# THE EU-SALVERE PROJECT: PRODUCING NATIVE SEEDS USING THRESHING MATERIAL AND SPECIES-RICH HAY FROM GRASSLANDS

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**Abstract:** "Semi-natural grassland as a source for biodiversity improvement (SALVERE)" is the name of a project within the Central Europe program that started on January 1st, 2009. Until December 2011, eight project partners from six EU countries work together: University of Padua, Department of Environmental Agronomy and Crop Production (Michele Scotton /lead partner) – Italy; Research and Education Centre for Agriculture Raumberg – Gumpenstein (Bernhard Krautzer) & Kärntner Saatbau GmbH (Christian Tamegger) – both Austria; OSEVA PRO Ltd, Grassland Research Station (Magdalena Sevcikova) – Czech Republic; Anhalt University of Applied Sciences (Sabine Tischew) & Rieger-Hofmann GmbH (Ernst Rieger) – both Germany; Agricultural Research Centre (Miriam Kizeková) – Slovakia; Poznan University (Piotr Golinski) – Poland. The aim of this project is to promote the use of native seed and plant material in restoration and to create species-rich grasslands typical for the concerned region. In addition, guidelines for seed production and harvesting on potential donor sites as well as best practise methods for the establishment of species-rich grasslands will be developed to enhance the exchange of knowledge about ecological restoration all over Europe.

**Keywords:** reclamation of former agricultural land, mesophile grasslands, harvesting techniques, restoration methods, green hay, on-site threshing material, seed stripping, seed mixtures, greenhouse experiments

## Introduction

In Central Europe, several studies have highlighted the extremely high biodiversity potential of extensively or less intensively managed semi-natural grasslands (e.g. Stoate et al. 2009, Korneck et al. 1998) and their steady decline in quality and quantity during the last decades (e.g. Kiehl et al. 2010, Klimek et al. 2007, Riecken et al. 2006).

The SALVERE project utilises local species-rich semi-natural grasslands as a seed source using the harvested seed and plant material to restore species-poor grasslands or to establish new species-rich grasslands on former arable land, on road embankments, on ski slopes, in mined sites, and on compensation sites. Besides the enhancement of best practise methods for harvest and re-vegetation, seed potential of selected donor sites and composition and germinability of harvested seed mixtures were analysed in laboratory and greenhouse experiments.

*Figure 1*. Arrhenatherion trials one year after implementation – left: Liptovksá Teplička / Slovakia, September 2010 (A. Kirmer); right: Strenzfeld Campus / Germany, August 2010 (S. Tischew).

## Materials and methods

In summer 2009, the project partners implemented 17 trials comprising different donor sites and different target plant communities: Arrhenatherion (all partners, 15 trials), Bromion (4 trials), Molinion (2 trials), Deschampsion (1 trial). Table 1 shows the site characteristics of eight selected Arrhenatherion trials.

*Table 1*. Site characteristics of eight selected Arrhenatherion trials in the SALVERE project.

| **Former land use** | **Arable land** | | | | **Degraded grassland** | | | |
|---|---|---|---|---|---|---|---|---|
| **Country** | **Italy** | **Germany** | **Slovakia** | **Poland** | **Austria** | **Austria** | **Slovakia** | **Poland** |
| Longitude (E) | 11° 35' 52'' | 11° 42' 09'' | 19°02'44'' | 16° 17' | 14° 06' 05'' | 14°04'18'' | 20°41' | 16° 18' |
| Latitude (N) | 45° 41' 30'' | 51° 49' 25'' | 48°44'57'' | 52° 26' | 47° 29' 41'' | 46°32'04'' | 48°55' | 52° 22' |
| Altitude (m a.s.l.) | 79 | 85 | 647 | 86 | 740 | 500 | 960 | 85 |
| Mean yearly rainfall (mm) | 1177 | 469 | 798 | 588 | 1014 | 1054 | 579 | 588 |
| Mean yearly temperature (°C) | 13.3 | 9.2 | 8.0 | 9.0 | 7.0 | 7.5 | 5.9 | 9.0 |
| pH value (in H2O) | 7.6 | 8.0 | 7.0 | 5.0 | 6.3 | 6.5 | 6.7 | 7.0 |
| ± *SD* | *0.09* | *0.03* | *0.05* | *0.01* | - | - | *0.04* | - |
| Plant available P (mg per 100 g soil) | 1.5 | 4.1 | 7.2 | 13.5 | 5.5 | 5.6 | 0.4 | 13.9 |
| ± *SD* | *0.8* | *2.3* | *0.7* | *0.5* | - | - | *0.04* | - |
| Total nitrogen (mass-%) | 0.18 | 0.2 | 2.03 | 0.15 | 0.15 | - | 3.51 | 0.12 |
| *SD* | *0.14* | *0.01* | *0.01* | *0.01* | - | - | *0.01* | - |
| Total carbonate (mass-%) | 0.5 | 2.2 | 1.5 | 0.9 | - | 1.7 | 3.3 | 0.7 |
| ± *SD* | - | *0.2* | *0.2* | *0.1* | - | - | *0.2* | - |
| Type of soil preparation | ploughing, harrowing | harrowing | ploughing, harrowing | ploughing, harrowing | ploughing | harrowing | none | ploughing, harrowing |
| Date of implementation | Aug-Sep 2009 | Aug 2009 | Jul 09 | Aug 2009 | Jul-Aug 2009 | Jul- Aug 2009 | Jul 09 | Aug 2009 |
| Methods used for re-vegetation | GH, DH, OST, SS | GH, OST, GH+S, OST+S | GH, DH | GH, OST, SS | GH, OST, GH+S, OST+S | GH, DH | GH, DH | GH, OST, SS |

