SALVERE

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Project 1CE052P3

”Semi-natural grassland as a source of biodiversity improvement” (SALVERE)

Final Report of work package 5

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1 Introduction

In general, grasslands are developed by sowing of commercial seed mixtures coming from the international seed market and mostly comprising non-native ecotypes or species. Even though, in the last 15 years, the knowledge about ecological restoration is increasing, the implementation of new methods into practice is yet not satisfying. All-over Europe, several studies highlighted the extremely high biodiversity potential of extensively or less intensively managed semi-natural grasslands. Their biodiversity can be protected by specific conservation measures but also by the transfer of seeds to suitable receptor sites. The latter, active, form of protection requires the development of sustainable and cost-effective methods. The selected donor site must fulfil specific criteria:

- representative species composition (typical for the vegetation type and the region)
- low amount of problematic species (neophytes, varieties and foreign ecotypes from propagation)
- good accessibility
- easy to harvest
- distance to the receptor site

In Austria donor sites are based on the Biotop Kartierung from every federal state in Austria. In the next step after choosing a donor site the nature conservation authorities and land owners must be contacted to obtain permissions for the harvest of seeds. The distance between donor site and restoration site shouldn't be too much. The donor site in Weißenbach/Liezen is close to the restoration site. Our planned Arrhenatherion donor site was destroyed in May 2009 because of infrastructural interventions. It was very hard to find an adequate site. At last it was decided to use the Welser Heide as donor site for the experimental site as well even it is 150 km away.

2 Arrhenatherion and Molina communities

2.1 General description of the donor sites

Project partner	**2 AREC**	**2 AREC**
Country	Austria	Austria
Type of donor community	Arrhenatherion	Molina
Use of material	Demonstration trial flood detention basin Stillbach	Demonstration trial Weißenbach/Liezen

	Experimental trial donor site Gumpenstein	Monitoring plots
Involved in Action	WP4, WP5, WP6	WP 5, WP6
Description of the site		
Location	Wels Airport (figure 7)	Weißenbach/Liezen (figure 10)
Natural landscape unit	Eferdinger basin	Flood plains of the Enns River
Longitude (° from Greenwich)	48° 18' 27" N	47°33'41" N
Latitude (°)	14° 03' 98" E	14°11'34" E
Altitude (m a.s..l.)	c. 310 m a.s.l.	c. 640 m a.s.l.
Aspect (0 °= North, 90 °=East,...)	plain	plain
Slope (%)	0 %	0 %
Use of the site	Nature reserve	Nature reserve
Extension (approx.)	1.5 ha	3 ha
Geology	Molassezone, fluvial terraces, tertiary accumulation gravel, sand, clay	northern limestone alps, Palaeozoic greywacke and crystalline schist; Werfner strata with gypsum deposits
Description of the climate		
Mean yearly rainfall (mm) 1971-2000	753,8 mm	962,2 mm
Mean rainfall in spring, summer, autumn and winter (mm)	192, 162, 344, 178	242, 271, 543, 232
Mean yearly temperature (°C) 1971-2000	8,8°C	6,7 °C
Mean date begin vegetation period (mean daily temperature 5°C for sequently fife days)	19th of March	25th of March
Mean date end vegetation period (mean daily temperature 5°C)	7th of November	4th of November
Mean length of vegetation period (days)	233	224

Climate chart 2008

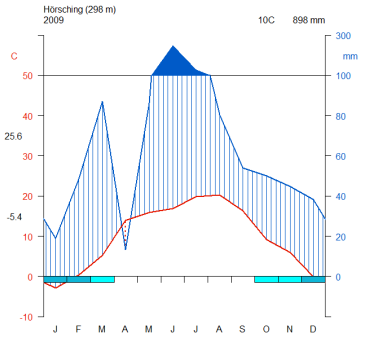


Figure 1:Weather station in Hörsching near the Welser Heide 2009

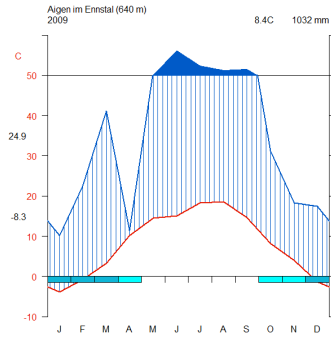


Figure 2: Weather station in Aigen/Ennstal near Weißenbach/Liezen 2009

Climate chart 2009

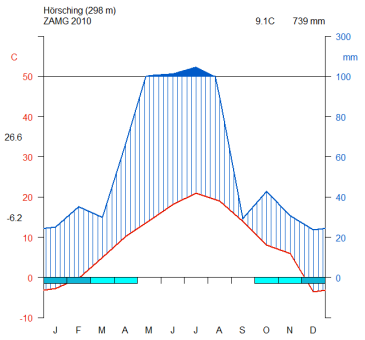


Figure 3: Weather station in Hörsching near the Welser Heide 2010

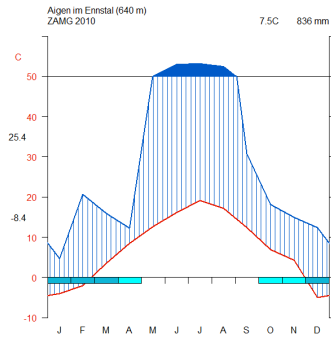


Figure 4: Weather station in Aigen/Ennstal near Weißenbach/Liezen 2010

Climate diagrams are brief summaries of average climatic variables and their time course. They have proven useful for a wide range of sciences, industry, and teaching. In bio- and geosciences, they are used as an instrument to show the relationships between soil, vegetation, and climate. The diagrams display monthly averages for temperature and precipitation over a year. Each tic mark along the horizontal line (abscissa) indicates a month. The diagrams start with January in the left corner of the diagram for the northern hemisphere and with July for the southern hemisphere respectively. Thus, the astronomic summer is always shown in the middle of the diagram. 20 mm of monthly precipitation (right ordinate) equal 10°C average temperature (left ordinate). When the precipitation curve undercuts the temperature curve, the area in between them is dotted (every 2 mm) indicating dry season. When the precipitation curve supercedes the temperature curve, vertical lines are plotted for each month (with tic marks every 2 mm) indicating moist season. A very important ecological variable is frost. The diagram shows daily average minimum temperatures below zero in black bars below the horizontal line (Heinrich Walter and Lieth Helmut 1967). The figures 1-4 show the yearly climate, the average temperature and the rainfall of the weather stations Hörsching near the donor site Welser Heide and the station Aigen/Ennstal near the donor site in Weißenbach/Liezen.

2.2 Welser Heide

The type of donor community at the donor site Welser Heide is an Arrhenatherion (poor form). The Welser Heide is situated in Upper Austria in a valley between the river Traun and the town Lambach till Hörsching (airport Linz). In earlier time the area was not fertile and consisted of dry sand and gravel fields but through hundreds of years of "Schlierdüngung", till the 18. century the plain got fertile and a lot of people started to colonize (Kutzenberger 1996). Through intensive agricultural use and the colonisation the area was almost destroyed. Only the Welser Airport with an area of app. 121 ha is the last part of semi natural grassland and the original Welser Heide. Because of the size and the special flora and fauna (rare species and red list species) it is an interesting area for the european agricultural policy. Till the end of the 1980 30 % of the Welser Airport was still in agricultural use but in the late 90ies the owner (Fliegerclub Weiße Möwe) of the airport started an environmental project. Since 1998 the whole area is free of fertilisation and is mown once a year at the end of June and the biomass will be removed. Within a couple of years the area changed from a nutrient rich and species poor meadow to a species rich Arrhenatherion community. Some red list and rare species appeared (*Dianthus carthusianorum*, *Nurmenius arquata*, *Bufo viridis*) which were extinct in Upper Austria and not found any more (Schuster, Strauch and Plasser 2006). Since 2005 a part (1 ha) of the area is used as donor site to harvest site specific seed mixtures.

Figure 5: Donor site Welser Heide June 2009

Figure 6: Donor site Welser Heide June 2010

Figure 7: Donor site Welser Heide June 2011

2.3 Weißenbach

The area is with its origin and management deeply connected with the river and the periodical floodings. The ground water fluctuations influenced by the Enns river are the main cause for the dynamics and thus the existence of this landscape. A highly complex equilibrium of natural conditions and cultural man made influences by the traditional land use of mowing as litter meadows, a high diversity both of plants and animals has developed. The hot spot of the species richness lies in the fresh and wet areas, mainly at the back waters, flood plain forests and fresh meadows between the villages of Niederstuttern and Trautenfels, at the Niderhofener Backwater

and the Leistenbach flood plain, the bog at Wörschach and its surroundings, additionally also around the district capital Liezen situated back waters, flood plain forests and fresh meadows. The bog at Wörschach is the biggest in the styrian part of the Enns valley with an area of 178 ha. Situated at the northern vicinity of the river, it is a focus in the valley, between the villages of Aigen, Wörschach, Weißenbach and Liezen and can be overseen from the higher parts of the valley (Wörschachberg, Kulm and Lassinger Mitterberg). The main part of the bog is under succession towards a heath and a forest bog. The original character has been lost following drainage, except small parts which form a nature conservation area nowadays. Fens on the western parts were also lost due to meliorisation. On the edges and old peat cuttings, a mosaic of different biotopes can be found, starting with undisturbed hollows, intermediate areas, different types of fens, meadows with *Molinia caerulea*, *Iris sibirica*, different reeds, flood plain forests, mixed with still and running waters, overall there are 15 different types of biotopes. (http://www.verwaltung.steiermark.at/cms/beitrag/10061879/2407657 (December 2010)

Figure 8: Donor site in Weißenbach/Liezen August 2009

Figure 9: Donor site in Weißenbach/Liezen August 2010

Figure 10: Donor site in Weißenbach/Liezen August 2011

2.4 Soil survey of the donor sites

Soil of the study sites Arrhenatherion was collected 2009 and 2011 and analysed in order to assess its physical and chemical properties and its fertility. On the 31st of June 2009 the soil depth on the Arrhenatherion meadow was measured 5 times on each plot (table 1). The measurement was done with a metal graduated stake up to a stone or rock. The average of soil depth in every Block is between 7 cm to 7.5 cm. Because of the history of the Welser Heide which was originally a gravel terrace landscape the soil depth is low. The Airport was partly destroyed during the 2nd World War, the gaps were refilled with construction waste.

Table 1: Results of the soil depth in block design from the donor site Welser Heide

	GH	OST	NT	OST/1	SS	Average soil depth
Block 1	7,2	7,8	7,4	7	7,8	7

Block 2	8	6,8	7,6	6,8	7	7,5
Block 3	6,4	8	7,8	7	6,6	7,5

The soil samples of the donor site Welser Heide were collected at two layers (0-10 cm and 10-20 cm) and analysed in the laboratory. In the following table the methods of the analysed parameters are described:

Table 2: Description of analysed soil parameters and used methods

Parameter	unit	discription	method	ÖNORM	extratktions
pH-value	-	pH-value CaCl2-MW		L 1083	
total carbonate	%	Kalkbestimmung			
total phosporus	mg/kg	P205 and K20 after CAL		L 1087/ L 1092	Calciumlactat, HCl
Phosphor	mg/kg	P205 and K20 after CAL	CAL Method	L 1087/ L 1092	Calciumlactat, HCl
Potassium	mg/kg	P205 and K20 after CAL	CAL Method	L 1087	Calciumlactat, HCl
Plant available magnesium	mg/kg	magnesium Schachtschabl		l 1093	
organic matter content	%	650°C TOC - carbon	dry burning	L 1080	
total nitrogen	%	total nitrogen		L 1095	
sand	%	grain size definition (3)	grain size <2000 µm - 63 µm		
gley	%	grain size definition (3)	grain size <63 µm - 2 µm		
lime clay	%	grain size definition (3)	grain size <2 µm	L 1061-2	

The results of the analysed soil parameters from the Welser Heide are in table 3. The grain size between sand and clay is around 40 % to 45 % which is in a good balance and typical for semi dry communities. Lime clay with 11 % is low. A high percentage of the grain size between <2000 µm to 63 µm has a low nutrient content, low water holding capacity, intensive soil aeration and easy machinability (Blum 1992). The pH-value is neutral to alkaline (6,3 – 7,4). The pH-value for this kind of community is in a reasonable area (Oberdorfer 2001). Phosphorus with < 20,7 mg/kg and potassium with <112,3 mg/kg are extremely low. On all variants are carbonate, the plant available magnesium and nitrogen are high for an Arrhenatherion community. The organic matter content is measured in percent and the soil is in the category strong humus (> 6,6 %) (BMLFUW 2006).

Table 3 Analysed parameters of the Arrhenatherion community Welser Heide

sample	sand [%]	gley [%]	lime clay [%]	total nitrogen [%]	total phosporus [mg/kg]	total potassium [mg/kg]	Plant available magnesium [mg/kg]	total carbonate [%]	pH-value	organic matter content [%]
GH 0-10 cm	43.15	45.15	11.75	0.66	16.00	99.33	570.00	7.97	6.92	13.57
GH 10-20 cm	43.80	43.47	12.80	0.44	13.00	49.67	416.00	12.33	7.22	8.27
OST 0-10 cm	47.40	42.00	10.60	0.67	19.33	112.33	552.67	7.93	7.01	14.33
OST 10-20 cm	42.37	41.63	12.73	0.36	13.00	39.67	321.33	22.17	7.25	6.60
NT 0-10 cm	40.10	44.45	15.45	0.66	16.67	112.00	543.67	9.23	6.98	13.77
NT 10-20 cm	45.10	42.33	12.60	0.37	8.33	47.33	343.00	19.10	7.24	6.83
OST1 0-10 cm	43.70	44.05	12.20	0.60	19.33	93.33	520.00	11.20	7.15	12.67
OST1 10-20 cm	44.83	43.23	11.93	0.39	13.00	41.33	348.33	18.37	7.36	7.27
SS 0-10 cm	44.53	45.20	10.27	0.62	18.33	98.67	523.33	8.87	7.17	12.70
SS 10-20 cm	46.40	42.17	11.43	0.43	20.67	45.00	365.67	15.70	7.34	7.90

2.5 Botanical survey

The botanical survey is the estimated total coverage of vegetation. The Sum of open ground, with rocks covered ground and the coverage of vegetation is the result of 100 percent. It is not an estimation in different levels, overestimation (more than 100%), or estimation of area percentage (Weinzierl 1917, Schechtner 1958). If the whole plot is covered with vegetation the value of the projective coverage is 100 % (Pötsch 1997). The estimation of the projective coverage is also called the “visible coverage”. The percentage of the total coverage vegetation is divided into grasses, legumes and herbs. The target species or sawn species are also estimated through the estimation of projective coverage.

