A survey found that approximately 90% of semi-natural grasslands (included in the TUVA database) receiving agri-environmental payments were actively grazed in a given year, but only 50% of the grasslands that did not receive agri-environmental payments were grazed (Glimskär et al. 2017). Especially, many small grasslands do not receive agri-environmental payments. The majority (85% of the area) of current semi-natural grasslands are grazed by cattle, and only 15% of the area are grazed by sheep or horses (Naturvårdsverket 2022). Larsson et al. (2020) analysed the relationship between the available number of grazers and the area of semi-natural grasslands. They concluded that there is indeed no lack of grazing animals (cattle, sheep, horses). Instead, the main problem, from a biodiversity conservation point of view, is that these animals are grazing the “wrong” land, i.e. cultivated grasslands rather than species-rich semi-natural grasslands. This is in turn explained by economic factors (Larsson et al. 2020). Despite financial support in the form of agri-environmental payments, it is more profitable for farmers to let their livestock graze on cultivated grasslands and feed them supplemental fodder, than to let them graze on semi-natural grasslands. One reason for this is that the AES payments do not account for differences in the cost of management. Larson et al. (2020) conclude that the differentiation in only two levels of payments (“regular” and “high value”) is too course, and results in financial over-compensation to low-biodiversity “regular” grasslands, and under-compensation to high-biodiversity “high value” grasslands. An interview survey among farmers identified that financial support is crucial for farmers to afford the management of semi-natural pastures (Manevska-Tasevska et al. 2023). Farmers were generally happy with the current support system, but they also found the regulations too rigorous, and expressed anxiety to control situations, where staff from authorities check that the rules are being followed (Manevska-Tasevska et al. 2023). Expert in Sweden referred that keeping agricultural land and wild meadows open is one of the 16 national level goals. The EU Nature Restoration Law is one of the discussion points currently – what reference year or percentage to use as a base line.

In South Sweden back in times there was a lot of agricultural land but now it is covered with forest and forest is one of the iconic and preferred landscape in Sweden.

There is a broad consensus among Swiss policy makers and in Swiss society that summer farming should be maintained and further supported. The justification for those payments is the maintenance of the summer pastures, avoiding shrub and forest encroachment (BLW, 2023). In addition to the agricultural support measures, there are also nature protection support measures for marginal grasslands. In Switzerland trends of the last 30 years show, that those measures have been only partially successful, and more than 60,000 ha of grassland got lost to shrub and forest encroachment. It seems that the support measures have not been sufficient to counteract the market forces of liberalization, which dominated the agricultural development also in Switzerland in the last decades (Helfenstein et al., 2022; Ackermann et al., 2023). Still, they certainly contributed to mitigate those trends and to maintain farming activities in agriculturally marginal areas. Experts also agree that the goal is, that the surface of semi-natural grasslands does not decline. As meadows of national importance are under protection, the cantons have to make effort to save typical flora and fauna. There are also meadows that are of regional importance, but they are less strictly protected. Meadows of regional importance are usually closer to urban areas, and they are threatened by real estate projects.

In Switzerland, there are two recent developments that may become increasingly important in the near future:

- The increase of wolf populations in mountain regions. In the last decades, the wolf has established itself again across the Alps and the Jura mountains. Mountain farmers complain about the increasing attacks of wolfs on livestock. Herding in remote regions has become more complicated because sheep and cattle require protection. Mink et al. (2023) have found that in regions with frequent wolf attacks, summer farming activities – in particular with sheep – actually decline. Recently, the national hunting law has been modified and now facilitates the regulation of wolf populations and even the elimination of entire packs. One of the regional specific questions to Swiss experts was: “What is your evaluation of the effect of the increasing wolf population? Has it already led to the abandonment of grassland? Or do you expect accelerated abandonment in the future?” The increasing wolf population and its impact on the abandonment of grassland has been a topic of debate. In Switzerland, the increase in the wolf population over the past decade has sparked fear and led to governmental action, with a notable percentage of the wolf population being culled. Sheep farmers, especially in certain regions, and those with smaller herds, are more affected by wolf predation. Absence of wolves in urban and populated areas, where dry meadows are more common, means that the impact is still limited. Consensus from the provided statements is that, so far, wolves have not been a significant factor in abandonment but if the population continues to rise without effective management, there is a potential for increased abandonment in the future.
- The planned installation of solar panels in mountain regions. Due to the energy crisis, there is a number of initiatives that propose the installation of vertical solar panels in high mountain regions with the intention to produce electricity also during the winter months. Although the days in the winter are shorter, there are less clouds in mountain regions than in the lowlands and the light is reflected by the snow so that projections show an increased production of electricity (Dujardin et. al, 2022; von Rütte et. al, 2021). The effects of such installations on the grazing, the maintenance and the biodiversity of the grassland’s underneath is largely unknown and will have to be monitored.

In Romania species have been maintained well in the dry grasslands because of the extensive land use that farmers and shepherds have used for generations. There is no need to create

new management plans or agriculture behaviours for these areas, instead there is a need to preserve the current traditional way of land usage, mixed, extensive farming without using synthetic fertilizers and pesticides. Strategic planning is essential for the future of these grasslands, mitigating negative economic pressures and highlighting their significance for European biodiversity. While traditional farmers may not consciously preserve their grasslands for aesthetics or biodiversity, ecologists acknowledge that their practices maintain impressive floristic diversity. To maintain this favourable situation, the optimal management approach involves monitoring traditional sheep grazing to ensure minimal impact on grass cover and prevent soil erosion. Encouraging the regular movement of sheep herds, along with promoting cattle grazing and increasing cattle numbers relative to sheep, is essential. The government has played a role in revitalizing traditional village grazers, particularly cows, contributing to the economic viability of farming communities. Instead of using fire, the recommended method for dry grasslands is efficient mechanical cutting, with successful trials of innovative Brielmeier mowers that minimize soil pressure, especially on steep slopes. Controlled and early spring fires may be considered for clearing scrub or excess grass, emphasizing the importance of rapid, limited, and well-controlled burns (Rákosy 2012; Akeroyd 2013; Crișan and Rákosy 2020; Integrated Management… 2016).

3.7 Discussion

Land abandonment is increasingly recognized as a significant environmental challenge. Its impact is worsened by factors like droughts and resource depletion, exacerbating biodiversity loss and ecological degradation. Human activity plays a role in this process; as lands are left to return to their natural states, the slow pace of ecological recovery is hindered even more by a changing climate. This prolonged recovery period and potential impossibility of returning to original ecosystem states in hotter climates mean that ecosystems are at risk of further degradation, with significant implications for both biodiversity and food security. Our case study countries involved two countries from Northern Europe, one from the East European steppic area and one Alpine country. This is a limitation, as generalisations to other European regions, notably to the Mediterranean, cannot be made.

