Best-practice methods for the development of species-rich grasslands - experiences from the SALVERE project

Erfolgreiche Methoden zur Entwicklung von artenreichen Wiesen – Erfahrungen aus dem SALVERE Projekt

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With contributions from all SALVERE partners

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Species-rich grasslands as donor sites / *Artenreiche Wiesen als Spenderflächen*

Directly harvested seed mixtures for restoration and re-vegetation / *Direkt geerntete Mischungen für Renaturierung und Neuanlage artenreicher Wiesen*

- Diversification of degraded grasslands
- Establishment of species-rich grasslands on former arable land
- Establishment of species-rich grasslands on raw soils (e.g. mining, road construction, dikes, ski slopes)

Calcareous grassland / Kalktrockenrasen

Species-rich grasslands as donor sites / *Artenreiche Wiesen als Spenderflächen*

Advantages / *Vorteile*

- Harvested seed mixture contains a composition of species, sub-species and regional ecotypes typical for the region
- Utilization of seeds for re-vegetation measure within the region will protect and enhance its biological diversity and can lead to an increasing consciousness of the value of still existing species-rich grasslands
- And this could lead to an increasing willingness to maintain these remnants with proper management → after degradation it is much more difficult to restore them to the original state

Mountain grassland / Bergwiese (Foto: René Schubert)

Possible problems / *Mögliche Probleme*

- Competition with already existing vegetation (e.g. degraded grasslands) / Konkurrenz
- High nutrient status of the sites (e.g. former arable land) / Nährstoff-Überangebot
- After implementation: High weed pressure on the sites and insufficient management in the first year of development / Unzureichende Entwicklungspflege nach der Umsetzung
- Establishment and spread of problematic species / Problematische Arten

Mesic grassland / Frischwiese (Foto: Jessica Arland)

Preparation and management of receptor sites / *Flächenvorbereitungen und -pflege*

Competition with already existing vegetation / Konkurrenz

- Destruction of the sward by milling, grubbing, ploughing
- Frequent grubbing to deplete seed bank of ruderal species
- Topsoil removal

Milling / Fräsen

Grubbing / Grubbern

Topsoil removal / Oberbodenabtrag

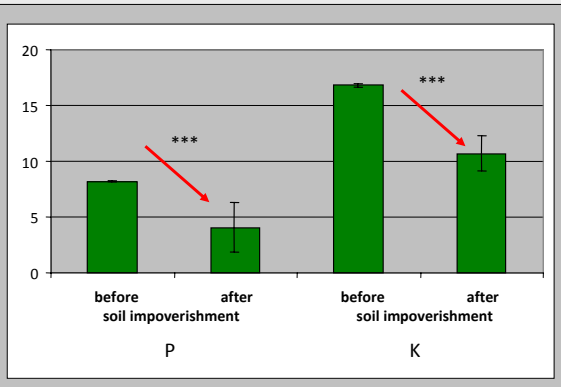
→ siehe Poster: Mahdgutübertragung zur Anreicherung von artenarmen Grünlandbeständen – Abhängigkeit des Renaturierungserfolges vom Störungsgrad der Grasnarbe. Schmiede, Donath & Otte 2011 (Univ. Gießen)

Preparation and management of receptor sites / *Flächenvorbereitungen und -pflege*

High nutrient status / Nährstoff-Überangebot

- Lowering of the nutrient level by cultivation without fertilization
- Mowing several times (2-3x) with biomass removal without fertilization
- Topsoil removal
- Deep ploughing (topsoil inversion)

Deep ploughing with Bovlund 64D (Denmark) / Tiefpflügen



Example: Strenzfeld Campus

Cultivation of oat without fertilization in 2007/08 and of winter barley in 2008/09

Subsequent grubbing (2-3 times after harvest in late summer 2008 and 2009)

↓

Significant decrease of P, K

No effect on N_t (0.15-0.18 %)

Depletion of the soil seed bank

Trials in the SALVERE project / *Versuchsflächen im SALVERE Projekt*

Realisation of 17 trials in summer 2009 and continuing of 5 "old" trials

Target plant communities	
Arrhenatherion	all partners (15 sites)
Bromion (Mesobromion)	4 partners (4 sites)
Molinion	2 partners (2 sites)
Deschampsion (Cnidion)	1 partner (1 site)

Used methods to establish species-rich grasslands	
seed-rich green hay	all partners
seed-rich hay	2 partners
material from on-site threshing	7 partners
material from seed stripping	4 partners
seed mixtures from regional origin and propagation	3 partners