2.6 Phenological survey

The BBCH code gives information about the morphological development and growing stage of plants. The code serves as scientific communications tool to answer questions of the plant development and to give information about the optimal harvesting time (Meier 2001).

Table 4: BBCH-Code

00-09	Germination, sprouting, bud development
10-19	Leaf development (main shoot)
20-29	Formation of side shoots / tillering
30-39	Stem elongation /shoot development (main shoot)
40-49	vegetative propagation / booting (main shoot)
50-59	Inflorescence emergence (main shoot) / heading
60-69	Flowering (main shoot)
70-79	Development of fruit
80-89	Ripening or maturity of fruit and seed
90-99	Senescence, beginning of dormancy

2.7 Harvesting techniques

The most differing methods for winning seed- and plant material for site-specific restoration processes have developed above all in the English- and German-speaking world in recent decades. The availability of a donor area which provides material that can be won for either direct use in restoration or for the further production of suitable material is definitely of importance (Krautzer et. al 2009). The ratio between surface donor site and surface receptor site depends on the seed production of the donor site. Therefore, for GH and OST, the extension of harvested donor site and the extension receptor site must be determined. After determination of fresh and dry weight of the different materials it is possible to calculate:

- yield per ha on the donor site
- amount of applied material per ha on the receptor site
- ratio area donor site : receptor site

The best time of harvesting was estimated through phenological surveys according to the BBCH-Code of the main species (table 5 and final report 4). On the harvesting day the weather was hot and cloudy. Based on the rain period it was humid with about 85 % humidity. The wind speed was low.

2.7.1 Not treated (NT)

On the not treated (NT) plots the data for Work package 4 were collected during the project period. After the botanical survey the plot were mown.

2.7.2 Green hay (GH)

A widespread method is the cutting of suitable donor sites at the time when most of the desired species are at an optimum stage of seed maturity. To avoid excessive losses, the material is cut preferably early in the morning when it is moist with dew and then immediately taken to the restoration area and spread there. To determine the ratio of seed production between donor site and extension receptor site one m^2 of the plot was cut and weighted. The weight for 1 m^2 green hay was about 1.5 kg. Based on experience data and the weight of the subplot the ratio donor site to receptor site was 2:1 to ensure a sufficient cover with plants and grasses on the experimental site. The size of the donor site is 30x30 m compared to the experimental site with 12x14.5 m. Finally it is to say that, the ratio 2:1 was too high. The layer on the receptor site was too thick and not all seeds could germinate. The green hay was cut with a mower, raked together, put it into big bags and transferred

by truck from Wels to Gumpenstein. On the same day the green hay was applied at the experimental site in Gumpenstein.

Figure **11**: Cut green hay plot at the Welser Heide

Figure 12: Implementation of Green hay on the experimental trial in Gumpenstein

2.7.3 On-site threshing (OST, OST/1)

A very efficient measure is the use of threshed material from suitable donor sites. Threshing takes place with an appropriately adapted combine harvester at the time of optimum seed maturity. The threshed material is subsequently dried as required and roughly cleaned. Through harvesting parts of several areas, a wide spectrum of species can be received at the right moment and stored for at least two years. On-site threshing material was harvested on the same day as green hay. The OST plots (2, 6, 13) were threshed with a CLAAS 320 Tucano thresher. The On-site threshing material was applied on the experimental trials in Gumpenstein. The variants OST/1 (4, 9, 14) were threshed with the Wintersteiger classic thresher. This material will be used to define the quantity and the quality of the seed mixture. The threshed material was dried for 3 days at room temperature. Afterwards it was roughly cleaned and analysed.

Figure 13: The CLAAS 320 Tucano thresher

Figure 14: The Wintersteiger classic thresher

2.7.4 Seed stripper (SS)

This method is used above all in North America and England without cutting the plant stand. With the aid of a rotating brush, the mature seeds are brushed from the plants into a container and the harvested material can be reused either fresh or dry. The SS-variants (5, 10, 15) were harvested with a pull-type seed stripper model no. 610, serial no. 0440806 imported from Canada (Prairier habitats Inc.) drawn by the Wintersteiger classic thresher at a speed of 3 km/h. Due to the advanced phenological stage of grasses, it was decided to fix the brush axes at 15 cm to get enough seeds from herbs, resulting in getting stems from grasses into the harvested material (see figure 16). The SS plots are harvested to test the quality of the seed mixture. The material of the seed stripper was dried for 3 days in a chamber at room temperature, weighted, roughly cleaned and analysed.

Figure 15: Pull-type seed stripper Model No. 610 imported from Canada

Figure 16: Harvested material from the pull-type seed stripper

2.8 Results of the Arrhenatherion community Welser Heide

The following diagrams and tables show the results of the botanical survey from the Welser Heide (Arrhenatherion community) and Weißenbach (species rich litter meadow). The botanical survey at the Welser Heide was done on 30th of June 2009 on every plot in a subplot of 7x7m. The subplot is in the centre of the plot to avoid border effects. A survey of the phenological stadium of the meadow was done once just before harvesting. A list of all present species was ascertained on the subplot. The Arrhenatherion community was harvested on the 1st of July 2009. The Green hay (GH) was implemented at the experimental trial in Gumpenstein right after harvesting and the on-site threshing (OST) material was sown on the 25th of August 2009 with 3 g/m^2 in Gumpenstein. The materials from the harvesting techniques OST/1 and SS were analysed in the laboratory to question if the harvesting method has any influence on the vegetation development. All harvesting trials GH, OST, NT, OST1 and SS are carried out in block design and replications in order to allow statistical analyses. The donor site is mown once a year at the beginning of July.

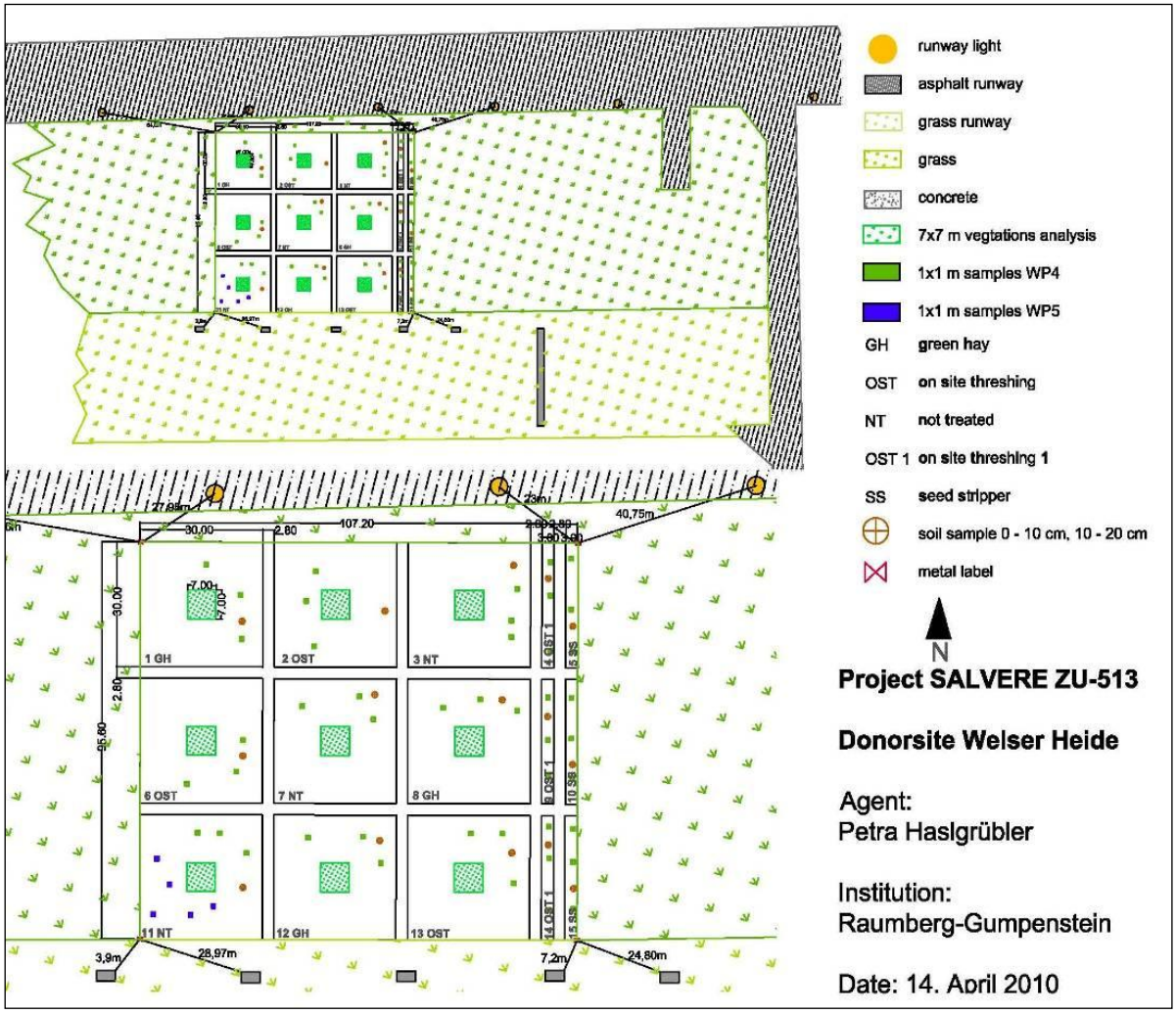


Figure 17: Map of the donor site Welser Heide

On each plot just before harvesting the phonological stage of each species was determined with the following the codes of BBCH (table 5). *Echium vulgare* was the only species which was in the category 50-59 Inflorescence emergence (main shot)/ heading. 8 species (3 grasses and 5 herbs) from the list in Table 13 are in the range 60-69 Flowering (main shoot) and developing their fruits. In the category 70-79 are 18 species (1 grass and 17 herbs) and developing their fruits. Most of the species (38) were in the category 80-89 Ripening or maturity of fruit and seed. From the 38 species 16 are grasses and 22 herbs. At the harvesting time 01 July 2009 almost all grasses were ripe. Most herbs reach maturity later and have a longer ripening time. To collect all species two harvesting dates would be recommendable. An early one in June to harvest the most of the ripe grasses and legumes and a late on in July to harvest the herbs and mix it (Hölzel and Otte 2003). In this case all species of a community would be in the mixture. The botanical survey was done on the 30th of June 2009 as described in point 2.5. Figure 18 shows the total vegetation coverage of all variants which is between 95 and 99 percent. The ratio of grasses herbs and legumes varies within the harvesting

methods because of the different share of *Salvia pratensis* and *Anthyllis vulneraria*. The part of our donor site was the most homogenous area on the Welser Heide. On the variants (GH, OST, OST/1 and SS) no significant differences are visible. The percentage of grasses is between 53 % and 58 %, herbs between 29 % and 31 % and the legumes lie between 10 % and 13 %. The variants harvested with the CLAAS 320 Tucano thresher show total % coverage on grasses between 67 % and 70 %. The percent of herbs is 22 % and 23 % and legumes are between 6 % and 8 % the lowest.

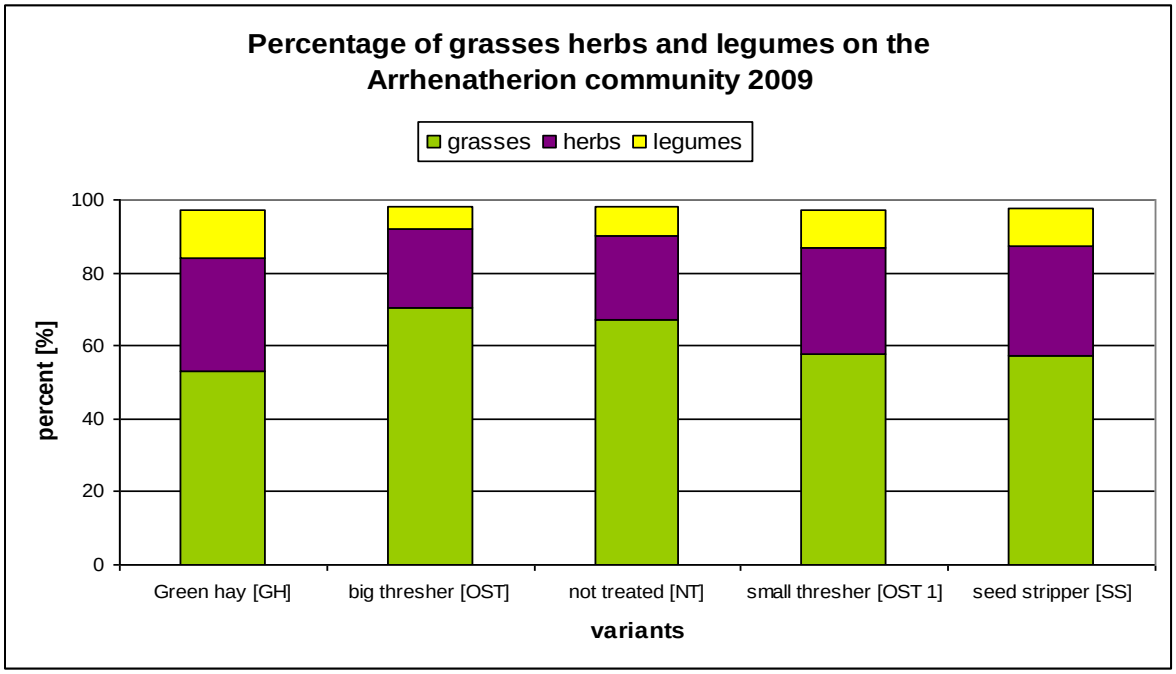


Figure 18: Results of the vegetation analysis on the Arrhenatherion community of the different harvesting techniques.