From a biodiversity standpoint, the management of semi-natural habitats is important. Yet, abandonment can lead to certain benefits, such as increased carbon sequestration due to the increase in biomass and carbon storage both above and below ground, as observed with the dominance of reeds in coastal grasslands, or through forest regrowth. Cost savings from reduced subsidies are another possible advantage.

Taking Sweden as an example, measuring the success of conservation efforts solely by the area of land maintained can be misleading. It provides an incomplete picture, potentially obscuring the true state of biodiversity which relies on both quantity and quality of habitat. In the cases of Estonia and Romania, conservation and monitoring is done dominantly in Natura 2000 area but not outside of it.

The study did not consider very current trends affecting marginal grasslands, such as the green transition and the ongoing war in Europe. The generally accepted positive view of agricultural biodiversity may shift towards a more "practical" agenda as societal and political priorities evolve. Similarly, the green transition, with its emphasis on decarbonization, could demand substantial investments that may not have been anticipated. We see here a need for ongoing research.

4 Acknowledgements

We would like to thank people who have participating our study, especially we appreciate input from:

Estonian State Forest Organisation

Estonian Fund for Nature

Estonian Ministry of Regional Affairs and Agriculture

Estonian Association for the Protection of Heritage Communities

Swedish Environmental Protection Agency

Swedish Board of Agriculture

The Rural Economy and Agricultural Societies in Sweden

Swiss Agroecological Planning Research Implementation (*Agrarökologische Planung Forschung Umsetzung*)

Eidgenössisches Departement für Wirtschaft, Bildung und Forschung

The Federal Department of Economic Affairs, Education and Research in Switzerland (*Das Eidgenössische Departement für Wirtschaft, Bildung und Forschung*)

RU Biodiversity & Conservation Biology WSL Swiss Federal Research Institute

Fundația ADEPT

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Annexes

Estonia grey literature

LITERATURE REVIEW: AGRICULTURAL LAND ABANDONMENT – CASE OF ESTONIA AND ESTONIAN SEMI-NATURAL GRASSLANDS

Agricultural abandonment is one of the dominant land use change processes in Europe. While the current extent of abandonment is unknown (Pointereau et al., 2008), European agricultural statistics and land cover maps show a clear decrease of agricultural areas in the past decades, especially for extensive and small-scale agricultural systems (Pinto Correia 1993; Renwick et al., 2013; Fuchs et al., 2015) and modeling studies predict significant levels of agricultural abandonment in Europe over the next 20–30 years (Renwick et al., 2013; Verburg and Overmars, 2009). Recent studies on agricultural abandonment in Europe show that agricultural abandonment primarily occurs in less productive areas, remote and mountainous regions and areas with soil erosion or unfavorable climatic conditions for agriculture (Rey Benayas et al., 2007; Keenleyside and Tucker, 2010). Secondary drivers of agricultural abandonment include rural depopulation and regional specific factors regarding land ownership and tax regimes (Rey Benayas et al., 2007; Keenleyside and Tucker 2010; MacDonald et al., 2000). An important regional event which triggered agricultural abandonment was the collapse of the Soviet Union in the 1980s, leading to widespread agricultural abandonment in Eastern Europe due to poorly established property rights and problems with land ownership (Kuemmerle et al., 2008; Hartvigsen, 2014). Agricultural policies also play an important role, as abandonment often occurs in areas where the land productivity does not provide an adequate income for farmers. Even with the support of subsidies such as the Less Favored Areas (LFA) support and agri-environmental payments, which are part of the rural development pillar of the Common Agricultural Policy (CAP), agriculture in these areas is often not competitive (Renwick et al., 2013).

Agricultural abandonment in marginal areas can be viewed as an example of land sparing, as agricultural activities are concentrated through intensification elsewhere or displaced to other world regions, driven by economic or other factors, while marginal areas are abandoned (Wentworth 2012).

For the European Union, the largest area of agricultural abandonment is due to globalization and economy driven reasons followed nature policy options. The areas being abandoned due to globalization and economy driven reasons are generally marginal and unsustainable areas that are abandoned as a result of intensification of more suitable land. Finland (27.6%) has the highest percentage of agricultural, expressed as percentage of all agricultural land in 2000, followed by Estonia with 25% (Van der Zanden et al., 2017).

In the period 2015-2030 about 11% of agricultural land in the EU are under high potential risk of abandonment due to factors, related to biophysical land suitability, farm structure and agricultural viability, population and regional specifics. In Estonia elevated agricultural

abandonment risk is mainly associated with remoteness and low population densities. Economic and structural farm factors are likely to be the primary cause for the increased agricultural abandonment. Economic factor and market instruments (including CAP) could largely mitigate those potential risks in a number, mostly Eastern countries and regions i.e Estonia (Perpiña Castillo C., Kavalov B., Diogo V., Jacobs-Crisioni C., Batista e Silva F., Lavalle C, JRC113718, European Commission 2018).

The decrease in arable land use is signifcant in the marginal districts of Estonia including the islands and also in the district surrounding the capital Tallinn (Peterson and Aunap, 1998). In Estonia, the abandonment of farmfields reached 10.1% in time periood of 1990-1998 (Lasanta et al., 2017). In the 1990s there were no subsidies for famers anymore and many of them stopped farming. Since Estonia joined the EU in 2004, farmlands have been cleared again due to increased land pressure, as a result of an increased demand for agricultural products and availability of subsidies (T. Van Der Sluis et al. 2018).

Projections of farmland abandonment should be taken carefully, as they are limited by available information, the uncertainty of political decision-making and future socioeconomic development. Models assume that landowners give a prompt response to external incentives, especially economic ones. However, reality often shows that farmers take into account social and cultural concerns, which lead them to cultivate land, although it is not a profitable activity; at other times, they maintain agriculture in spite of being anti-economic, as an income support (Lasanta et al., 2017). The modelled projections about abandonment do, however, need to be considered with caution, as they are constrained by available data, lags in policy assumptions and uncertainty over future socioeconomic developments and policy decisions. In particular, the projections of very high levels of abandonment may be exaggerated because their scenarios assume levels of market liberalisation and weak environmental regulation that are probably unrealistic (Keenleyside, Tucker 2010).