Example I / *Beispiel I*

Arrhenatherion trial Strenzfeld Campus 2009-2010

Complete block design, total area c. 0.3 ha, 4 variants

GH: green hay (c. 670 g/m²); species nunber on donor site: 84 (55 target species)

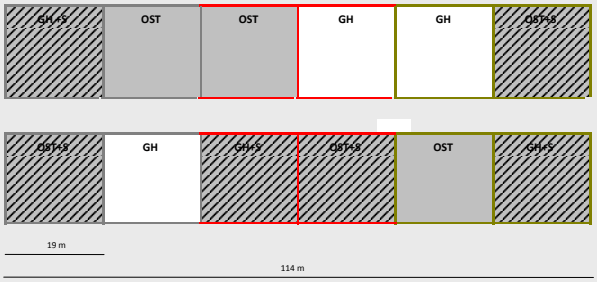
GH+S: green hay with additional sowing (1,5 g/m²) of 37 local species from regional propagation

OST: on-site threshing material (c. 15 g/m², not cleaned)

OST+S: on-site threshing material (see OST) with additional sowing (see GH+S)

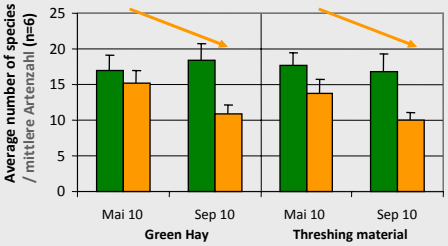
Harvest with thresher / Ernte mit kleinem Mähdrescher, 24.08.2009

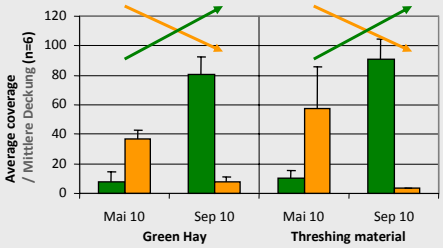
Implementation August 2009



Example I/ *Beispiel I*

Arrhenatherion trial Strenzfeld Campus 2009-2010





Target species / Zielarten

Non-target species / Nicht-Zielarten

- Number and coverage of non-target species is decreasing between May and September
- Coverage of target species is increasing between May and September
- On plots with threshing material, coverage of target species is slightly higher

→ Application of green hay and sowing of threshing material was very successful until now

Example I/ *Beispiel I*

Arrhenatherion trial Strenzfeld Campus 2009-2010

25 August 2009

11 December 2009

18 May 2010

First cut: 7 June 2010

5 July 2010

9 August 2010

2 September 2010

Example II / *Beispiel II*

Arrhenatherion trial Profen mining site 2004-2010

Complete block design, total area c. 1.2 ha, 3 variants

LD low-diversity seed mixture (3 commercial grass cultivars), sown with 10 g /m²

LD+ with additional seed-poor mulch layer (c. 5 cm)

HD high-diversity seed mixture of grassland species: 11 grasses, 10 legumes, 30 other herbs, sown with 2 g /m²

HD+ with additional seed-poor mulch layer (c. 5 cm)

Implementation December 2004

Sowing on Profen trial / Ansaat auf dem Blockversuch Profen, Dec. 2004

Block 1				Block 2				Block 3			
LD	HD	HD+	LD+	HD	LD	LD+	HD+	HD	LD+	HD+	LD

Example II / *Beispiel II*

Arrhenatherion trial Profen mining site 2004-2010

Vegetation development after 1.5 years / Vegetationsentwicklung nach 1,5 Jahren (6/2006)

Low-diversity mixture (3 grass cultivars)

High-diversity mixture / artenreiche Mischung

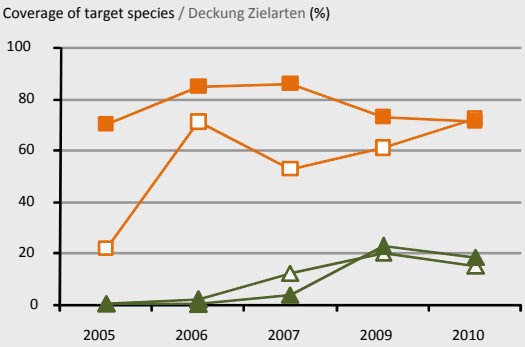
High-diversity mixture (37 regional species) / artenreiche Mischung + Mulch

Low-diversity mixture (3 grass cultivars) + Mulch

Example II / *Beispiel II*

Arrhenatherion trial Profen mining site 2004-2010

Vegetation development after 6 years / Vegetationsentwicklung nach 6 Jahren (8/2010)