Table 14 is the species list and the results of the single species coverage (in percent) at harvesting time on the 01st of July 2009. The results are average values from 3 replicates. Targetspecies were defined through literature research (Pils 1999, Klötzli et al. 2010, Oberdorfer 2001, Adler, Oswald and Fischer 2008, Ellenberg 1996). On the whole area 63 different species were found 17 grasses, 38 herbs and 8 legumes. 30 species were encountered an all subplots. The meadow is dominated *of Arrhenatherion elatius* (~15%) *Avenula pubescence* (~14%), *Festuca rubra* (~7%), *Poa pratensis* (~6%), *Galium album* (~5%), *Salvia pratensis* (~2,5%) and *Thymus praecox* (~2%). More detail information is in table 7.

2.8.1 Lab analyses seed quantity/quality

Before harvesting subsamples in a size of 1x1 m^2 of 3 replicates were taken. The different weights and the purity of the plots are outlined in table 17. Most pure seeds were harvested with Green hay making. The disadvantage of Green hay making is that only on harvesting time is possible. As

already mentioned it would be better to mix the seed mixtures of two harvesting times to have as much as possible different seeds in the mixture. The purity of the harvesting methods OST, OST/1 and SS are at around 45 – 55 % pure seeds. In figure 19 are the weight of pure seeds compared to the used harvesting methods in kg ha^{-1}.

Table 5: Harvested seeds of different harvesting methods on the Arrhenatherion community

average weight - harvesting plots - donor site

	plot size [m^2]	fresh biomass [kg]	dry biomass [kg]	after first cleaning [g]	chaff [kg]	pure seeds [kg]	**pure seeds [g/m2]**	**pure seeds [kg /ha]**	chaff [%]	pure seeds [%]
GH	900	1282	255	-	1211.0	71.0	**11.440**	**114.40**	94.46	5.54

	plot size [m^2]	fresh biomass [kg]	dry biomass [kg]	after first cleaning [g]	chaff [g]	pure seeds [g]	**pure seeds [g/m2]**	**pure seeds [kg /ha]**	chaff [%]	pure seeds [%]
OST	900	-	9950	9950	5486	4464	**5.010**	**50.10**	55.1	44.9
OST1	90	2597	1377	1083	473	610	**6.780**	**67.80**	43.7	56.3
SS	90	1350	776	384	179	205	**2.303**	**23.03**	46.7	53.4

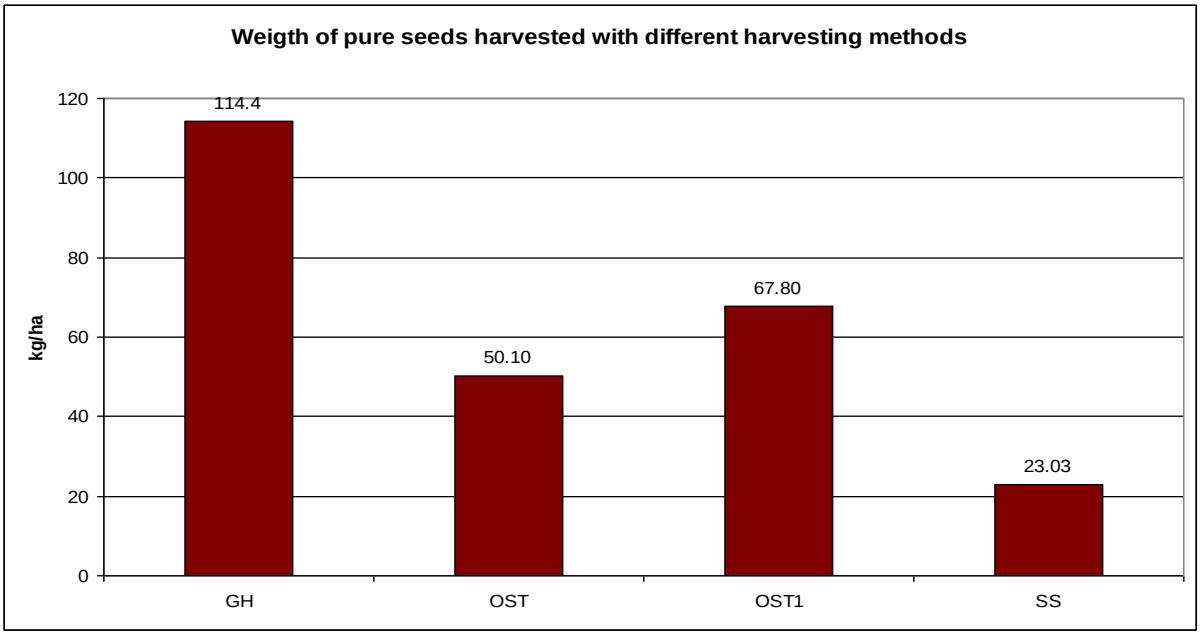


Figure 19: Size and average weight of harvested plots with the described harvesting methods in kg/ha on the Arrhenatherion community

2.9 Results of the donor site species rich litter meadows at Weißenbach/Liezen

The species rich litter meadows are situated northwest of the golf course and south of the railway station. S1 is a *Molinia caerulea* rich litter meadow, S2 is a tall sedge swamp and S3 an *Iris sibirica* rich litter meadow. The litter meadows are mown once a year. The *Iiris sibirica* rich litter meadow is integrated in the golf course and was established in the 90ies through Bernhard Krautzer (Lutzmann 2008). The threshed materials from the meadows (Figure 23) were used to establish and recultivate a new area near the golf course in Weißenbach/Liezen.

The material was harvested 2005 and the receptor sites were established 2006. During the summer 2009 botanical survey were done and subsamples with the Wintersteiger classic thresher and the pull type seed stripper were taken. S1 the *Molina caerulea* rich litter meadow and S3 the *Iris sibirca* rich litter meadow were harvested in the middle of September. The botanical survey was done in three replicates in a size of 7x7 m, as in figure 21 shown.

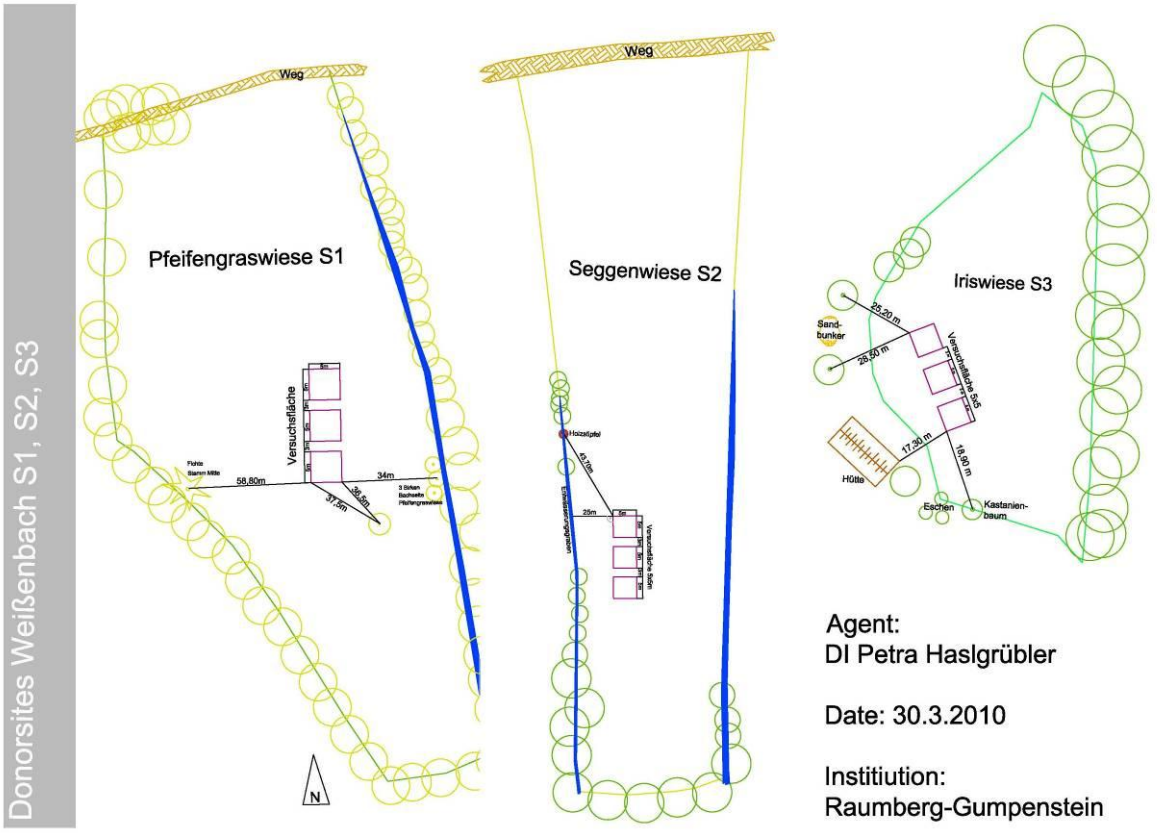


Figure 20: Map of the donor site Weißenbach/Liezen

The botanical survey was done on the 17th of August 2009 as in point 4.1 described. On each plot the total coverage of the whole vegetation was estimated and divided into grasses, legumes and herbs. The single coverage in percent of each species was visually estimated. A species list of all each plot was created (table 16). The following diagram shows the results of the first botanical survey 2009.

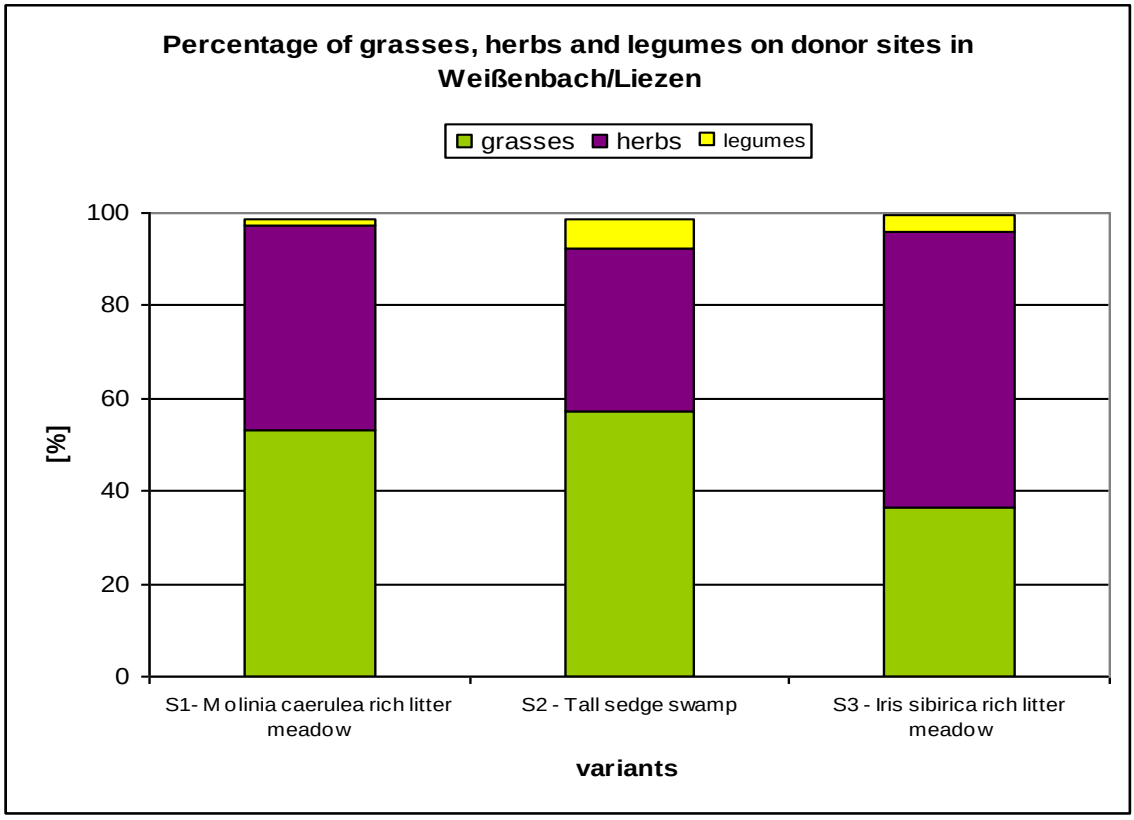


Figure 21: Results in percent of grasses herbs and legumes ratio 2009 in Weißenbach/Liezen

In figure 22 the total vegetation coverage on all meadows (S1 = *Molinia caerulea* rich litter meadow, S2 = Tall sedge swamp, S3 = *Iris sibirica* rich litter meadow) achieves almost 100 %. The ratio between grasses, herbs and legumes varies according to the different litter meadows. S2 has the highest percentage on grasses with 58 %. S3 has the highest percent on herbs with 60 %. S1 shows the lowest percentage on legumes with 2 %. Altogether 102 different species were observed on all meadows. From the 102 species were on S1 45 species on S2 69 species and on S3 68 species encountered. The litter meadows in the Ennstal valley are species rich and host a lot of red list species. In the first Colum are the target species which are important for calculation of the transmission rate to implement new HNV-areas.

2.9.1 Lab analyses seed quantity/quality

The species rich litter meadows are sown by a farmer and also managed by him. The tall sedge swamp was mown on 25th August 2009 and the *Molina caerulea* rich litter meadow and the *Iris sibirica* rich litter meadow were mown on the 15th September 2009. Subsamples of the harvesting method OST1 and SS were taken at the end of August, dried and stored under different conditions (room temperature, cooling chamber and freezer). The weight and the purity analysis were done in the laboratory and outlined in Table 17.