Traditional agricultural landscapes are part of Estonia's cultural heritage. From the perspective of cultural heritage, semi-natural grasslands deserve special recognition. In the early 20th century, semi-natural grasslands accounted for an estimated 40% of Estonia's territory. As of 2020, the estimated area of hay meadows is around 130,000 hectares. (ÜPP KSH 2022) However, for centuries, humans and livestock have played a crucial role in maintaining open landscapes, ensuring the preservation of the natural values and species associated with semi-natural grasslands. Without mowing or grazing, the semi-natural grasslands become overgrown, eventually turning into forests, becoming marshy, and subsequently undergoing changes in their characteristic species composition. Historically, semi-natural grasslands ecosystems have been widespread throughout Europe, but their extent has decreased in all regions due to changes in land use and intensification of agriculture. The area of semi-natural grasslands began to decline after World War II when manual labor was replaced by large-scale production and intensive agriculture. As a result, difficult-to-manage grasslands were left unused, became overgrown, and gradually covered with shrubs, reeds, or forests. Additionally, since the 1950s, efforts were made to drain marshy meadows and former wetlands unsuitable for intensive agriculture, leading to their afforestation. The majority, 51%, of semi-natural grasslands are located on private land, while 49% are on state-owned land. (Pärandniitude tegevuskava 2021)

Natural and semi-natural grasslands are sources of diversity within agricultural landscapes, acting as core areas that provide essential feeding, breeding, nesting, living, hibernation, and sheltering habitats for numerous organisms, including those that directly contribute to the necessary ecological services for agriculture, such as pollination and natural pest control. The conservation of the natural values of semi-natural grasslands relies solely on human intervention. Without mowing or grazing, the semi-natural grasslands become overgrown, leading to changes in their characteristic species composition and a decline in biodiversity. Maintaining a suitable management regime through proper mowing or moderate grazing

ensures the ecological health and long-term preservation of these ecosystems. (ÜPP KSH 2022)

Compared to the "do-nothing" scenario, the CAP strategy's environmental measures, including conditionality, have a positive environmental impact. However, the current state of the environment and its trends also indicate that addressing negative trends, such as the decline in farmland bird populations, requires more than the measures already implemented through EU agricultural policies. It is necessary to go beyond the existing set of interventions and/or target interventions more precisely. Important practices that avoid or mitigate negative impacts and promote biodiversity in agricultural landscapes and production include landscape diversity, avoiding the use of chemical pesticides, preserving and protecting species-rich semi-natural grasslands, and more. (ÜPP KSH 2022)

Semi-natural grasslands are important not only from a nature conservation perspective but also have socioeconomic impacts as they serve as a significant livelihood source in rural areas. The maintenance of semi-natural grasslands diversifies rural life and ensures the diversity of agricultural practices and a varied food supply across Estonia. Supporting the restoration of semi-natural grasslands and the maintenance practices that ensure their preservation is considered by the European Commission's report as one of the most effective investments within the CAP for preserving the diversity and richness of agricultural landscapes. (Pärandniitude tegevuskava 2021) According to a survey conducted among businesses involved in the maintenance of semi-natural grasslands, it was found that semi-natural grasslands management is more of a supplementary rather than a primary activity, and this kind of work diversifies rural life. The preservation of traditional landscapes, biodiversity, and the maintenance of ancestral lands were identified as significant motivations for engaging in semi-natural grasslands management in the surveyed area. Support for semi-natural habitats is crucial for the continued proper maintenance of existing semi-natural grasslands (METK 2023). In 2020, approximately 41,000 hectares of semi-natural grasslands were under maintenance and restoration. The goal by 2027 is to maintain semi-natural grasslands on at least 50,000 hectares in order to contribute to the preservation of grassland habitats and improve the favourable conditions for associated species. To achieve this goal, areas with high restoration value, providing the best landscape connectivity and offering the greatest ecological efficiency, have been mapped. Restoration of these areas is a priority. (Pärandniitude tegevuskava 2021)

Semi-natural grasslands restoration and maintenance rely on the willingness and interest of landowners and/or land managers. If landowners are not interested in maintaining semi-natural grasslands or renting out the areas, the regulations do not provide an option for the state to acquire those lands. Additionally, organizing work on the land without the landowner's consent is generally not advisable, as it may create resistance to achieving nature conservation objectives. (Pärandniitude tegevuskava 2021)

Estonian topographic database indicates that semi-natural grasslands are located on various land cover types, such as forest land, arable land, wetlands, and coastal areas. Changing the land cover within a protected area requires the consent of the area manager, but compliance with this requirement has been problematic. In practice, there have been cases where semi-natural grasslands have been destroyed by plowing or damaged by unsuitable land management practices (such as seed sowing or afforestation). If a semi-natural grasslands is located within an arable land cover, there is no legal requirement to change the land cover, and conventional agricultural activities can be carried out on such areas. Part of the problem is exacerbated by the fact that plowing, fertilizing, or afforestation are not activities that require permits, which often leads landowners to unknowingly plow, fertilize, or plant trees on semi-natural grasslands. To address this issue, an amendment to the Nature Conservation Act was initiated in 2020, aiming to prohibit any activities within protected areas that cause the destruction or damage of semi-natural grasslands. (Pärandniitude tegevuskava 2021)

The decline in the area of semi-natural grasslands and their isolation is associated with fragmentation, which is most commonly caused by human activities such as road construction, building development, and afforestation of semi-natural grasslands areas. The lack of maintenance can be attributed to several reasons, including a lack of economic interest, limited awareness of nature conservation and the possibilities and requirements of semi-natural grasslands management, low population density in rural areas, the complexity and cost of maintenance work (as meadows are often located in flood-prone or inaccessible areas), a lack of maintenance tools, a lack of viable uses for the harvested hay, and the cost of transportation. Consistent maintenance is crucial for the preservation of biodiversity.

After restoration, there is an obligation to maintain the area for at least five years in order to receive subsidies. However, there are situations where maintenance is not continued after the five-year obligation period, and the area is temporarily or permanently taken out of use. The analysis of ensuring the sustainable management of semi-natural habitats highlights the following reasons for discontinuing or not continuing maintenance obligations:

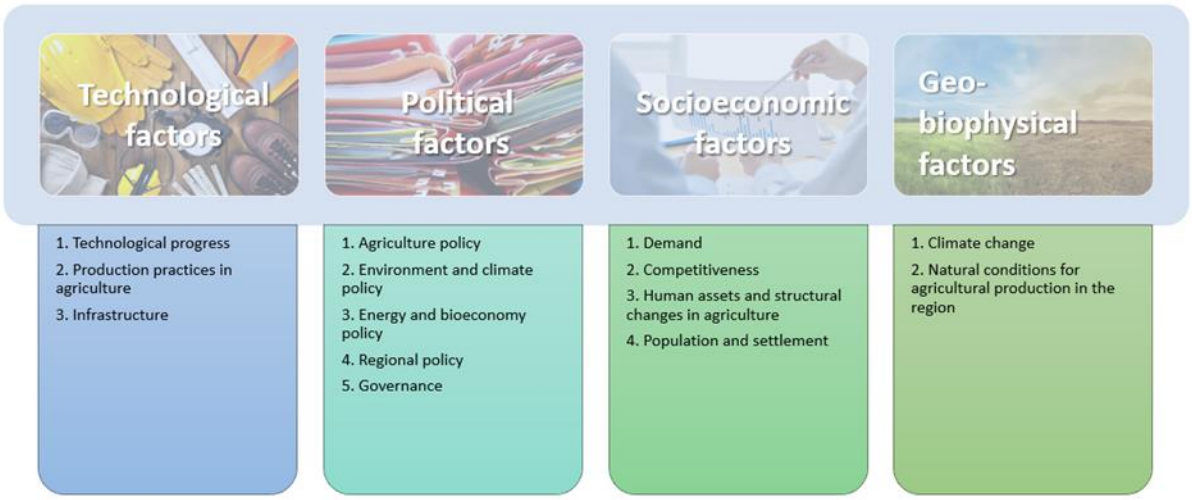
- Maintenance of the meadow is not cost-effective.
- The natural conditions do not allow for continued maintenance.
- The landowner did not renew the land rental agreement.
- The farm or, more specifically, the management of hay meadows is discontinued. (Pärandniitude tegevuskava 2021)