The following re-vegetation methods were used for the introduction of target species:

- Green hay (GH): Mowing of species-rich grasslands and harvesting of fresh material. Ratio donor : receptor site depends on biomass production and seed content of donor site (varies between 3:1 and 1:2).
- Dry hay (DH): Comparable to the green hay method but the material was dried on the site ("haymaking") before collection.
- On-site threshing (OST): Mowing and immediate threshing ("on-site") of the material with a thresher. Application rate depends on seed content in threshing material and varies between 5 and 20 g /m².
- Seed stripping (SS): Stripping of the vegetation with special equipment (pulled by tractor or by hand). Application rate depends on seed content in the threshing material and varies between 5 and 20 g /m².
- Seed mixtures from propagation (S): Seeds for propagation are collected and multiplied within the concerned region. The mixture should consist of 6-10 grasses and 10-15 herbs (minimum standard). The recommended sowing density is 2-5 g /m² and the number of seeds per species depend on the thousand grain weight of the seeds (approx. 1000-3000 seeds /m²). This method was used in combination with GH and OST.

In addition, several laboratory and greenhouse experiments were carried out:

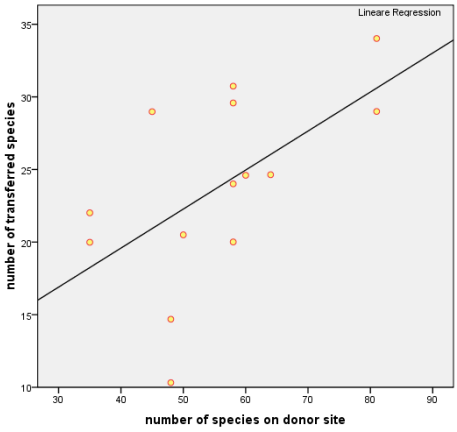
- Analysis of seed potential and biomass production in donor sites (all partners)
- Analysis of seed production of selected species in Arrhenatherion donor sites (all partners)
- Germination tests with selected species from Arrhenatherion donor sites (all partners)
- Composition and germinability of seed mixtures (all partners)

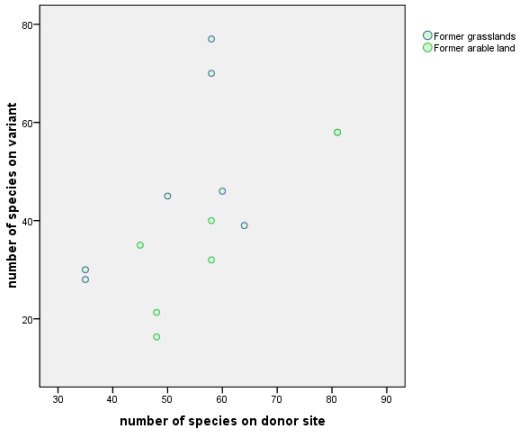
- Separation experiments and effect of storage on the germinability of seed mixtures (4 partners)

In Germany, on-site threshing material and green hay was sampled and the material was used for germination experiments in greenhouses with nine repetitions for each methods (Eis 2010). Reference value is the amount of harvested material on 1 m² donor site (on-site threshing: 10.2 g per m² (*SD* ± *3.1*), green hay: 583.7 g per m² (*SD* ± *113.8*)). Green hay was threshed carefully to reduce the amount of stems and leaves without loosing seeds. The material was applied on 1 m² - trays with a basic layer of 3 cm Isoself® and a 4-5 cm layer of sterile potting soil. The experiment started on the 2nd of March 2010. Germinated seedlings were determined, plucked and counted in regular intervals. The experiment will be continued until the 2nd of March 2011.

## Results and discussion

A first evaluation of data showed that the number of transferred species depends on species-richness on donor sites. There was no significance relationship to other parameters such as method of re-vegetation or site characteristics. If we considered all species on the variants the former land use proved to be significant in addition to the number of species on donor sites. On the degraded grassland sites, residual species increase the species number on receptor sites. Restoration method, climatic and soil parameters are not significant, yet.