Table 6: Size and average weight of harvested plots on the Molina caerulea meadow S1 and the Iris sibirica meadow S3 in Weißenbach/Liezen

	size [m^2]	variant	moit mass [g]	dry mass [g]	after 1st cleaning [g]	**pure seeds [g]**	**chaff [g]**	**pure seeds [%]**	**chaff [%]**
S3	22.5	OST1	3106.7	1366.7	1050.6	**434.0**	**616.6**	**41.3**	**58.7**
	27	SS	1040.0	473.3	236.6	**152.1**	**84.5**	**64.3**	**35.7**
S1	22.5	OST1	973.3	493.3	388.5	**164.6**	**223.9**	**42.4**	**57.6**
	27	SS	470.0	253.3	130.3	**86.4**	**43.9**	**66.3**	**33.7**

3 Harvesting costs

It is not possible to have general costs for harvesting and implementation of semi natural grassland because there are a large number of options. In any case it's important to have an early, good and technical draft. It is also important to calculate the production costs and the follow up cost in the whole costs calculation. The costs vary in allowance of harvesting method, meadow type, distance donor-receptor site, side preparation and implementation method.

In the following report Green hay, on site threshing and seed stripping are calculated, via literature recherché and personal experiences (Greimel et al. 2003, Stehle and Schick 2011, Schubert 2009, Kirmer and Tischew 2006b). The calculation was done for an Arrhenatherion community. In the calculation are the working hours, needed machines and personal costs (ÖKL 2009) on the donor site considered but not the transport from the donor site to the receptor site. The implementation of the material isn't considered as well. A lot of preparation before harvesting has to be regarded. In the following figure the most important parameters are described (Kirmer and Tischew 2006b).

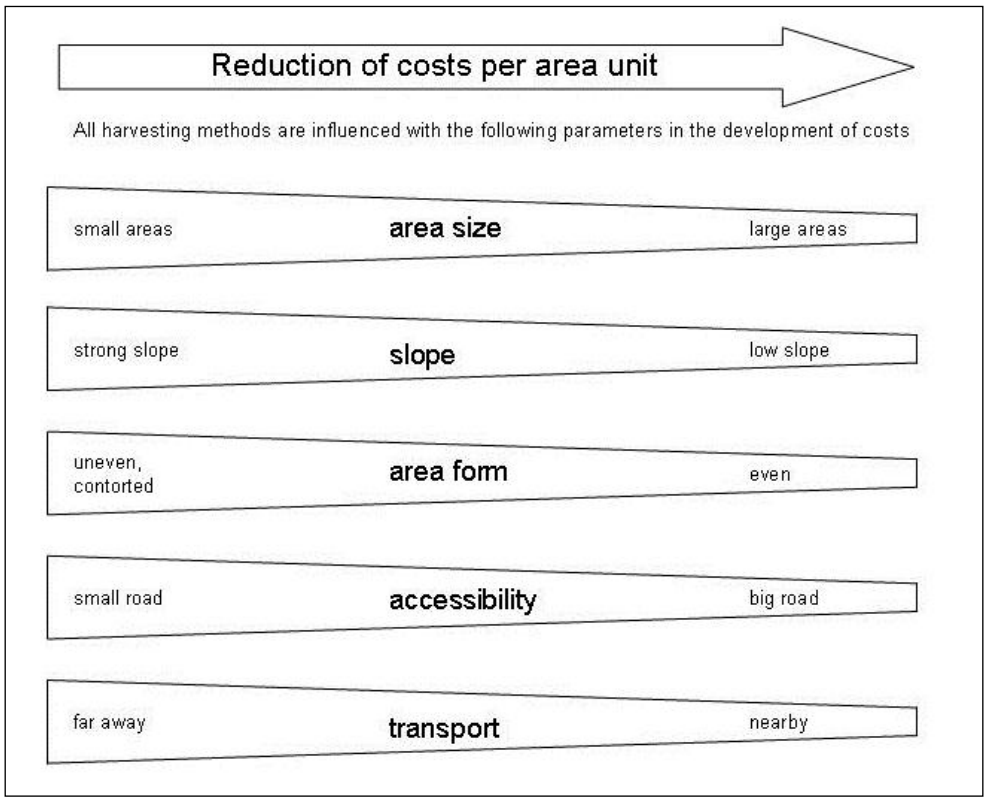


Figure 22: Development of harvesting costs in order of important parameters (Kirmer et. at. 2006)

3.1 Harvesting costs

The harvesting costs in table 18 are prizes from the ÖKL Homepage 2009. All used machines are listed, for the different harvesting methods. Working hours are included in the calculation. Green hay is listed twice because a smaller area is cheaper harvested by a hand mower than with a double rotary mower. On-site threshing is calculated with the CLAAS 320 Tucano thresher and the Wintersteiger Calssic thresher. In table 8 are the calculated harvesting costs for different harvesting methods which were used. The calculation for Green hay is not. For drying and cleaning 220 €/ha are calculated. The prices are only harvesting costs and no costs for quality parameters (purist, thousand seed weight, and germination capacity) are included.

Table 7: List of the harvesting costs per unit on the Arrhenatherion meadow Welser Heide

Costs of different Harvesting Methods						
Type of Community: Arrhenaterion community Welser Heide		OST/1	SS	OST	GH	NT
Harvesting date		01.Jul.09	01.Jul.09	01.Jul.09	01.Jul.09	01.Jul.09
Size of harvested surfaces	m2	90	90	900	900	900
Harvesting time per harvesting trail	min/ha	70	60	35	?	no data available
Raw weight of harvested propagation material	kg/ha	120.33	42.66	111	128200	
Pure seed obtained	kg/ha	67.80	23.03	50.1	114.4	
Raw weight of harvested propagation material	t/ha	0.12033	0.04266	0.11055	128.2	
Costs per unit harvested surface	€/ha	390.38	306.83	343.12	?	
Costs per unit harvested weight of raw propagation material	€/t	3244.24	7192.45	3103.75	?	
Transport overall per kg	€/kg	0,20	0,20	0,20	0,20	
Costs per unit harvested raw prop. Materia	€/kg	3.24	7.19	3.10	?	
Costs per unit harvested pure seed	€/kg	5.76	13.32	6.85	?	
Costs per unit harvested pure seed	cent/m2	0.058	0.133	0.068	?	
Manipulations costs						
Drying per ha		€ 150/ha	€ 150/ha	€ 150/ha	€ 150/ha	
Cleaning per ha		€ 70/ha	€ 70/ha	€ 70/ha	€ 70/ha	

4 Harvesting effects

The botanical survey at the Welser Heide was done on 30th of June 2009, on the 06th of July 2010 and on the 22th of June.2011 on every plot in a subplot of 7x7m. The subplot is in the centre of the plot to avoid border effects. The botanical survey is the estimated total coverage of vegetation is divided into grasses, legumes and herbs. The target species are also estimated through the estimation of projective coverage.

4.1 Researchquestion

Is there a statistical significant influence on vegetation structure and species composition due to the different harvesting methods applied, over a period of three years, in comparison to a not treated variant?

4.2 Material and Methods

The analyses were done with the statistics language R (R Development Core Team 2011), especially with functions provided by the "vegan" package (Oksanen et al. 2011). The first procedure applied is a non-parametric test of the general multivariate hypothesis of differences in the composition and/or relative abundances of organisms of different species (variables) in samples from different groups or treatments, implemented via the "adonis" function in R. It partitions dissimilarities for the sources of variation, and uses permutation tests to inspect the significances of those partitions. "Adonis" is analogous to multivariate analysis of variance, specially designed for ecological data; it studies the differences in the group means. It has significant advantages on previous methods because it can be based on any measure of dissimilarity and can partition variation directly among individual (Anderson 2001).

The specific analysis applied was based on the Jaccard dissimilarity index, which is the recommended index with quantitative data to find ecological gradients (Oksanen et al. 2011).

Additionally, to check the results, an analysis of homogeneity of groups and beta diversity was performed with the "betadisper"-function, also found in the "vegan"-package. The "betadisper"-function studies the differences in group homogeneities. β-diversity is defined here as the slope of the species-area curve, or the exponent z of the Arrhenius model where the number of species S is dependent on the size X of the study area. For pairwise comparison of sites the slope z can be found from the number of species shared between two sites (a) and the number of species unique to each sites (b and c). In general, β-diversity is taken as the parameter to show what makes assemblages of species more or less similar to each other (Anderson et al. 2011). The significance of the model was analysed using standard parametric ANOVA and the Tukey HSD Test (Tukey multiple comparisons of means - Tukey's 'Honest Significant Difference' method). (Oksanen et al. 2011).

The analysis was done in three steps:

- The complete dataset (all relevés of the different treatments) was separated following the treatments and for each treatment an analysis was done with "adonis", the different years and plot (replicate) as dependent variables.
- After that, an analysis of the complete dataset was done, with "treatment", "year" and "single plot" (replicate) as variables, stratified that randomizations happen only within each treatment.
- Finally, β-diversity as a measurement of change in time was analysed and compared.

4.3 Results

4.3.1 Results of multivariate ANOVA, separated by treatment (adonis)

Table 8: Results of the statistical analysis separated by treatment

Not treated (null variant):

	Df	SumsOfSqs	MeanSqs	F.Model	R^2	P r(>F)
year	2	0.26776	0.133882	1.70607	0.33898	0.050 *
plot	1	0.15530	0.155296	1.97896	0.19660	0.038 *
year:plot	2	0.13143	0.065715	0.83741	0.16639	0.649
Residuals	3	0.23542	0.078474		0.29804	
Total	8	0.78991			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

Green Hay

	Df	SumsOfSqs	MeanSqs	F.Model	R^2	P r(>F)
year	2	0.23956	0.119781	2.10348	0.36249	0.003 **
plot	1	0.14701	0.147014	2.58172	0.22245	0.001 ***
year:plot	2	0.10347	0.051734	0.90851	0.15656	0.638
Residuals	3	0.17083	0.056944		0.25849	
Total	8	0.66088			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

On-site threshing

	Df	SumsOfSqs	MeanSqs	F.Model	R^2	P r(>F)
year	2	0.25998	0.129989	1.15447	0.27322	0.303
plot	1	0.20199	0.201988	1.79391	0.21228	0.043 *
year:plot	2	0.15177	0.075884	0.67395	0.15950	0.875
Residuals	3	0.33779	0.112596		0.35500	
Total	8	0.95152			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

On-site threshing 1

	Df	SumsOfSqs	MeanSqs	F.Model	R^2	P r(>F)
year	2	0.21019	0.105093	1.8156	0.31549	0.031 *

plot	1	0.19673	0.196726	3.3986	0.29529	0.001 ***
year:plot	2	0.08565	0.042823	0.7398	0.12856	0.826
Residuals	3	0.17365	0.057884		0.26066	
Total	8	0.66621			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

Seed stripper

	Df	**SumsOfSqs**	**MeanSqs**	**F.Model**	**R^2**	**P r(>F)**
year	2	0.31711	0.158553	1.69178	0.36752	0.055
plot	1	0.17276	0.172762	1.84340	0.20023	0.081
year:plot	2	0.09180	0.045901	0.48977	0.10640	0.981
Residuals	3	0.28116	0.093719		0.32586	
Total	8	0.86283			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

Comparison: Complete dataset (adonis):

	Df	**SumsOfSqs**	**MeanSqs**	**F.Model**	**R^2**	**P r(>F)**
year	2	0.7988	0.39942	5.1833	0.16962	0.001 ***
treatment	4	0.7781	0.19453	2.5244	0.16522	0.001 ***
plot	1	0.2813	0.28134	3.6510	0.05974	0.001 ***
Residuals	37	2.8512	0.07706		0.60541	
Total	44	4.7095			1.00000	
Signif. codes: 0 '*' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1**						

4.3.2 Results for the analysis of the homogeneity of groups (betadisper)

Here, homogeneity of group dispersions (variances) was analysed: Non-euclidean distances between objects and group centroids are handled by reducing the original distances to principal coordinates. This procedure been used as a means of assessing beta diversity (Oksanen et al. 2011).

Table 9: Average distance to centroid

Green Hay	**On-site threshing**	**Not treated**	**On-site threshing 1**	**Seed Stripper**
0.2100	0.2199	0.2416	0.2009	0.2497

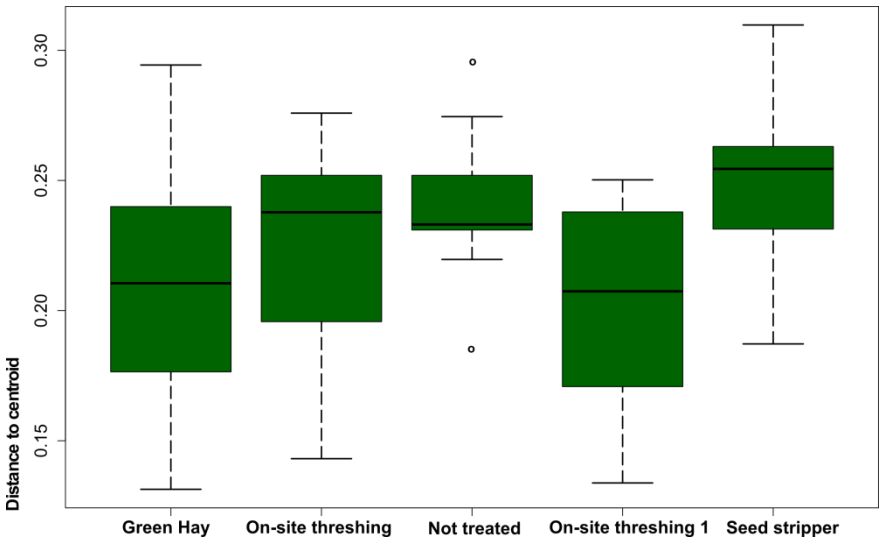


Figure 23: The distribution of ecological distances of different relevés from the group centroid for the different treatments, representing the within group variance; no statistical significant difference could be found – see also figure 2.