There are also situations where lease agreements on state-owned lands are terminated due to challenging natural maintenance conditions and inadequate infrastructure. The predominant issue is often a low grazing load and neglecting the management of semi-natural grasslands. Afforestation is a problem outside protected areas. (Pärandniitude tegevuskava 2021)

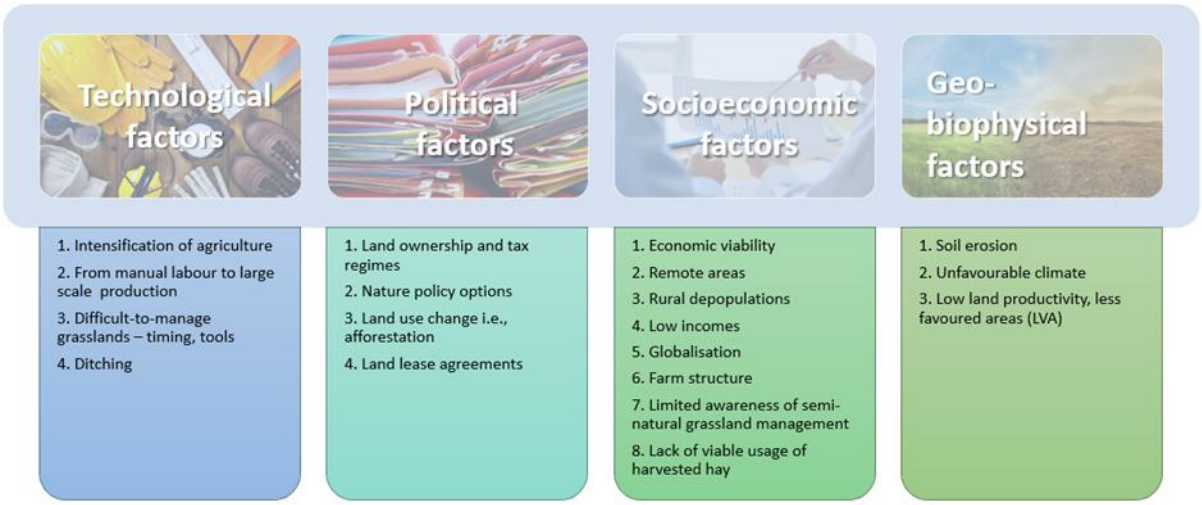
Development and construction activities cause both complete destruction and fragmentation of semi-natural grasslands. The impact can be significant, especially in densely populated areas and aesthetically attractive regions such as coastal areas. As the supported area increases, the actual area of semi-natural grasslands decreases. The Environmental Board has mapped the reasons for discontinuing support on a site-specific basis, which mainly include challenging natural maintenance conditions (accessibility, excessive moisture), non-renewal of lease agreements, health concerns, and support conditions. A significant portion (almost 1/3) of the discontinued areas is associated with a lack of landowner interest or lease agreement issues, making it unknown whether further management of those areas is possible. The remaining discontinued areas require additional actions to bring them into good condition. In the case of individual areas, leaving them to natural development should be considered, as maintenance activities have proven to be extremely challenging, and achieving satisfactory maintenance results is not feasible. (Pärandniitude tegevuskava 2021)

Interventions that support traditional land use practices, including the preservation of semi-natural grasslands (support for hay meadow maintenance, support for valuable permanent grasslands, support for animal welfare promoting grazing, etc.), can be considered as interventions with a strong positive impact. It is crucial that the CAP strategy includes an increase in the supported area of semi-natural grasslands. To enhance positive impacts on cultural heritage, it is important to support the preservation of agricultural practices and knowledge. In this regard, the additional support for semi-natural grasslands maintenance using scythes or horse-drawn mowers is worth mentioning as it contributes not only to environmental conservation but also to the preservation of traditions. The continued recognition of stone walls, which enrich the landscape and are part of the cultural heritage, among the supported landscape elements, is also positive. Indirectly, environmental

conservation-oriented interventions support the sector by enabling enterprises/landowners to meet environmental requirements (e.g., compensating for lost income in Natura 2000 forests) and addressing growing expectations for environmentally sustainable activities. Specifically, interventions targeted at semi-natural grasslands maintenance and/or livestock grazing help maintain agricultural activities in remote areas and regions with lower soil fertility, where conventional agriculture is less prevalent. (ÜPP KSH 2022).



Joonis 1 Major and subcategories of agricultural land use change drivers according to Estonian study "Analysis of changes in agricultural land use depending on future scenarios"



Joonis 2 Land Abandonment Factors for Estonian Semi-Natural Grasslands according to literatuure review (inc gray literatuure)

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Sweden grey literature

Marginal grasslands in Sweden – current status and drivers of abandonment

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Background and some definitions

The total area of managed grasslands in Sweden is approximately 450 000 ha (SCB 2019), or about 1 % of the total land area, excluding alpine grasslands above the treeline. However, this number includes much more grassland area than those that can be defined as "marginal", and most of these are in fact cultivated grasslands or permanent grassland on former arable land.

There is no official definition of "marginal" grasslands, so here I will use the term broadly as all semi-natural grasslands outside of the most productive agricultural regions. This means that it is difficult to estimate the area of "marginal" grassland specifically. There is also no official definition of "semi-natural" grasslands. Two potential definitions are a) the area of grasslands identified in a national mapping of high nature value grasslands, and b) the area of grasslands receiving agri-environmental payments and classified as "high value" (see below). According to definition a), there is about 270 000 ha of semi-natural grasslands (https://jordbruksverket.se/tuva), but since this includes also grasslands where only a small part has high nature values it is probably an over-estimation. According to definition b) the area of semi-natural grasslands is about 150 000 ha. However, since not all managed grasslands are included in these agri-environmental schemes, this is probably an under-

estimation. Regardless of definition, the majority of the area of semi-natural grasslands could probably also be classified as “marginal”, even if there are also fragments of species-rich grasslands left also in the most productive and intensively farmed regions.