Linear regression

| model | | not standardized coefficients | | standardized coefficients | |
|---|---|---|---|---|---|
| | | B | SE | Beta | significance |
| step 1 | (constant) | 8.84 | 6.32 | | 0.187 |
| | species number on donor site | 0.27 | 0.11 | 0.57 | 0.031 |

a. Dependent variable: number of transferred species

Note: $R^2 = 0.27$

Linear regression

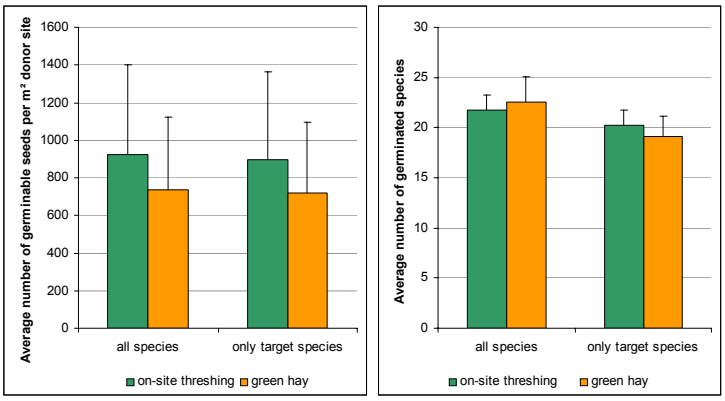
| model | | not standardized coefficients | | standardized coefficients | |
|---|---|---|---|---|---|
| | | B | SE | Beta | significance |
| step 1 | (constant) | 1.04 | 17.25 | | 0.953 |
| | species number on donor site | 0.75 | 0.30 | 0.58 | 0.029 |
| step 2 | (constant) | -1.84 | 13.92 | | 0.897 |
| | species number on donor site | 0.97 | 0.26 | 0.75 | 0.003 |
| | Former land use | -18.77 | 6.84 | -0.55 | 0.019 |

a. Dependent variable: number of species per variant

Note: $R^2 = 0.28$ for step 1, $R^2 = 0.54$ for step 2

*Figure 2*. Significant relations to the dependent variables number of transferred species (left) and number of species per variant (right).

Results from greenhouse experiments with on-site threshing material and green hay are shown until the 7th of July 2010 (Fig. 3). In general, target species comprised approximately 90 % of the number of all germinated species. In on-site threshing material, the content of germinable seeds is slightly higher than in green hay variants but the difference is not significant. In relation to the number of target species found on the donor site, in the greenhouse experiment 53 % germinated from on-site threshing material and 45 % from green hay (unpubl. data). For both methods, the number of germinated species is quite similar.




| ONEWAY ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| | | sum of squares | df | mean squares | F | Signifikance |
| number of species | Between groups | 2.72 | 1 | 2.72 | 0.62 | 0.44 |
| | Within groups | 69.78 | 16 | 4.36 | | |
| | total | 72.50 | 17 | | | |
| number of target species | Between groups | 5.56 | 1 | 5.56 | 1.70 | 0.21 |
| | Within groups | 52.44 | 16 | 3.28 | | |
| | total | 58.00 | 17 | | | |
| number of seedlings | Between groups | 159537.18 | 1 | 159537.18 | 0.85 | 0.37 |
| | Within groups | 2996226.54 | 16 | 187264.16 | | |
| | total | 3155763.72 | 17 | | | |
| number of seedlings from target species | Between groups | 140238.08 | 1 | 140238.08 | 0.78 | 0.39 |
| | Within groups | 2889149,54 | 16 | 180571.85 | | |
| | total | 3029387.62 | 17 | | | |

*Figure 3.* Comparison of different parameters (number of germinated species, number of germinated target species, number of seedlings, number of seedlings from target species) between the methods „on-site threshing" and „green hay" in greenhouse experiments in Germany. Reference value is the material harvested on one square meter donor site.

## Conclusions

Harvesting of species-rich grasslands is an effective way to obtain regional seed mixtures for restoration and re-vegetation. On-site threshing and green hay are effective harvesting methods for seeds and plant material. First assessments of the data sampled in the first vegetation period after implementation showed that species-richness of donor sites increases restoration success.

Greenhouse experiments with material from on-site threshing and green hay demonstrated the extremely high seed potential of harvested seed and plant material. After four months, 53 % (on-site threshing) and 45 % (green hay) of the target species from the donor site were able to germinate. Differences between harvesting methods are not significant, yet. Whereas green hay is easier to harvest (tractor with rotary mower and loader wagon), material from on-site threshing is bulk reduced and can be stored more easily for later use.

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