The following table shows the comparisons of means between the not treated and the other variants, as a result from a Tukey HSD Test, the values of the comparisons between the different harvesting methods (treatments) were omitted for better readability:

Tukey multiple comparisons of means; 95% family-wise confidence level

Fit: aov(formula = distances ~ group, data = df)

Table 10: Results oft he Tukey HSD Test

	Diff	**lower**	**upper**	**p adjusted**
NT - GH	0.031530737	-0.026651059	0.08971253	0.5385410
NT - OST	0.021690869	-0.036490926	0.07987267	0.8232189
OST1 - NT	-0.040681007	-0.098862803	0.01750079	0.2860028
SS - NT	0.008136546	-0.050045250	0.06631834	0.9944177

No statistical significant differences were found.

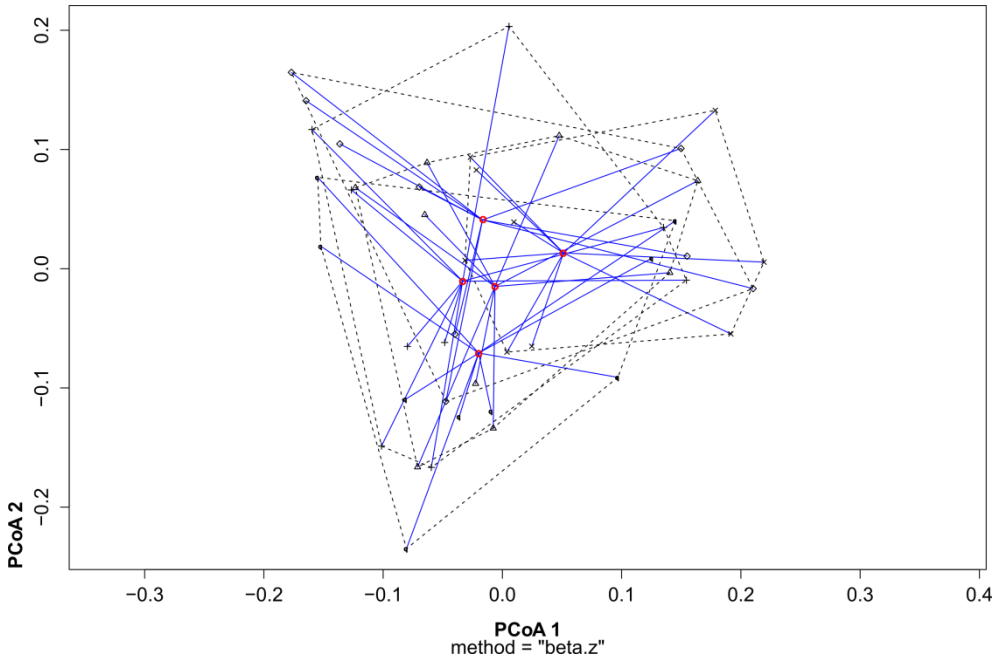


Figure 24: Principal Coordinate Analysis with β-diversity as distance matrix, showing the differences between the different treatments; the centroids of each are marked as red circles: no statistical difference can be found, see also figure 1.

On a first observation, the analysis gives inconclusive results: mostly only weak statistical significance, no real pattern can be observed. Most of the variance comes from the different plots (replicates) itself, R^2 of the different treatments for the variable "plot" lies around 0.2 and is also statistical significant, except on the "seed striper" – variant. Even the results from the "not treated" (null variant) plots show significant differences within the plots, and also during the years. The last result hints that there are no biological significant interactions between harvesting methods applied and species composition and vegetation structure.

5 Seed separation and Conservation

The harvesting methods considered will be OST1 and SS. The seed separation into single species will be done with laboratory seed cleaning machinery and afterwards by hand. The Assessment of the seed separation, the purity assessment and the 1000 seed weight (TSW) and the germination capacity, will be done under controlled conditions following the International Rules of Seed Testing Association (ISTA 2009) and the defined methods by the SALVERE Team.

Workflow from threshing - seed separation to conservation

1. Thresher two shaking sieves in different sizes

2. Drying in the air chamber by cold/hot air - not over 37°C because of germination capacity
3. Intermediate storage in the cooling chamber with 2-5°C and 40% humidity
4. Depending on the weight; cleaning with the right machine
5. Taking a homogenous sample
6. Testing the purity, TSW, germination capacity of a sample
7. Storage in the Freezer (-20°C), cooling chamber (2-5°C, 40-50 % humidity) or in a barn (10-20 °C).

5.1 Drying of the harvested material

At AREC the harvested material will be dried with hot or cold air. Hot air should not be higher than 37°C because afterwards the germination capacity of the seeds will be destroyed. Under normal conditions the material will be dried by room temperature for at least three days. It depends on the moisture and the amount of the harvested material.

Figure 25: Drying of the harvested OST1 material by room temperature

Figure 26: Drying of harvested SS material by room temperature

Figure 27: The drying system with hot/cold air at AREC

5.2 The Machines to clean seed samples in small and big fractions

At AREC different cleaning machines are available. The variety of machines with different sieves is important because different seeds have different demands. The following chapter will describe the machines which are used at the Agricultural and Education Research and Educations centre.

5.2.1 Röber Mini-Petkus

The MINI-PETKUS has been designed as a laboratory machine; it meets all requirements of a modern seed cleaning machine, performing all necessary functions. The built-in fan provides a large air volume for the suction in the vertical main aspiration. The sieves are cleaned by means of an automatic vibrator unit. Efficient operation and compactness result from the built-in indented cylinder arrangement. Also very quick and easy changed of the indented cylinders. Only a

extremely short time required for changing type of sorting to suit change in varieties or grains. All grading operations are clearly visible when the machine is in operation and can be adjusted quickly and easily if required. The machine is self- emptying within a very short period of time. The machine is manufactured in standard units – separate items such as deawner, indented cylinder and support table can be added as required. The support table is equipped with a holder for interchangeable sieves. The grading result is in correspondence with that achieved in practical operation with a high- capacity seed cleaner and grader. The RÖBER MINI-PETKUS therefore is the ideal machine for use in laboratories of scientific institutes, seed breeding and testing stations (Baumann Saatzuchtbedarf 2008).

Figure 28: Röber mini pectus from the company Baumann

Figure 29: Detail of the two sieves on the Röber mini pectus

5.2.2 Seed cleaner for small samples – SCHLINGMANN

The small sample cleaner SCHLINGMANN was developed with a feeding pipe with flap, wooden catch container with plastic pane and ventilator with switch and transformator for infinitely variable air stream. The seeds are put in the feeding channel. Depending on the desired cleaning intensity of the seeds it is possible to regulate the air stream speed of the ventilator with the transformator or by opening the flap of the feeding pipe. The heavy seeds fall down through the feeding pipe; the lighter seeds go in the wooden container, where they can be removed by the drawer (Baumann Saatzuchtbedarf 2008).

Advantages

- constant stream of material
- variable, adjustable
- with adjustable funnel
- maintenance- free, CE- conform

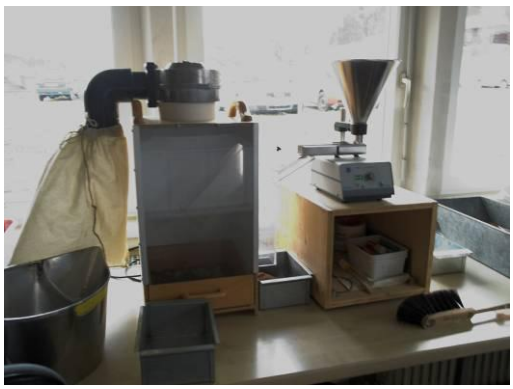


Figure 30: Seed cleaner SCHLINGMANN for smal samples

Figure 31: Detail of the seed cleaner SCHLINGAMNN

5.2.3 Air separator

The "Saugluft- Stufensichter" type 2 (small type) and type 3 (bigger type) are suitable for plant breeding stations where exact wind separation is required. Separation into 1st (heavy), 2nd (medium) and 3rd (light) grade is done. The infinitely adjustable air separation enables in many cases fine sorting out of germinating and not germinating seeds and grains. The "Saugluft- Stufensichter" works exclusively with air separation and is equipped with a vibration feeder as accessory or a big plastic funnel, permitting a proportionate filling-in of the material. The front side of both machines is covered with easily removable windows, which permit the observation of the grading process in the uniflow air channel. Even in case of fine seeds there is no danger of mixing. It has to be considered that the capacity is dependent on the soiling of the seed and the cleaning result required. Strictly speaking, the most important effect of these machines is not to reach a high capacity per hour, but to achieve exact cleaning results by simultaneous elimination of the danger of mixing of seeds or grains (Baumann Saatzuchtbedarf 2008) (figure 32).

Figure 32: Air separator

Figure 33: The Universal Thresching machine

5.2.4 „ALLESDRESCHER“ Universal Threshing Machine

This Machine is suited for threshing and grating of cereals, clover and grass, vegetable legume and other seeds. The threshing process takes only a few seconds. The “Allesdrescher” work fast and is easy to operate. Large, detachable windows at the front side of the threshing drum and of the precision-air-separator permit observation of the threshing and the separation process and give full survey into the interior of the threshing drum and the separator. There is no damage to seed and grains because of smooth walls and rubber like beaters; correctly chosen threshing baskets (for very sensitive material rubber baskets) and infinitely adjustable speed control. No mixing of seeds and grains because steep walls prevent leftover seeds and grains, and large detachable windows permit observation of the threshing drum and the separator. Hundred percent yield of threshing because the material remains in the threshing drum until completely threshed out. No loss of seeds and grains because all seeds and grains get into the separator through the openings of the threshing basket (Baumann Saatzuchtbedarf 2008) (figure 33).

5.2.5 The Cimbria Delta 100-Series

The Cimbria Delta Super cleaners ensure excellent efficiency and purity in the cleaning all kinds of crops such as garden seeds, grass seeds, flower seeds, corn, leguminous seeds etc. It is easy to operate with it because all adjustments are placed at a suitable height and all operating handles are on the same side as the outlets. The air Lifting channel eliminates light seeds in the variable expansion chamber. Chaff, dust etc. are led with the airflow to the after suction system. The air lifting sieve screen forces the product under passage to turn its biggest surface against the air flow

in order to obtain optimal separation. The air Lifting Unit is capable - by means of staggered fans and air guides – of giving a completely uniform air pressure from beneath the product when it leaves the cleaner. The finished product has a high quality because it is clearly illustrated by the difference between the cleaned seed/product and the discarded light product over the air lifting system (www.cimbria.com/files/CAS_brochure_cleaner_GB.pdf) (figure 34).

Figure 34: The Cimbria delta cleaner type 101

Figure 35: A Retsch sieve

5.2.6 Retsch separations sieves

RETSCH analytical sieve shakers are used in research and development, quality control and production monitoring. Main areas of application are Chemicals, coal, coffee, fertilizers, fillers, flour, metal powders, minerals, sand, seeds, soils, washing powder, cement clinker. The patented electromagnetic drive of the sieve shakers AS 200 control, AS 300 control and AS 450 control produces a 3-D throwing motion which ensures optimum use of the open sieve area and lets the sample move equally over the whole sieving surface. These instruments feature digital amplitude adjustment which allows for sharp fractionizing of the sample even after very short sieving times. All sieve shakers of the series “control” come with an inspection certificate and can be calibrated. (www.retsch.de/de/produkte/sieben/analysensiebe) (figure 35).

5.3 Taking a sample and seed separation by hand

When taking samples, a sufficiently large and representative seed sample has to be taken from the entire harvest. Within the sample, every component (pure seeds, undesired species, chaff) should be at the same ratio as found in the batch. The validity of the seed assessment results is decisively dependent on the care undertaken when taking the sample. The quantity of a representative sample is related to the entire harvest volume and is defined according to ISTA (2011). Taking samples

manually is the most suitable method for seed with bad seed flow. The containers from which the first samples are taken are to be selected randomly or systematically from the entire batch. The first samples are to be taken from the top, middle and bottom of the containers. To acquire samples from the bottom of a sack, it may be necessary to completely or partly empty a certain number of sacks. If the first samples appear to be uniform, they are then tipped into a clean container and mixed at the end of sampling. Part samples are gained from repeated halving of the mixed samples. Care must be taken that the seed do not become unmixed through stirring (AGES 2004, Hebeisen and Graff 2008, ISTA 2009, ISTA 2011).

Figure 36: Sieving by hand

Figure 37: Chaff of the seed stripper material

Figure 38: Seeds of the seed stripper material

Figure 39: seed separation in the laboratory with binocular microscope and hand lenses

Figure 40: seed separation in the laboratory with a pair tweezers

5.4 Purity assessments and 1000 seed weight

The composition and quality of green hay, dry hay, stripped material or on-site threshing material differs greatly from year to year. The share of chaff and impurities, such as earth, can be very high. Stalks and leaves should be roughly cleaned from the dried material before storage and spreading. A sieve with a mesh size of 3-6 mm is recommended. If the seed mixture contains larger and bulky seeds, the mesh size of the sieve used is to be according to the size of the largest seed. A homogenous sample, as described above, has to be taken from the cleaned material. The chaff and seeds are separated in the laboratory and the individual components of the seed mixture are defined. This will require 3-6 working days according to the type of meadow. Determination of the purity of the harvested seed and plant materials is important to ascertain the volume of pure seeds

that are contained in the material, which then defines the actual sowing volume of the entire material. For determination of the thousand-seed weight, four times 100 randomly selected pure seeds are counted and weighed. A homogenous sample is decisive for achieving a uniform result (ISTA 2011).

5.5 Storage of the harvested material

The assessment of the storage influence on the germination capacity will be done by storing on-site threshing, seed stripping material and the pure seed under different temperatures, cooling chamber 2-5 °C and 40-50% humidity, freezer -18 °C and under room temperature between 15-20 °C. The assesments of seed germinability will be done after one and two years of storage. The germination capacity of the seed mixtures will be tested in the Greenhouse.The nine most common species of the Arrhenatherion meadow were separated from the seed mixture and stored under room temperature and in the cooling chamber. The species stored under room temperature were tested 2010 and 2011 one and two years after harvesting. The samples stored in the cooling chamber were tested 2011 two years after harvesting.