A third definition could be the area of grasslands categorized as any of the grassland types listed in the EU Habitats Directive. According to this definition, there is about 350 000 ha in Sweden, but this also includes alpine grasslands. Of this area, about 90 000 ha is currently protected within the Natura 2000 network in Sweden. The majority of this area is on the two large islands in the Baltic sea; Öland and Gotland.

Historical perspective

The area of semi-natural grasslands in Sweden reached its maximum extent around 1800 – 1850. The remaining grassland area is only a few percent (on average 3 % in a study by Dahlström (Blom 2009), but with variation from 0 to 14% depending on the region).

The number of agricultural enterprises (“farms”) has decline from 155 000 in 1970 to 53 000 in 2016 (SCB 2019). The number of farms with cattle decreased from 86 000 in 1975 to 15 000 in 2022.

Active policies to preserve remaining semi-natural grasslands have apparently been successful. Different forms of financial compensation to farmers for managing semi-natural grasslands since the 1980-s (both before and after Sweden joined EU in 1995) have halted the decline in the area of grasslands (Hasund 2017). As a consequence, Sweden has larger remaining areas of semi-natural grasslands comparted to other countries in northern Europe (Emanuelsson 2009). Model estimates indicate that 98 000 ha of grasslands would already have been abandoned or converted to other land uses (mainly forestry) without the AES payments (Hasund et al. 2014).

Grasslands and CAP

To maintain species-rich grasslands, there is an agri-evironmental payment scheme for managing grasslands through mowing or grazing. Grasslands are categorized into two classes (“regular” and “high value”), mainly depending on their biodiversity. The level of the payment depends on this classification, with larger compensation for managing “high value” grasslands. Approximately 420 000 ha of grasslands are in total covered by these AES. Due to EU definitions of “farmland”, not all grasslands qualify for the Single Farm payment (i.e. grasslands with high tree cover or high cover of rocky outcrops), but farmers are compensated for this be receiving a sum corresponding to the Single Farm payment for these grassland types as well. One problem is that the rules and regulations for qualifying for the grassland AES has changed frequently, often with changes between each CAP period.

Jamieson & Hessle (2021) estimated that, for a farmer specializing in meat production of cattle or sheep, the incomes consists to approximately 10% of targeted agri-environmental payments for grasslands, while other types of (CAP) support accounts for 30-45% of the income, and 45-60 % come from selling the products. According to a survey among farmers, 16% of respondents would completely stop grazing their grasslands if they did not receive the agri-environmental payments targeted to grasslands, and another 28 % would stop grazing at least 1/3 of their grassland area (survey by Landja, referred to in a talk by Lisa Karlsson, 2023-11-21).

Current status and trends

Swedish semi-natural grasslands are extremely species-rich, and also harbour large numbers of rare and threatened species. Despite covering less than 1% of the land area in Sweden, semi-natural grasslands are the habitat of 27% of the species on the Swedish national Red list (Eide et al. 2020). Abandonment of specie-rich grasslands was identified (together with forest clear-cutting) as one of the two most frequent threats against nationally re-listed species in Sweden (Eide et al. 2020).

The total area of grasslands has remained relatively constant over the last decades (SCB 2019). Hence, at the national scale, the main problem is not a decrease in the total grassland area, but rather a decrease in the average quality. This is in turn partly a result of a loss of quality of existing grasslands (though non-optimal management). But, masked in the statistics, there is also a gradual loss due to a gradual abandonment of the most species-rich grasslands, which is partly balanced through conversion of arable fields to cultivated and species-poor grasslands. The result is that the total area of grasslands remains relatively constant, but a continuous decline of the associated biodiversity. This is because grasslands on former arable land typically is species-poor, and it might take several hundred years until their biodiversity reaches the same level as the remaining semi-natural grasslands (Schmid et al. 2017).

There is about 90 000 ha of grassland habitats within the Natura 2000 network in Sweden. The majority of this area is on the two large islands in the Baltic sea; Öland and Gotland. Of these 90 000 ha, about 30 000 ha do not receive any AES payment, or any other type of financial support (Naturvårdsverket 2018). A survey found that approximately 90% of semi-natural grasslands (included in the TUVA database) receiving agri-environmental payments were actively grazed in a given year, but only 50% of those grasslands that did not receive agri-environmental payments were grazed (Glimskär et al. 2017). Especially, many small grasslands do not receive agri-environmental payments.

The majority (85% of the area) of current semi-natural grasslands are grazed by cattle, and only 15% of the area is grazed by sheep or horses (Naturvårdsverket 2022.) Larsson et al. (2020) analysed the relationship between the available number of grazers and the area of semi-natural grasslands. They concluded that there is indeed no lack of grazing animals (cattle, sheep, horses). Instead. The main problem, from a biodiversity conservation point of view, is that these animals are grazing the “wrong” land, i.e. cultivated grasslands rather than species-rich semi-natural grasslands. This is in turn explained by economic factors (Larsson et al. 2020). Despite financial support in the form of agri-environmental payments, it is more profitable for farmers to let their livestock graze on cultivated grasslands and feed them supplemental fodder, than to let them graze on semi-natural grasslands. One reason for this is that the AES payments do not account for differences in the cost of management. Larson et al. (2020) conclude that the differentiation in only two levels of payments (“regular” and “high value”) is too course, and results in financial over-compensation to low-biodiversity “regular” grasslands, and under-compensation to high-biodiversity “high value” grasslands.

An interview survey among farmers identified that financial support is crucial for farmers to afford the management of semi-natural pastures (Manevska-Tasevska et al. 2023). Farmers were generally happy with the current support system, but they also found the regulations too rigorous, and expressed anxiety to control situations, were staff from authorities check that the rules are being followed (Manevska-Tasevska et al. 2023).

Identified drivers

A few different reports have tried to identify obstacles to increasing the area of managed marginal or semi-natural grasslands, or drivers of grassland abandonment.

A report by the Swedish Environmental Protection Agency (Naturvårdsverket 2018) tried to identify why not all grasslands in Natura 2000 areas received agri-environmental payments, through a questionnaire to regional conservation bodies. Some of the factors identified were:

a) The grassland does not qualify according to the regulations for Single Farm payments, or the regulations for grassland agri-envionment payments

b) The grassland does not qualify for any of the special classes of grasslands that can receive targeted payments

c) The regulations for grassland agri-envionment payments are not compatible with the Management plan for the specific Natura 2000 site

d) The regulations for grassland agri-envionment payments are not compatible with the need to targeted management actions (targeted to certain species etc.)

e) The level of the payment is too low

f) Lack of farmers who are willing to manage the land

Of these factors, a), e) and f) were the ones that applied to the largest areas of grasslands (21%, 20% and 19% of the grassland area without AES payments, respectively; Naturvårdsverket 2018).