Orange: high-diversity mixture / *artenreiche Mischung*

Green: low-diversity mixture / *artenarme Mischung*

Filled symbols: with additional mulch layer / *gefüllte Symbole: mit zusätzlicher Mulchabdeckung*

Example II / *Beispiel II*

Arrhenatherion trial Profen mining site 2004-2010

dependent variable	independent variables	df	year	F	p	year	F	p
plant species richness (all species)	seed mixture	1	2005	29.073	**0.001**	2010	19.027	**0.002**
	mulch	1		0.618	0.454		3.735	0.089
	seed mixture * mulch	1		0.000	1.000		0.076	0.789
coverage herb layer (all species)	seed mixture	1		0.278	0.612		12.996	**0.007**
	mulch	1		32.31	**0.000**		0.280	0.611
	seed mixture * mulch	1		1.699	0.229		3.274	0.108

→ Species mixture determines plant species richness

→ Even after 6 years, coverage of species was influenced by the sown mixture

→ At the begin, a mulch layer enhances vegetation development

Conrad & Tischew (2011, *Ecol.Engin.*) found that dominance of *Festuca rubra* cultivars has a negative effect on the immigration and development of grassland target species on restoration sites

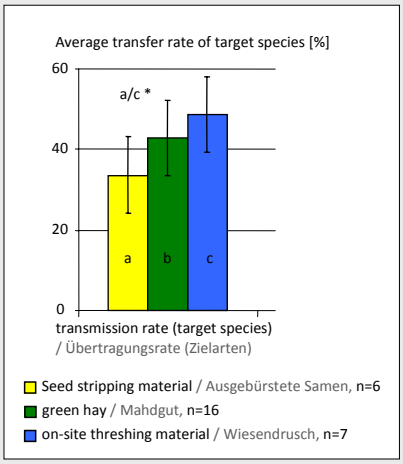
Parameters for restoration success / *Faktoren für den Renaturierungserfolg*

- Effect of restoration method (stripping, mowing, threshing)
- Effect of donor site (dry grassland, mesic grassland, wet grassland)
- Effect of receptor site (raw soil, former arable land, disturbed grassland)
- Effect of age (years since implementation)

Data set: 42 different restoration sites

Parameters for restoration success / *Faktoren für den Renaturierungserfolg*

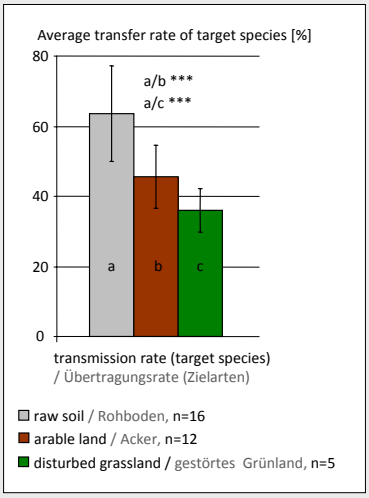
Effect of restoration method (only arable land/grasslands)



- the highest transfer rate was reached by the method "on-site threshing"
- differences between methods are only significant between seed stripping and threshing

Parameters for restoration success / *Faktoren für den Renaturierungserfolg*

Effect of type of receptor site (only green hay method)



- the highest transfer rate after application of green hay was found on raw soil
- the lowest transfer rate was found on disturbed grassland
- differences between receptor sites are significant between raw soil and arable land as well as between raw soil and disturbed grassland

Parameters for restoration success / *Faktoren für den Renaturierungserfolg*

Univariate GLM

Dependent variable: Transfer rate of target species

Independent variable	F	p
type of receptor site	**4.049**	**0.033**
years since implementation	**5.633**	**0.011**
type of donor site	0.061	0.941
restoration method	1.000	0.385

interactions: not significant

→ in the model, the parameters type and age of the receptor site proved to have a significant influence on the transfer rate of target species

Conclusions / *Schlußfolgerungen*

→ species-rich grasslands are very suitable to harvest regional seed mixtures

→ the methods stripping, mowing and brushing can be recommended

→ in case of missing or not yet flowering species on donor sites, additional sowing can be useful

→ site conditions on receptor site and competitonwith already existing vegetation determine restoration success

→ on raw soil and former arable land higher establishment rates are found than on grasslands

→ years since implementation is very important because the sites will get more species-rich with ongoing time and vegetation development after sowing of seeds from stripping, mowing, and brushing will become more similar

Calcareous grassland / Kalkmagerrasen

Thank your
for your attention

Wet grassland / Feuchtwiese