5.6 Germination capacity tests - Jacobsen Germination apparatus and greenhouse

The Jacobsen apparatus mainly consists of a germination plate being temperature-conditioned by means of the water basin below. The water bath is equipped with an automatic temperature control. The germination spirals being equipped with a paper substrate which is placed on the germination plate. The wick is being led through slots in the germination plate and reaches into the water bath below, thus supplying the required humidity and the desired temperature to the paper substrate. The circular filter papers are covered with a transparent or dark cover dome to provide the air humidity being required for the germination. A small hole in the upper end of the dome ensures sufficient supply of fresh air and minimum evaporation at the same time. Units being executed with active cooling allow day-night temperature alternation, as well as any temperature profile (ISTA 2009). There is no prescribed method for the determination of the germination capacity of seed mixtures harvested from meadows. Therefore, a method was developed within the scope of the SALVERE project and existing literature for previous successfully applied germination treatments (Heilinger and Florineth 2003, Molder 2008, ISTA 2009, Godefroid, Van de Vyver and Vanderborght 2010) to gain sufficiently valid statements about the seed potential of a harvested donor site within a clear period of time, and with limited technical and personnel expenditure. After determination of the purity, TSW and the pre-tests in the Phytotron (Haslgruebler, Krautzer and Graiss 2011) the

greenhouse trials were implemented and a specific volume (about 3-5 g/m^2 of pure seeds) was sown in four bulb trays on seeding soil. The four samples were counted once a week and divided into monocotyledone and dicotyledone seedlings. The duration of the trial was 4-6 weeks. It was also tested if storage over two years at differing temperatures and the effect of pre-chilling for one week has an influence on the germination capacity. The germination trial was done for an Arrhenatherion and an *Iris sibirica* rich litter meadow.

Figure 41: Jacobsen apparatus

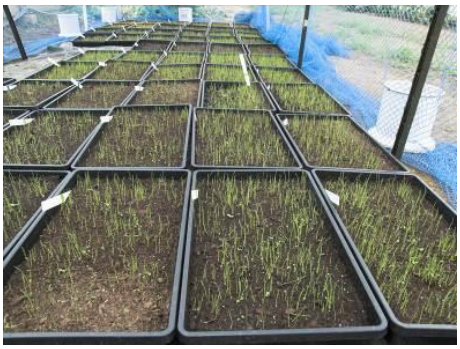


Figure 42: Germination in the Greenhouse

5.7 Results of the seed separation

The seed production of plants and the biomass of a meadow stock are dependent on the course of precipitation- and temperature during the year. Thus, harvesting time and harvested volume are dependent on the weather prevailing during the respective vegetation period (Krautzer et al. 2003). Especially with dry- and semidry types of meadows, early harvesting in June means that the percentage share of grasses is higher, while a harvest carried out in July or August increases the share of herbs (Hölzel and Otte 2003). It would generally be desirable to mix an early and late harvest to cover the greatest possible spectrum of species. Species number and the composition of the harvested material are strongly dependent on the type of meadow. A harvesting date set too early or too late can lead to the disappearance of several plants (Kirmer and Tischew 2006a). With moist or alternating types of one cut meadows, the optimum harvesting time is between middle of August and middle of September. In this respect, it is usually a case of valuable nature-conservation areas, which cannot be mown before a set date. In Austria, for example, it is not permitted to mow litter meadows, which are defined as NATURA 2000 areas, before the beginning of September.

Table 11: Share of grasses and herbs, harvested volume of pure seeds, TSW and length of the harvest with different harvesting methods and meadow types during harvesting (2009)

community type	**Harvesting method**	**Harvest time**	**Seed : chaff [%]**	**Grasses : forbes [%]**	**Pure seeds [kg/ha]**	**TSW [g]**
Arrhenatherion meadow	On-site threshing (plot thresher) (OST)	End of June	60:40	80 : 20	60 - 150	1,04
	Seed stripping (SS)	End of June	55:45	80 : 20	20 - 60	0,84
Species rich litter meadows	On-site threshing (plot thresher) (OST)	September	40:60	10 : 90	40 - 120	0,94
	Seed stripping (SS)	September	60:40	10 : 90	10 - 60	1,83

After the harvested seed material was roughly cleaned the purity was determined. The purity from species rich litter meadows varied depending on the harvesting method. The share of pure seeds for stripped seeds was 65% and for on-site threshing 40%. On Arrhenatherion meadows the content of pure seeds was between 50-60%. The thousand seed weight of harvested seed material varied and depended on the seed size, seed weight and amount of different species in the mixture. The actual number of seeds in the stripped material or on-site threshing is dependent on various factors, such as the type of meadow, management ($1^{st}/2^{nd}$ cut), time of day during harvesting, harvesting time in the course of the year, weather conditions and potential seed production. In figure 44 are the seeds m^{-2} shown. With the harvesting method on-site threshing around 7000 seeds m^{-2} were harvested compared to the seeds stripper with 2400 seeds m^{-2}. In both variants more grasses than forbs or legumes are harvested, because of the harvesting time. The Arrhenatherion meadow was harvested at the 1^{st} July 2009, at this time around 80 % grassed and 20 % forbs were mature. Figure 45 show the harvested seeds/m^2 on a species rich litter meadow rich in *Iris sibirica*. The meadow was harvested at the end of August. In this case the percentage of forbes is higher with 90 %. The amount of harvested seeds with the thresher is more effective and is around 2500 seeds m^{-2} in comparison with the seed stripper were 400 seeds m^{-2} harvested. On both meadows more seeds were harvested with the thresher because not mature seeds were harvested as well. Seeds are able to ripe afterwards in the drying chamber where the material is dried. The seed stripper only harvests the mature seeds which easily brush out of the plant (Scotton et al. 2009).

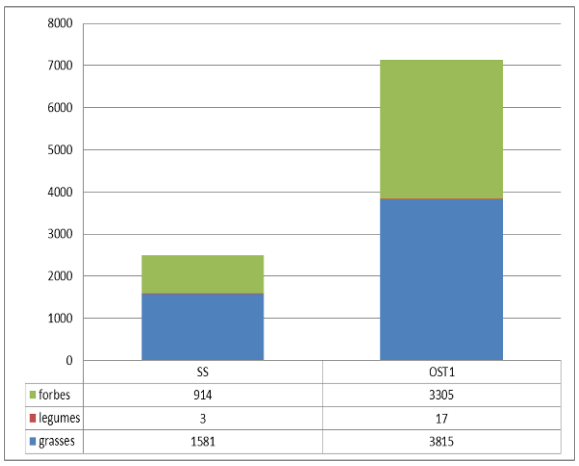


Figure 43: Seeds m^{-2} harvested with the seeds stripper (SS) and the thresher (OST/1) on the Arrhenatherion community

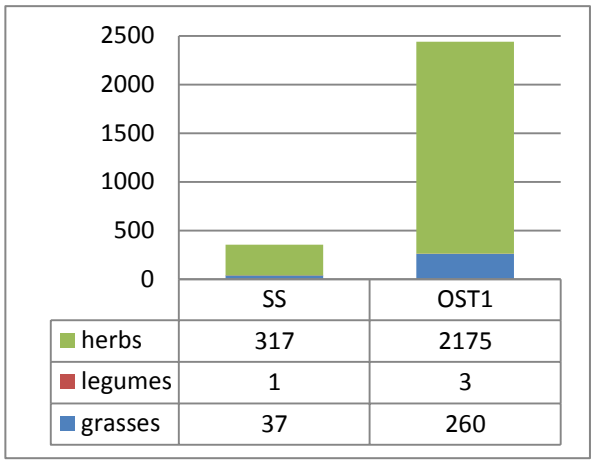


Figure 44: Seeds m^{-2} harvested with the seeds stripper (SS) and the thresher (OST/1) on the species rich litter meadow, rich in *Iris sibirica*

5.8 Results of the germination capacity

5.8.1 Single species

In Figure 46 and 47 are the results of the germinations capacity of single species harvested with seed stripping and on-site threshing. The tested species are *Arrhenatherhum elatius, Avenula pubenscens, Bromus erectus, Dacylis glomerata, Dianthus carthusianorum, Festuca pratensis, Poa pratensis, Salvia pratensis* and *Trisetum flavesens*. The main result is that four species (*Avenula pubenscens, Bromus erectus, Dianthus carthusianorum* and *Salvia pratensis)* lost half of the germination capacity after the storage over two years either if they are stored under cool or warm conditions. The other five species didn't show any significant differences. The germination capacity results of on-site threshing are higher compared to seeds stripping. Only *Festuca pratensis* reached the 80 % threshold with both harvesting methods.

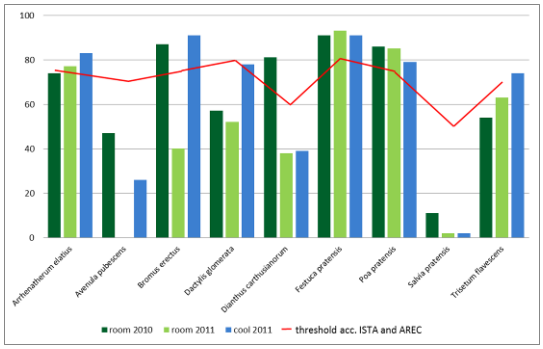


Figure 45: Results of the germination rate of single species stored over two years harvested with the seed stripper

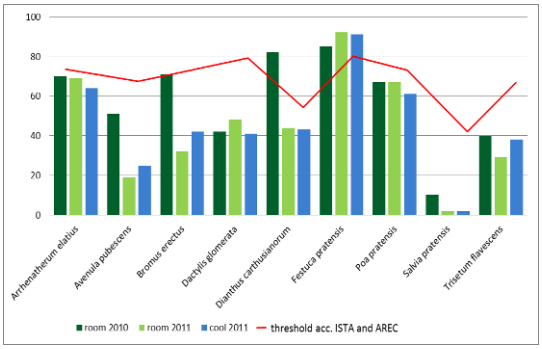


Figure 46: Results of the germination rate of single species stored over two years harvested with the plot thresher

5.8.2 Harvested seed mixtures

The results of the germinations trials on Arrhenatherion meadows showed that pre-chilling, the storage under different conditions and the length of storage had a big influence on the germination capacity. The reason for counting in monocotyledone and dicotyledone was because of the inhomogeneity of the harvested material. The dormancy breaking treatment pre-chilling had a decreasing effect on seeds of Arrhenatherion meadows. Even the second year showed the variants without pre-chilling had a higher germination capacity. The storage under different temperatures had a big influence in the germination capacity. The results displayed that the material stored under cool conditions reveal a higher capacity (over 50%) also in the second year. The samples stored under room temperature achieved results fewer than 50 % germination capacity after the second year.

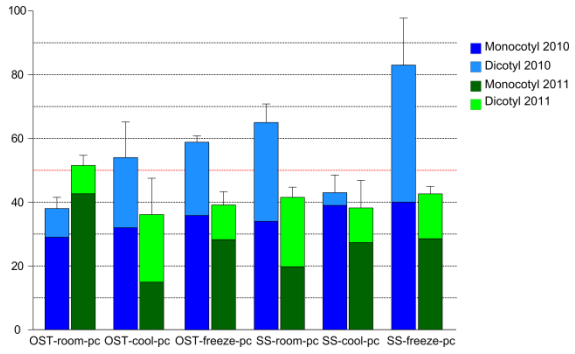


Figure 47: Germination capacity (%) of an Arrhenatherion meadow stored under different temperatures for one (2010) and two (2011) years with dormancy breaking treatment pre-chilling. (Source Blaschka)

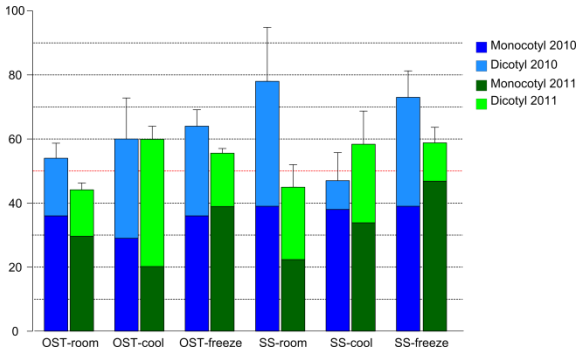
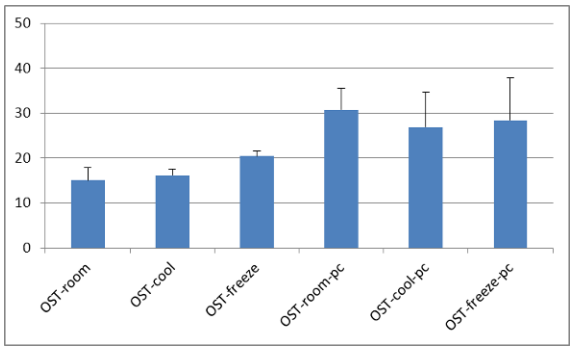


Figure 48: Germination capacity (%) of an Arrhenatherion meadow stored under different temperature for one (2010) and two (2011) years. (Source Blaschka)

The seed material from the *Iris sibirica* rich litter meadow reached a lower germination capacity than the seeds from the Arrhenatherion meadow. The different storage temperatures had no significant influence on the germination capacity but the effect of pre-chilling turned out a higher germination capacity on the seeds material from species rich litter meadows.