Jamieson and Hessle (2021) analysed the potential for increasing the area of semi-natural grasslands that is managed though grazing, from a farmer perspective. They identified the following factors as main obstacles to increasing the area of semi-natural grasslands managed by grazing (in no particular order, and with no attempt to rank their relative importance):

- Urbanization, leading to marginalization of rural areas
- Lack of knowledge about the role of farmers and farming in the conservation of semi-natural grasslands
- Lack of nuance in the debate on the role of livestock and meat production for climate change
- Constantly changing rules and regulations for agri-environmental support
- Complex rules and time-consuming administration related to AES
- Agri-environmental payments are too low
- Too rigid rules regarding animal welfare
- Lack of trust between farmers and public authorities
- Lack of knowledge about farming among public authorities
- It is increasingly challenging to make a living and run an enterprise in rural areas
- The young generation moves to cities and is not prepared to take over
- It is not economically viable to manage small and remote grasslands
- High costs for certification
- Difficult to sell high quality products
- Difficult to predict yield between years (i.e. dry vs. wet years etc.)
- Difficult and expensive to keep the livestock over winter (i.e. outside of the vegetation season)
- Fencing and supervision of the livestock is time-consuming and expensive, particularly in remote areas.
- Difficult to keep grazing animals in areas with high density of large predators, such as wolf

A PM from the Swedish Environmental Protection Agency (Naturvårdsverket 2022) tried to identify causes of decreased semi-natural grassland management. The main decisions by farmers affecting grassland abandonment were:

1) Agricultural enterprises (farms) with livestock being shut down, for example when the farmer is retiring.

2) Livestock are grazing cultivated species-poor grassland instead of specie-rich semi-natural grasslands

3) Livestock are kept in stables rather than allowing them to graze.

Based on this, they also went on to identify the following underlying drivers:

- Low economic profitability in letting the livestock graze on species-rich semi-natural grasslands, because these typically have lower productivity. This in turn depends on the balance between costs, incomes through selling products (mainly meat) and agri-environmental payments (Naturvårdsverket 2022). As noted above, for a typical farmer the incomes are approximately 50% from selling products and 50% from agri-enivornmantal payments and other support (Jamieson and Hessle 2021). Many marginal grasslands are managed by small farming enterprises, which means that the costs are higher, but the costs could protentially be reduced of neighbouring farms cooperate (Kumm and Hessle 2020; Jamieson and Hessle 2021). Such cooperation can however often be hard to achieve. Incomes could potentially increase if meat and other products from species-rich grasslands could be sold at a higher price than currently, but there is limited willingness of consumers to pay the necessary prices (Naturvårdsverket 2022). When farmers rent land for grazing (i.e. rather than owning it themselves), this often reduces the incentives to invest in stables for the winter, fencing etc. Using “virtual fences”, i.e. GPS collars that nudges the livestock to stay within a restricted area, could be a promising way of reducing costs for fencing (Jordbruksverket 2020). However this practice is still not allowed in Sweden.
- Some different administrative aspects are also influencing farmer’s decisions regarding grazing on marginal grasslands. The administration related to agri-environmental payments is relatively complex, and may prevent some formers from applying for the payments. This might be the case particularly for smaller farms (Naturvårdsverket 2022). There have also been delays in distributing the payments to farmers, and farmers can also perceive a risk that the will need to pay back some or all of the payments if they do not fulfil all the criteria. Also the fact that there are more specific requirements and criteria related to the management of the “high value” grasslands compared to the “regular” grasslands leads to a decreases incentive to manage the most species-rich grasslands compared to grasslands with lower biodiversity.
- The risk that farming cease for example when a farmer retires is related to larger socio-economic factors in society at large, especially related to rural development. Here, the (real or perceived) risk of losing livestock to large predators, especially wolf, is a factor that influences the willingness of younger generations to take over a farm (Sjölander-Lindqvist et al. 2021)

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Switzerland grey literature

Marginal grasslands in Switzerland – current status and challenges

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How much marginal grasslands are there?

"Switzerland is a grassland" (AGFF, 2023). Of the total area of Switzerland (41,000 sqkm), 10,000 sqkm are utilized agricultural area (UAA = all farmland, excluding summer pastures

and woods), including 6,000 sqkm of natural grassland (BLW, 2020). In addition, there are 5,000 sqkm of alpine pastures in the Swiss Alps and in the Jura mountains (BFS, 2021). In total, therefore, there are currently 11,000 sqkm of “permanent grassland”, including meadows and pastures in the lowlands and in the summer pasturing alpine zone.

Between 1985 and 2018, on 235 sqkm of alpine pastures the density of shrubs increased to a level that in the land cover inventory, these areas are no longer recorded as pastureland. An additional 280 sqkm were overgrown with forest. In the same period, 142 sqkm of grassland that had been part of the UAA, were abandoned and overgrown with forest. In this period, therefore, 657 sqkm of formerly marginal grassland has been abandoned and was transformed to shrubland or forest. This corresponds to about 6 per cent of the Swiss grassland area (BFS 2021). These losses were spatially not uniform, but were stronger in the Southern and in the Western Alpine region, whereas the losses in the Northern Alps and in the Jura mountains were significantly less.

These developments are generally seen as undesirable and therefore, there are several policy instruments in place to slow down the loss of farmland and of marginal grasslands, in particular.

Legal situation and regulations

Switzerland is not a member country of the European Union. Therefore, it does not participate in the Common Agricultural Policy of the EU but has its own agricultural policy. In the following paragraphs, the legal framework that is relevant for marginal grasslands, is summarized.

The Swiss Constitution defines the purpose of agriculture. In addition to the production of food and raw materials, the Swiss agricultural sector shall make “an essential (…) contribution to the conservation of natural resources and the upkeep of the countryside” and to the “decentralized population settlement of the country” (Federal Constitution of the Swiss Confederation, Article 104). The Swiss Law of Agriculture (Bundesrat 2023), already in Article 4, stipulates that farmers in “Difficult production and living conditions” should get particular support, in particular in hilly and mountain regions. The most important support measures are then defined in the Ordinance about Direct Payments to Agriculture (Bundesrat 2022a).

As Switzerland conducts its agricultural policy independently of the CAP of the EU, cross compliance was already introduced in the early 2000s (Aviron et al., 2009) to require minimum ecological standards in agriculture. At the same time, several policy instruments were put in place to support the management of marginal farmland – grassland in particular (BLW, 2021):

- Basic area payments for agricultural management, with increasing contributions from the hilly to the upper mountain zones.
- Direct payments for farmland in the hilly and mountain zones of Switzerland, with increasing contributions per hectare. The land must be managed in a way that there is no forest encroachment.
- Direct payments for the management of grasslands with inclinations of 18 % and more.
- Direct payments of particularly steep grassland with inclinations of 30 % or more, with increasing contributions depending on the steepness.
- Direct payments for farms that send their cattle, sheep or goats to alpine summer pastures. This payment is calculated per livestock unit (LU), depending on the category of the animal.