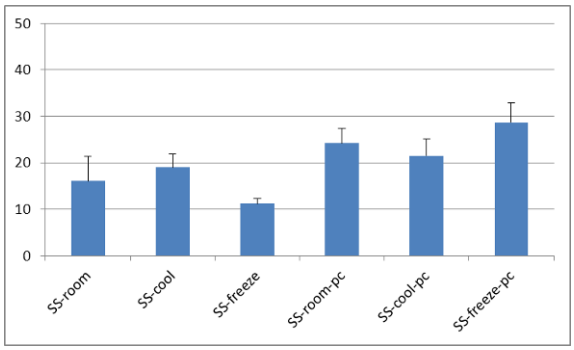


Figure 49 - 50 Germination capacity (%) of an *Iris sibirica* rich litter meadow stored under different temperature conditions for one year with and without pre-chilling

6 Conclusions

The used harvesting methods of a potential donor sites show an effective way to harvest seed mixtures for the restoration of semi-natural grasslands. The harvested material contained 40-60% of pure seeds depending on the meadow type. The TSW depends on different facts like seeds size, species composition and so on. If samples have a higher proportion of grasses the germinations capacity is higher. Species rich litter meadows react positively to pre-chilling because most of the species are frost germinators (Graiss, Krautzer and Blaschka 2009) weather seeds from Arrhenatherion meadows show a lower germination capacity. In our germination trial, most of the seeds germinated within the first two weeks, allowing the conclusion that an observation period of four weeks was sufficient. Storage under different temperatures over two years has a big influence on the germination capacity. The storage under cool conditions reveals better results and the material can be stored longer, at least for two years. In fact of the inhomogeneity of the material the results of the trials show that the method which was used is practicable and recognisable. Four of the most common species in the Arrhenatherion community lost half of the germination capacity.

The harvesting time varies between the harvesting methods. Most seeds m^{-2} were harvested with the Wintersteiger classic thresher. The highest price was obtained with the seed stripper but also the lowest amount of harvested seeds. We can say that the seeds stripper is most expensive harvesting method but the acquisition costs are lower than for a thresher. It is always depending if the machine is available. By now no seed stripper is available in Austria, but a thresher can be rented. These prices are guide numbers and should show tendency and how much it could cost. The prices are also varying from year to year and case to case.

The site where the trial was set up is not homogeneous and as an extensive, almost not managed, meadow it is a dynamic system where stochastic, short-term changes are to be expected. In conclusion, the harvest of plant material from the site, independently of the method applied, caused no changes in species composition or vegetation structure during the project period. Due to the relatively small sample size and short project duration, evidence for the validity of the results in the long-term has yet to be shown. Therefore it is important to mention, if more than three to five harvests in a row are planned, a close monitoring is still necessary.

After two years of implementation the restoration success of the experimental and the demonstrations trial are satisfying. The transfer rate after two years of implementation of the Arrhenatherion community is between 30% and 50 % depending on the implementation method. The transfer rate of target species is between 55% - 60%. The total vegetation cover lies between 70% - 90%. The species rich litter meadow was implemented in 2006 and after 5 years the transfer rate is between 34% - 50%. The transfer rate of target species is between 50% - 60 % and the total

vegetation cover is around 90%. The results show the restoration success. In our case it was very important to deep plough the experimental trial because of this treatment the pressure of unwanted weeds was not as high as assumed.

To guarantee a fast vegetation development on receptor sites and a protection against erosion, a minimum germination capacity of 50 % should be used as quality criteria for directly harvested seed mixtures. The results presented confirm that Green hay, on-site threshing and seed stripping of potential donor sites are an effective way to harvest seed mixtures for the restoration of semi-natural grasslands.

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8 Annex

8.1 Arrhenatherion community

Table 12: Results of the phenological stage according to the BBCH-code

species		range
Echium vulgare	56	50-59 Inflorescence emergence (main shoot) / heading
Thymus praecox	61	60- 69 Flowering (main shoot)
Agrostis gigantea	65	
Securigera varia	65	
Sedum sexangulare	65	
Achillea millefolium agg.	67	
Apera spica-venti	69	
Medicago falcata	69	
Hypericum perforatum	69	
Galium album	70	70-79 Development of fruit
Lotus corniculatus	71	
Galium verum	71	
Trifolium campestre	72	
Convolvulus arvensis	72	
Euphorbia esula	73	
Phleum pratense	75	
Galium pycnotrichum	75	
Plantago media	75	
Potentilla sterilis	75	
Sanguisorba minor	75	
Veronica chamaedrys	75	
Veronica serpyllifolia	75	
Vicia cracca	75	
Foeniculum vulgare	76	
Pastinaca sativa	76	
Pimpinella major	76	
Plantago major	79	
Elymnus repens	81	80-89 Ripening or maturity of fruit and seed
Trifolium pratense	81	
Centaurea jacea	81	
Centaurea stoebe	81	
Daucus carota ssp.carota	81	
Rumex acetosella	81	
Bromus erectus	85	
Dactylis glomerata	85	
Medicago lupulina	85	
Trifolium repens	85	
Fallopia arvensis	85	
Knautia arvensis	85	
Plantago lanceolata	85	
Bromus sterilis	87	
Festuca pratensis	87	
Festuca rubra	87	
Poa annua	87	
Silene vulgaris	87	
Anthoxanthum odoratum	89	
Arrhenatherum elatius	89	
Avenula pubescens	89	
Bromus hordeaceus	89	
Festuca rupicola	89	
Poa trivialis	89	
Poa angustifolia	89	
Poa pratensis	89	
Trisetum flavescens	89	
Anthyllis vulneraria	89	
Campanula patula	89	
Cerastium holosteoides	89	
Dianthus carthusianorum	89	
Leontodon hispidus	89	
Leucanthemum vulgare agg.	89	
Myosotis sp.	89	
Orobanche sp.	89	
Rhinanthus sp.	89	
Salvia pratensis	89	
Taraxacum officinale	89	

Table 13: Species list, target species and single coverage in percent of the Arrhenatherion community Welser Heide

botanical survey 2009	target species	GH	OST	NT	OST/1	SS
Achillea millefolium		2.9	4.1	11.3	6.7	2.3
Acinos arvensis		0.6	0.6	0.7	0.8	0.7
Agrostis gigantea			4.0	2.0		
Anthoxanthum odoratum	x	0.3				
Anthyllis vulneraria	x	1.5	0.8	1.0	2.2	2.0
Arrhenatherum elatius	x	17.1	14.3	13.2	15.6	12.1
Avenula pubescens	x	10.5	14.6	17.1	11.3	10.3
Bromus erectus		2.5	3.0	2.0	5.8	6.2
Bromus inermis	x				2.0	2.0
Bromus sterilis			2.0	0.3		0.6
Campanula patula	x		0.3			
Centaurea jacea	x	1.5	0.9	1.0	1.3	1.0
Centaurea stoebe		1.0	0.3	1.0	0.7	2.0
Cerastium holosteoides				0.7		
Convolvulus arvensis		1.0		0.3		1.1
Dactylis glomerata	x	2.3	2.0	2.7	2.7	3.3
Daucus carota	x	1.0			1.0	
Dianthus carthusianorum	x	2.3	1.2	1.7	1.7	1.7
Echium vulgare			0.8		0.7	0.3
Elymus repens				1.5		
Erigeron annuus					0.7	
Euphorbia esula		2.0	1.0	1.0		1.0
Fallopia sp_		0.3				
Festuca pratensis	x	4.0	4.7	4.0	3.3	4.0
Festuca rubra		6.0	8.3	8.3	7.0	6.0
Festuca rupicola	x	3.0	5.3	4.3	1.7	2.3
Foeniculum vulgare		0.3			0.7	0.3
Fragaria sp_				0.3		
Galium album	x	6.7	4.8	3.8	6.7	5.6
Galium verum		1.0			1.0	1.0
Hypericum perforatum					1.0	1.0
Knautia arvensis	x	1.0	1.0	1.7	1.0	1.0
Lamium amplexicaule						
Leontodon hispidus	x			2.0	2.0	1.0
Lotus corniculatus		2.2	3.0	1.0	1.5	1.0
Medicago falcata		1.7	8.0	1.2	1.7	1.0
Medicago lupulina	x	1.0		1.0	0.3	0.6
Mentha sp_					0.3	
Pastinaca sativa	x	2.0	2.0		1.0	1.3
Phleum pratense	x	2.0	1.1	2.0	1.1	0.8
Pimpinella major	x	0.4		1.0		
Plantago lanceolata	x	0.9	0.8	1.3	1.7	1.3
Plantago media			0.7			0.7
Poa angustifolia		2.0	2.0	3.0	1.0	1.0
Poa annua		0.3				
Poa pratensis	x	4.7	9.2	8.0	6.0	8.5
Potentilla erecta		1.1	1.5	0.6	0.3	
Potentilla recta						3.0
Rhinanthus sp_					0.3	0.7
Rumex acetosella		1.0		0.3		0.3
Salvia pratensis	x	4.7	2.0	3.2	3.3	4.6
Sanguisorba minor		0.6		0.3	0.7	
Securigera varia		4.3	1.0	2.7	2.6	3.4
Sedum sexangulare		1.0	1.0		0.7	1.0
Silene vulgaris		1.3	1.2	1.0	1.3	2.0
Taraxacum officinale			0.7			
Thymus praecox		2.7	2.0	1.4	2.0	2.3
Trifolium campestre		1.7	1.5	1.5	0.9	0.9
Trifolium pratense	x	2.3	1.7	1.2	1.3	1.3
Trifolium repens		0.7	1.3	1.0	1.0	1.5
Trisetum flavescens	x	2.0	1.7	1.3	2.3	2.0
Veronica chamaedrys	x	1.0	0.7	0.5	1.0	1.0
Veronica serpyllifolia			0.3	0.4		0.3

Table 14: Results of the seed separation from different harvesting methods; Arrhenatherion meadow Welser Heide

Seed separation Welser Heide	GH			OST			SS			OST/1			
species	%	g/m²	diaspores/m 2	%	g/m²	diaspores/m 2	%	g/m²	diaspores/m 2	%	g/m²	diaspores/m2	1000 grain weight all
Alopecurus pratense	0.001	0.002	9							0.016	0.002	2	0.50
Anthoxanthum odoratum	0.001	0.002	5	0.014	0.002	3							0.44
Arrhenatherum elatius	2.984	5.708	1809	8.610	0.945	324	21.08	0.973		16.643	2.385		3.03
Avenula pubescens	0.262	0.587	319	0.695	0.075	49	1.61	0.066	36	7.751	0.459	316	1.66
Bromus erectus	0.267	0.737	174	3.292	0.369	90	6.81	0.2389	92	5.117	0.965	266	3.64
Bromus inermis				0.298	0.033	7	0.96	0.0592	26				3.63
Dactylis glomerata	0.262	0.449	524	0.989	0.109	138	1.49	0.072	89	1.774	0.247	362	0.79
Festuca pratensis	0.529	0.942	599	3.655	0.401		3.34	0.122	81	4.672	0.439	243	1.63
Festuca sp.	0.352	0.704	1031	4.657	0.512	633	5.39	0.215		7.753	0.565	829	0.72
Poa annua	0.000	0.000	4										0.10
Poa pratensis	0.116	0.217	1172	1.683	0.185	912	2.22	0.103		0.815	0.090		0.19
Trisetum flavescens	0.051	0.108	565	0.232	0.025	100	1.17	0.052		0.521	0.065	314	0.22
grasses	**4.83**	**9.46**	**6210**	**24.13**	**2.656**	**2254.53**	**44.07**	**1.90**	**324.10**	45.061	5.216	564	
Anthyllis vulneraria	0.071	0.1986	73	0.491	0.0524	14	0.066	0.0023	1	0.864	0.054	14	3.37
Lotus corniculatus	0.013	0.0284	22	0.092	0.0105	11	0.020	0.0009	1				1.10
Medicago lupulina	0.075	0.1214	107	0.135	0.0147	11	0.068	0.0022	2	0.042	0.004	3	1.25
Securigera varia				0.060	0.0064	2							3.00
Trifolium badium				0.014	0.0015	4							0.35
Trifolium campestre				0.006	0.0007	2							0.30
Trifolium pratense	0.011	0.0219	19	0.114	0.0125	8	0.078	0.0027	2	0.016	0.003	4	1.20
Trifolium repens	0.001	0.0014	3	0.020	0.0022	4	0.020	0.0007	1	0.030	0.006	12	0.65
Vicia sp.	0.014	0.0297	9	0.070	0.0081	2							3.48
legumes	**0.18**	**0.40**	**232**	**1.00**	**0.109**	**58.72**	**0.25**	**0.01**	**6.27**	0.952	0.067	10	**10.51**
Achillea millefolium				0.035	0.004	31	0.002	0.000	1	0.024	0.002	22	0.11
Arabis hirsuta				0.020	0.002	17							0.13
Campanula patula				0.003	0.000	21				0.002	0.000	8	0.02
Capsella bursa-pastoris	0.000	0.000	3	0.002	0.000								0.10
Centaurea jacea				0.038	0.004	2				0.028	0.001	2	1.30
Cerastium arvense				0.088	0.010	73				0.009	0.002	18	0.11
Cerastium holosteoides	0.002	0.005	62										0.08
Dianthus carthusianorum	0.104	0.208	353	1.072	0.119		0.579	0.020	18	0.467	0.045	75	0.75
Euphorbia sp.	0.004	0.009	26										0.35
Galium sp.	0.491	1.139		17.077	1.904	3969	7.557	0.340		8.693	1.267	2991	0.45
Hypericum quadrangulum							0.138	0.004	44				0.10
Knautia arvensis	0.014	0.032	7	0.140	0.015	3	0.143	0.005	2	0.214	0.026	6	4.25
Leontodon hispidus				0.024	0.003	3							0.80
Leucanthemum vulgare				0.010	0.001	2							0.50
Matricaria chamomilla				0.002	0.000	2							0.10
Myosothis				0.026	0.003	10				0.006	0.001	7	0.21
Plantago lanceolata	0.001	0.003	4	0.005	0.001	2				0.002	0.000	1	0.34
Ranunculus acris				0.329	0.037	11	0.198	0.006	3	0.062	0.006	2	2.95
Reseda lutea				0.028	0.003	7							0.47
Rumex crispus				0.022	0.002	2							1.10
Salvia nemorosa				0.127	0.014	45	0.040	0.002	5	0.089	0.009	34	0.30
Salvia pratensis	0.076	0.176	156	0.654	0.073	72	0.250	0.012	12	0.843	0.094	88	1.05
Sanguisorba minor				0.105	0.012	5				0.131	0.011	2	3.50
Serratula tinctoria				0.009	0.001	1							1.40
Silene vulgaris	0.001	0.002	4	0.106	0.012	26	0.107	0.006	12	0.161	0.021	45	0.51
Taraxacum officinale										0.008	0.001	1	0.80
Thymus praecox				0.008	0.001	5				0.003	0.001	8	0.12
Veronica chamaedrys				0.035	0.004	18				0.022	0.005	29	0.18
Veronica sp.	0.002	0.003	4				0.002	0.000	2				0.42
Viola arvensis	0.002	0.006	16										0.37
unbekannt 1	***0.003***	***0.004***	***7***	***0.06***	***0.006***	***22***	***0.01***	***0.000***	***3***	***0.02***	***0.005***	***8***	***0.41***
unbekannt 2				***0.10***	***0.012***	***60***	***0.19***	***0.006***					***0.20***
unbekannt 3				***0.02***	***0.002***	***2***	***0.01***	***0.000***	***1***				***0.68***
unbekannt 4				***0.006***	***0.001***	***2***							***0.30***
herbs	**0.70**	**1.58**	**635**	**19.97**	**2.246**	**4327.01**	**9.02**	**0.39**	**102.20**	**10.76**	**1.50**	**3349**	
all seeds	**5.71**	**11.44**	**7077**	**45.09**	**5.011**	**6640.27**	**53.34**	**2.303**	**432.57**	**56.78**	**6.78**	**3923**	
chaff	**94.29**	**201.96**		**54.91**	**6.05**		**46.66**	**1.97**		**43.224**	**5.253**		
whole sample [g]	**100**	**213.40**		**100**	**11.06**		**100**	**4.27**		**100**	**12.03**		

8.2 Species rich litter meadows Weißenbach/Liezen

Table 15: Species list, target species and single coverage in percent of the litter meadows S1, S2, S3

	target species	S1 = Molinia caerulea rich litter meadow	S2 = Tall sedge swamp	S3 = Iris sibirica rich litter meadow
grasses [%]				
Agrostis capillaris			1.00	1.00
Agrostis gigantea				1.65
Agrostis stolonifera			0.30	
Alopecurus geniculatus				0.87
Anthoxanthum odoratum			0.57	
Avenula pubescens			0.67	
Briza media			2.67	
Carex flava	1	1.67	2.33	0.30
Carex lepidocarpa	1	6.00	1.33	
Carex pendula	1	3.00	3.67	
Carex riparia	1		0.30	0.67
Carex sp.		1.00	10.30	3.00
Dactylis glomerata				2.00
Deschampsia cespitosa	1		1.23	
Elymus repens				1.33
Festuca pratensis			1.15	0.40
Festuca rubra			1.43	3.70
Glyceria fluitans			0.30	2.33
Holcus lanatus			0.53	
Juncus arcticus			2.33	
Juncus articulatus	1	2.00	6.23	
Juncus effesus	1		2.67	
Juncus inflexus			3.67	
Lolium perenne				3.00
Molinia caerulea	1	21.33	5.67	1.77
Phalaris arundinacea				0.30
Phleum pratense	1	2.00	3.67	6.23
Phragmites australis			0.65	
Poa pratensis			1.10	2.67
Poa trivialis			0.30	3.00
legumes [%]				
Scirpus sylvaticus	1	24.23	5.33	4.33
Lathyrus pratensis	1	1.00	1.43	2.57
Lotus corniculatus		0.50	1.17	
Lotus pedunculatus	1			0.75
Medicago lupulina			0.50	
Trifolium hybridum			1.43	
Trifolium pratense			0.77	
Trifolium repens			0.77	
Vicia cracca		0.40	0.60	0.60
herbs [%]				
Achillea millefolium		1.35		3.00
Aegopodium podagraria		0.70	1.10	0.43
Alisma plantago-aquatica				0.30
Angelica sylvestris	1	2.33	2.90	1.15
Artemisia vulgaris				1.00
Caltha palustris		0.30	1.10	
Cardamine pratensis	1		0.30	0.70
Carum carvi		3.00	3.33	
Centaurea jacea	1	2.67	0.77	1.87
Cerastium holosteoides			0.30	
Cirsium arvense				4.33
Cirsium oleraceum	1	1.33	1.43	2.33
Cirsium palustre	1	1.00		0.30
Equisetum palustre	1	0.53	1.03	
Eupatorium cannabinum			1.00	0.30
Euphrasia sp.	1		0.43	
Filipendula ulmaria	1	3.33	2.70	5.00
Galium palustre	1	1.15	2.00	0.30
Galium sp.		0.85		3.33
Galium verum			0.30	0.30
Geranium sp.	1	0.77	0.70	0.70
Glechoma hederacea		0.30		0.30
Hypericum sp.		0.30		
Hypericum tetrapterum			0.70	
Iris sibirica	1	15.90	3.13	20.93
Leucanthemum vulgare			2.33	
Lychnis flos-cuculi	1		0.50	
Lysimachia nummularia			1.00	
Lysimachia vulgaris	1	1.10	0.67	3.33
Lythrum salicaria	1	2.00	2.50	1.43
Mentha aquatica		0.30	0.50	0.57
Myosoton aquaticum			0.30	0.30
Pedicularis sylvatica				0.10
Peucedanum palustre	1	1.67	1.43	0.30

Table 16: Results of the seed separation from different harvesting methods; species rich litter meadows Weißenbach /Liezen

species rich litter meadows: 27.08.2009	Iris litter meadow						Molinion litter meadow						
	OST/1			SS			OST/1			SS			
species	[%]	g/m2	diaspores/m 2	[%]	g/m2	diaspores/m 2	[%]	g/m2	diaspores/m 2	[%]	g/m2	diaspores/m 2	1000 grain weight
Agrostis capillaris	0.053	0.017	153				0.010	0.002	24	0.129	0.0067		0.09
Alopecurus geniculatus	0.002	0.001	3										0.30
Anthoxantum oderaturm				0.001	0.00	1							
Carex flava							0.041	0.005	8	0.005	0.0002	1	0.66
Carex pendula							0.032	0.005	5	0.008	0.0004	1	1.08
Carex sp.							0.380	0.043	43	0.003	0.0001	1	0.70
Dactylis glomerata	0.055	0.026	38	0.012	0.001	2	0.011	0.002	1				1.08
Elymus repens	0.475	0.208	47	0.376	0.031	8							4.11
Festuca rubra	0.045	0.019	19	0.000	0.003	3							0.90
Festuca sp.				0.023	0.002	3				0.022	0.0010	1	0.90
Glyceria fluitans				0.025	0.002	2							0.95
Juncus articulatus				0.007	0.000	18	0.001	0.000	3	0.001	0.0000	5	0.02
Juncus inflexus							0.664	0.073		1.757	0.0906		
Molinia caerulea				0.011	0.050	31	13.827	1.697	1318	14.444	0.6677	560	1.36
Phleum hirsutum Honck	0.001	0.129	1294	1.071	0.049	90							0.32
Phleum pratense	0.620	0.135	406				0.111	0.016	33	0.021	0.0011	2	0.45
Poa pratensis	0.290	0.047	231	0.070	0.001	10							0.15
Scirpus sylvaticus							0.019	0.002	40	0.026	0.0013	23	0.06
grasses	**0.630**	**0.271**	**260**	**1.60**	**0.14**	**37**	**15.09**	**1.84**	**1474**	**16.41**	**0.77**	**594**	**6.20**
Lathyrus pratensis				0.156	0.012	1	0.915	0.121	13.191	0.2367	0.0123	1	10.90
Lotus corniculatus							0.019	0.002	2.418				0.93
Medicago lupulina	0.002	0.001	3										
legumes	**0.002**	**0.001**	**3**	**0.16**	**0.01**	**1**	**0.93**	**0.12**	**15.609**	**0.24**	**0.01**	**1**	**8.48**
Achillea millefolium							0.003	0.0005	0	0.0040	0.0002	2	0.10
Angelica sylvestris	0.093	0.038	25	0.081	0.025	12	3.597	0.4712	1	6.3207	0.2912	147	1.72
Caltha palustris							0.301	0.0272	2				1.74
Centaurea jacea							0.755	0.1117	2	1.8107	0.0849	48	1.83
Cirsium arvense	0.241	0.122	135	0.105	0.008	9							0.91
Cirsium oleraceum	0.042	0.018	6				0.023	0.0035	2	0.0653	0.0034	2	2.29
Filipendula ulmaria	20.569	9.123		21.374	1.567		2.905	0.3921	678	3.3613	0.1659	312	0.56
Galeopsis speciosa	0.059	0.028	9	0.027	0.002	1							2.49
Galium palustre							0.127	0.0138	22				0.63
Galium sp.	0.717	0.318	651	0.294	0.015	24	0.130	0.0152	47	0.0580	0.0029	4	0.53
Iris sibirica	18.595	8.342	834	40.285	2.875	246	16.935	2.2300	225	36.5787	1.7342	177	10.35
Lysimachia vulgaris	0.215	0.107	441	0.019	0.001	3							0.33
Mentha arvensis	0.001	0.000	3										0.10
Mentha longifolia	0.001	0.001	6										0.10
Peucedanum palustre							0.831	0.1114	84	0.2520	0.0104	7	1.36
Pimpinella major	0.100	0.045	36	0.311	0.020	16	0.284	0.0405	28	0.2540	0.0128	8	1.38
Potentilla erecta							0.001	0.0002	1				0.20
Prunella grandiflora							0.010	0.0016	2				0.75
Ranunculus acris	0.013	0.006	3				0.030	0.0034	2	0.0180	0.0007	1	1.62
Rumex acetosa	0.013	0.006	9										0.67
Silene dioica				0.002	0.000	1							0.30
Stachys officinalis	0.019	0.010	10	0.011	0.001	1	0.321	0.0339	49	0.9393	0.0461	47	0.97
Thalictrum lucidum				0.027	0.002	3	0.025	0.0038	4				0.80
unbekannt	0.005	0.003	7	0.007	0.000	1.00	0.060	0.005					0.75
herbs	**40.68**	**18.16**	**2175**	**62.54**	**4.52**	**317**	**26.3384**	**3.47**	**1148**	**49.66**	**2.35**	**755**	
all seeds	**41.31**	**18.44**	**2438**	**64.29**	**4.67**	**355**	**42.37**	**5.43**	**2638**	**66.31**	**3.13**	**1350**	
chaff	**58.69**	**25.96**		**35.71**	**2.59**		**57.63**	**7.390**		**33.69**	**1.59**		
whole sample [g]	**100**	**44.40**		**100**	**7.26**		**100**	**12.82**		**100**	**4.72**		

Table 17: Calculated costs from the ÖKL Homepage in August 2009

Variante 1 Green Hay					
Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
standard tracotr with rear wheel drive 60 kW (82 PS)	21.14	0.00	10.00		31.14
double rotary mower 165 cm	8.28				8.28
self-loading bale trailer - 6 cutsites 20 m³ (13,1 m³ after DIN)	20.35		10.00		30.35
10% addition green hay self-loading bale trailer					3.04
harvest / apply the green hay from 2 persones		20.00			20.00
Total price for 1 €/h GH	49.77	20.00	20.00		**92.81**

Variante 2 Green Hay					
mower 5,8 kW (8 PS)	27.08	10.00			37.08
standard tractor with rear wheel drive 60 kW (82 PS)	21.14		10.00		31.14
trailer to transfer t/h oneaxialdumper 25 km/h 5,0 t	5.20				5.20
harvest/ upload / apply the green hay 2 persones		20.00			20.00
other costs					0.00
Total price for 1 €/h GH	53.42	30.00	10.00		**93.42**

On Site Threshing					
Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
harvester-thresher incl. chopper 60 kW (82 PS)	127.03		10.00		137.03
fourwheel tractor with rear wheel drive 120 kW (163 PS)	48.78		10.00		58.78
trailer to transfer t/h oneaxialdumper 25 km/h 8,0 t Tandem	9.53				9.53
drying				150.00	150.00
cleaning				70.00	70.00
storage bigpack 3 months					20.00
other costs					0.00
Total price for 1 €/h OST	185.34	0.00	20.00	220.00	**445.34**
Total price for 1 €/ha OST	108.12	0.00	15.00	220.00	**343.12**

Not Treated (hay making)					
Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
standard tractor with rear wheel drive 60 kW (82 PS)	21.14		10.00		31.14
trailer to transfer t/h oneaxialdumper 25 km/h 5,0 t	5.20				5.20
mulch per ha					0.00
other costs					0.00
Total price for 1 €/h NT	26.34	0.00	10.00	0.00	**36.34**

small thresher

Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
harvester-thresher incl. chopper 55 kW (75 PS)	106.84				106.84
standard tractor with rear wheel drive 60 kW (82 PS)	21.14		10.00		31.14
trailer to transfer t/h oneaxialdumper 25 km/h 5,0 t	5.20				5.20
drying				150.00	150.00
cleaning				70.00	70.00
storage bigpack 3 months					20.00
other costs					0.00
Total price for 1 €/h OST 1/SS	133.18	0.00	10.00	220.00	**383.18**
Total price for 1 €/ha OST 1/SS	155.38	0.00	15.00	220.00	**390.38**

Seed stripper

Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
Seed stripper	30.04				30.04
standard tractor with rear wheel drive 60 kW (82 PS)	21.14		10.00		31.14
trailer to transfer t/h oneaxialdumper 25 km/h 5,0 t	5.20				5.20
drying				150.00	150.00
cleaning				70.00	70.00
storage bigpack 3 months					20.00
other costs					0.00
Total price for 1 €/h OST 1/SS	56.38	0.00	10.00	220.00	**306.38**

fieldpreparation GUMPII/B

Activity / Machine	price per Hour [€/h]	working hour [€/h]	tractordriver per hour [€/h]	€/ha	total
fourwheel tracotr with rear wheel drive 120 kW (163 PS)	48.78		10.00		58.78
drainage plough, till 70 cm depth 3 harrow	12.72				12.72
other costs					0.00
Total price for 1 €/h OST	61.50	0.00	10.00	0.00	**71.50**