Those payments are all subject to ecological cross compliance, which means that farmers can only claim the direct payments if their records show that they fulfill the “proof of ecological performance”. The large majority of Swiss farmers complies with those requirements, as the direct payments make up a substantial part of their income. The relative importance of direct payments is highest for farmers in marginal mountain regions, it decreases towards the more fertile lowlands, which are also easier to manage. This shows that one of the objectives of the direct payments is to maintain the management of marginal farmland – and of grassland in particular.

As part of the “proof of ecological performance”, farmers have to manage at least 7% of their farmland as “biodiversity promotion areas” or ecological focus areas (EFA), according to the CAP terminology (maximum share 50%, average share currently around 12%). Farmers are free to choose among different EFA types, provided that they reach the required minimum of 7% of their UAA. Several EFA types, however, are particularly promoted with additional direct payments, among them the different grassland EFA types (BLW, 2021):

- Extensively managed meadows: Late cut (depending on altitude), no fertilization, no mulching (the cut grass has to be removed).
- Low intensity meadows: Same regulation as extensively managed meadows, but organic manure is allowed (max. 30 kg N/ha)
- Wet grassland (litter): Late cut (after September 1st)
- Extensively managed pastures: Pastured at least once per year
- Tree pastures: Same regulations as for extensively managed meadows, the payments are granted for the grassland area only.

Grassland EFA make up about 80% of the total EFA area on Swiss farmland. In the lowlands they contribute to mitigate the loss of farmland biodiversity, whereas in the mountain regions, they contribute to the maintenance of traditional farming practices and thus to the conservation of biodiversity, which is still comparatively intact in mountain regions as compared to the lowlands (Weyermann et al., 2006; Kampmann et al., 2012; Riedel et al., 2019; Meier et al., 2021).

Those regulations and subsidies apply to the UAA. In addition, there is a set of support policies for the alpine summer farms and pastures, which are often differently managed than the farmland of the UAA (Herzog et al. 2013):

- Summer pastures are seasonally managed, as a kind of transhumance system;
- There are various types of summer farms, some are privately owned, others are communal grasslands owned by cooperatives or municipalities;
- The actual area of summer pastures is not well defined. Whereas the lower boundary of summer pastures (between summer pastures and UAA) is delimited and well defined, there is no actual upper boundary. Instead, there is a gradient of actively managed (pastured) grassland towards unproductive land at higher elevations, which is not actively used or only occasionally used by e.g., sheep.

There is a broad consensus among Swiss policy makers and in Swiss society that summer farming should be maintained and further supported. Therefore, in the Ordinance of Direct Payments to Agriculture (Bundesrat, 2022a), specific support measures are foreseen:

- Direct payments per LU that spend a summering season on a summer farm (100 days at least);
- Biodiversity payments for EFA on summer pastures, provided that a minimum number of indicator plant species is present, indicating a certain level of ecological quality.

The justification for those payments is the maintenance of the summer pastures, avoiding shrub and forest encroachment (BLW, 2023).

In addition to the agricultural support measures, there are also nature protection support measures for marginal grasslands. Because dry meadows and pastures are particularly species rich and – at the same time – less productive than mesic grasslands and therefore threatened by abandonment, those species rich grasslands have been inventoried and are now protected at national or cantonal level. The national inventory comprises almost 4,000 objects with altogether 300 sqkm, protected by article 18a of the National Law for Nature Protection (Bundesrat, 2022b). The Ordinance About the Protection of Dry Meadows and Pastures of National Importance (Bundesrat 2021b) aims at the protection and promotion of those grasslands.

In addition to the government measures for the maintenance of (marginal) grasslands, there are also private initiatives that support their management. Some examples are:

- Labels by retailers that support mountain farming (e.g., Pro Montagna) and summer farming (e.g., milk from alpine summer farms in the region of Bern, Alpleben);
- Foundations that support mountain farming and the upkeep of traditional grassland management (e.g., Bergwald Projekt);
- Local associations and clubs that maintain the tradition of mowing marginal mountain grasslands, often in particularly remote, steep and actually dangerous situations (see Wikipedia);
- Private initiatives by mountain farmers and associations that seek volunteers to engage in the mowing of marginal grasslands, which require a high amount of manual labour because they are too steep even for modern machinery (e.g., Bergheuet).

Current trends

Those government regulations and private initiatives illustrate the importance that the society in Switzerland attaches to the maintenance of marginal grasslands, mainly because of its landscape and biodiversity values. Nevertheless, the trends of the last 30 years show, that those measures have been only partially successful and more than 600 sqkm of grassland got lost to shrub and forest encroachment. It seems that the support measures have not been sufficient to counteract the market forces of liberalization, which dominated the agricultural development also in Switzerland in the last decades (Helfenstein et al., 2022; Ackermann et al., 2023). Still, they certainly contributed to mitigate those trends and to maintain farming activities in agriculturally marginal areas.

There are two recent developments that may become increasingly important in the near future:

1. The increase of wolf populations in mountain regions. In the last decades, the wolf has established itself again across the Alps and the Jura mountains. Mountain farmers complain about the increasing attacks of wolfs on livestock. Herding in remote regions has become more complicated because sheep and cattle require protection. Mink et al. (2023) have found that in regions with frequent wolf attacks, summer farming

activities – in particular with sheep – actually decline. Recently, the national hunting law has been modified and now facilitates the regulation of wolf populations and even the elimination of entire packs.

2. The planned installation of solar pannels in mountain regions. Due to the energy crisis, there is a number of initiatives that propose the installation of vertical solar panels in high mountain regions with the intention to produce electricity also during the winter months. Although the days in the winter are shorter, there are less clouds in mountain regions than in the lowlands and the light is reflected by the snow so that projections show an increased production of electricity (Dujardin et. al, 2022; von Rütte et. al, 2021). The effects of such installations on the grazing, the maintenance and the biodiversity of the grasslands underneath is largely unknown and will have to be monitored.

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Romania grey literature

The biodiversity of Transylvania grasslands has been reduced through afforestation or conversion of the land in vineyard terraces. This was mostly because the productive value of this dry grasslands is low and they were repurposed. Still, this type of grasslands make up in their importance by the amount of floristic and faunistic species they hold. Many of this species are rare or have disappeared in other parts of Europe.

In Transylvania, the reason why these species have been maintained so well in the HNV dry grasslands, is because of the extensive land use that farmers and shepherds have used for generations. There is no need to create new management plans or agriculture behaviours for this areas, we just need to preserve the current traditional way of land usage, mixed, extensive farming without using synthetic fertilizers and pesticides. In our document we will be discussing about two areas, which can be considered prime examples of extensive and traditional agriculture which protected under its umbrella a vast number of floral and animal species, many which disappeared from the rest of Europe.

The East Cluj Hills Site is a Natura 2000 area with a surface of close to 19.000 hectares, which was created in 2011. Most of this area is characterised by hills with HNV grasslands maintained with a traditional management and extensive grazing. There are 10 habitats community importance that were identified here, which include: stepic subpanonic pastures, low altitude pastures and mezoxerofil seminatural pastures with shrubs on calcarous substrate. In the protected area, 26 species of plants and animals are proctected, out of which one of the most important group is the “blue butterflies” from the Maculinea genus. Here we have 4 species of Maculinea, this 4 species are endemic to this area alone and are found nowhere else.

The other very important area in Transylvania with a HNV grasslands area is in Shighișoara-Târnava Mare region. These grasslands serve as habitats for diverse species, contributing to the area's cultural identity and attracting visitors. Despite their cultural significance, they are not static but dynamic landscapes where farming communities actively contribute to regional economic development. The diversity of grasses and wildflowers, including clovers and legumes, provides invaluable feed for farm animals and essential habitats for insects, invertebrates, birds, and mammals, contributing to the landscape's ecological structure. Conservation of these grasslands is crucial for European agriculture, given their irreplaceable biodiversity. This preservation requires retaining elements of traditional management in a modern context to sustain the unique natural resource.

The grasslands exemplify how historical mixed farming, once widespread in Europe, can serve as a model for conserving and restoring High Nature Value farmland habitats. Safeguarding these habitats requires creative design, traditional practices, and the preservation of plant- and animal-rich areas within the broader farmed landscape to prevent fragmentation, a critical concern across much of Europe.

Strategic planning is essential for the future of these grasslands, mitigating negative economic pressures and highlighting their significance for European biodiversity. While traditional farmers may not consciously preserve their grasslands for aesthetics or biodiversity, ecologists acknowledge that their practices maintain impressive floristic diversity. The sensitivity of these grasslands to chemical fertilizers is emphasized, as they replace crucial plants, release pollutants, and pose threats to nearby waters. Intensive grassland practices in Europe, with heightened fertilizer use and excessive grazing, damage biodiversity and incur high costs, while traditionally managed grasslands provide additional functions beyond biodiversity protection. The healthy semi-natural grasslands yield 'public goods and services' due to their beautiful, stable environment.

Semi-natural grasslands contribute to public goods, including preventing soil erosion in unstable areas, purifying rainwater for local rivers, trapping carbon, serving as a gene bank for valuable plants, and generating tourism revenue through wildflower-rich meadows. The area's high-quality foods reflect regional identity and are popular, allowing for lucrative sales. Conservation of dry grasslands for biodiversity complements and enhances economic activities, particularly in managing pastures and hay-meadows, with a concentration of rare species found on challenging, marginal lands. Maintaining the health of dry grasslands is crucial for farmers to qualify for European Union agri-environment payments. However, various factors, such as overgrazing by sheep, invasion by scrub, uncontrolled burning, weed and alien species, and excessive soil erosion, negatively impact these habitats, especially on steep, sunny slopes. Overgrazing by sheep has particularly affected the Sighișoara-Târnava Mare area, causing degradation of over 94% of dry steppic grasslands. Scrub invasion, decline in farming activity, uncontrolled burning, and invasion by weeds further contribute to the challenges, impacting biodiversity and soil stability in the Saxon Villages region.

To address these challenges, the optimal management approach involves monitoring traditional sheep grazing to ensure minimal impact on grass cover and prevent soil erosion. Encouraging the regular movement of sheep-folds, along with promoting cattle grazing and increasing cattle numbers relative to sheep, is essential. ADEPT has played a role in revitalizing traditional village grazers, particularly cows, contributing to the economic viability of farming communities. Instead of using fire, the recommended method for dry grasslands is efficient mechanical cutting, with successful trials of innovative Brielmeier mowers that minimize soil pressure, especially on steep slopes. Controlled and early spring fires may be considered for clearing scrub or excess grass, emphasizing the importance of rapid, limited, and well-controlled burns.

Other applicated measures are as follows:

1. Prohibit land use category changes from grasslands to arable land.

2. Ensure a maximum animal load of 0.7 Livestock Units (LU) per hectare for pastures.

3. Specify grazing conditions, including a minimum vegetation cover height (8-15 cm) and grass apex height (6-10 cm), starting after April 15th.

4. Set a grazing season duration of 150-230 days (April 15th – November 30th), with 3-5 grazing cycles, adjusting for seasonal conditions, and reducing cycles during drought years.

5. Monitor management results every 3 years, adjusting measures accordingly.

6. Implement ecological reconstruction for degraded grasslands, prohibit inappropriate reseeding, and encourage traditional mowing practices.

7. Remove invasive species through manual or mechanical means.

8. Collaborate with local communities to raise awareness of biodiversity importance.

9. Monitor rare plant species populations and prohibit their collection.

Since 2008, farmers have received rewards for preserving High Nature Value (HNV) grasslands through practices that safeguard diverse flora and fauna. European Union agri-environment measures permit grazing and mowing but impose restrictions on natural and chemical fertilizers, excessive grazing, and early-season mowing. Management requirements emphasize traditional practices, including the use of natural fertilizers, avoiding over-grazing (with low stocking rates), delaying mowing to support plant seeding and wildlife, and promoting lighter machinery or scythe use to prevent soil damage and harm to young animals.

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Questionaire

Date:

Name of the interviewee:

Organisation/position/expertise:

General and compulsory questions:

1. **What other means government or sector is offering besides monetary payments to avoid abandonment of semi-natural grasslands?**
2. **How have support schemes evolved over past two decades? How often they are revised?**
3. **Please list in order three main current drivers of semi-natural grassland abandonment starting from the most important.**
4. **What are possible additional measures to prevent abandonment of semi-natural grassland?**
5. **What is national goal of maintaining semi-natural grasslands? Is it reached or are additional measures needed?**
6. **As we don't make during this study interviews with farmers themselves – According to your experience, what opinion do they have regarding semi-natural grasslands and their abandonment?**

Regional specific questions:

1. **What is your opinion regarding to activity-based payments or result based payments? Is there any research done so far in Sweden?**
2. **Why there are still unmanaged semi-natural grasslands (including Natura 2000 areas) in Estonia?**
3. **What is your opinion on results-based payments? Pros and cons. (Estonia)**
4. **What is your evaluation of the effect of the increasing wolf population in Switzerland? Has it already led to the abandonment of grassland? Or do you expect accelerated abandonment in the future?**

- **Additional comments.**