Grassland renovation in Austria - specific aspects of grassland improvement in mountainous regions

E.M. Poetsch[1], R. Resch[1], A. Schaumberger[1], B. Krautzer[2] and W. Graiss[2]

[1]*Federal Research Institute for Agriculture in Alpine Regions, BAL Gumpenstein, Department for grassland management and cultural landscape, Irdning 11, A-8952 Irdning, Austria*
[1]*Federal Research Institute for Agriculture in Alpine Regions, BAL Gumpenstein, Department for forage plant breeding and recultivation, Irdning 11, A-8952 Irdning, Austria*

1. Introduction

For most of the Austrian grassland and dairy farmers the home-grown forage from their meadows and pastures is a substantial element of their farm management system. Different measures, aiming at the improvement of forage quality, are therefore of great interest. Beside aspects of fertilisation, weed control and forage conservation, grassland renovation is one of the basic keys to succeed. Due to the specific climatic and topographical conditions, renovation of mountainous and alpine grassland is a special challenge both from a technical and ecological point of view.

2. General information

More than 90% of the Austrian farm land, grown with grasses, clover and herbs, is permanent grassland, which by the definition of Schechtner (1978) is at least 20 to 25 years old and has never been ploughed up and renewed within that period. Due to climatic (low temperatures, frost periods, long period with snow cover) and topographical constraints (steepness) as well as for shallow and stony soils most of the Austrian grassland has to be described as obligatory grassland (Schechtner, 1993; Taube et al. 2002). *Figure 1* points out the geographical distribution of grassland (not including appr. 500.000 ha of alpine meadows and pastures, wherefore no INVEKOS-data are available at the moment) and ley farming areas in Austria. Grassland, especially extensive grassland is the dominating culture in the western and central production areas “Hochalpen”, “Voralpen” and “Alpenvorland”, whereas ley farming areas are basically concentrated in the more favourable regions in the eastern and southern part of the country.

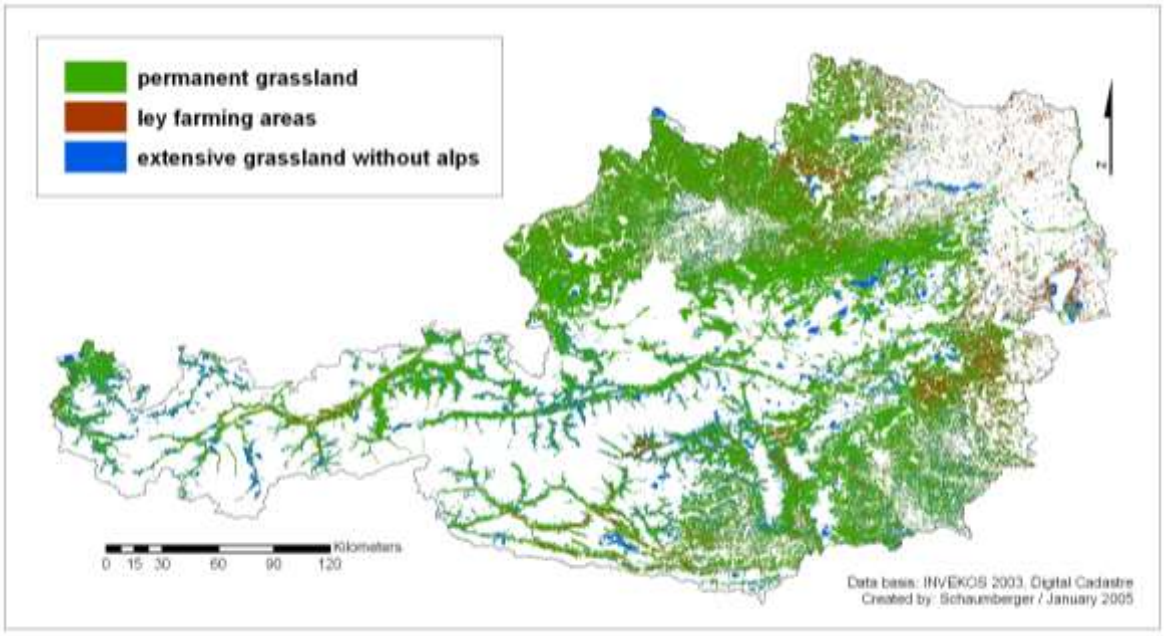

Figure 1: Geographical distribution of grassland and ley farming areas in Austria

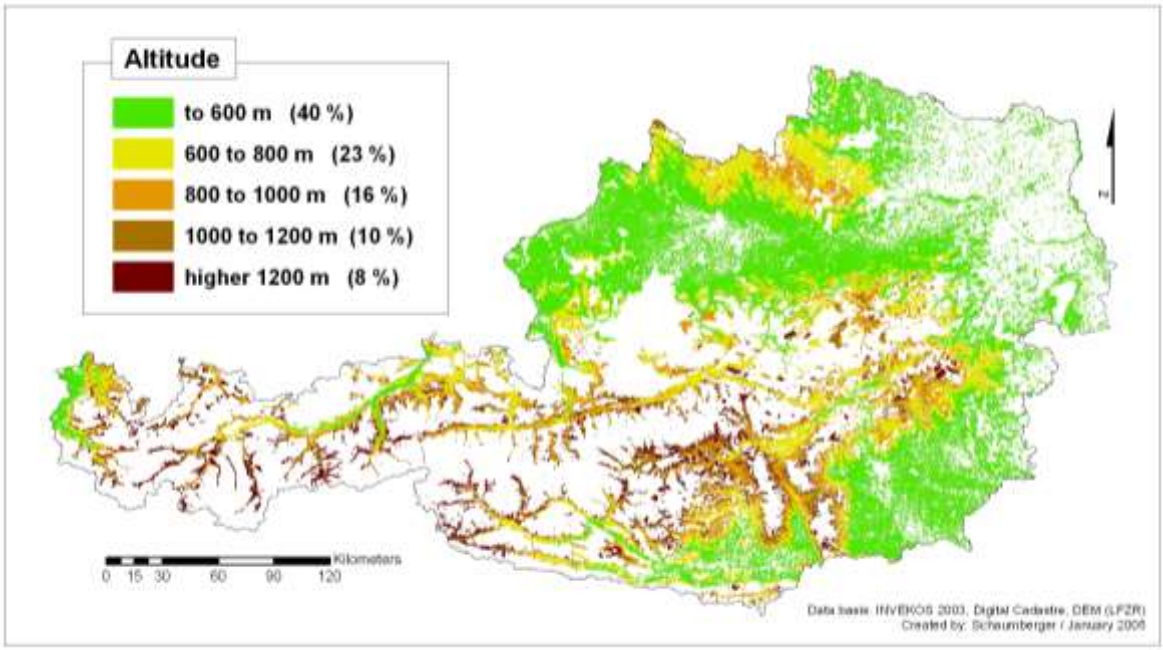

Figure 2: Distribution of grassland and ley farming areas in Austria according to the altitude

40% of the grassland and ley farming areas are located lower than 600m above sea, 23% can be found between an altitude of 600 and 800 m and 34% are located higher than 800m above sea (*figure 2*). Due to the therefore decreasing vegetation period, there is just a short time available for setting up renovation measures on grassland in higher altitudes. More than 70% of all grassland and ley farming areas are exposed from south-east to south-west (>90° < 270°).
Approximately 40% of the grassland areas have a slope higher than 25%, even ranging up to more than 50%, which causes comprehensive problems in the management, especially concerning aspects of harvesting, fertilizing and resowing.

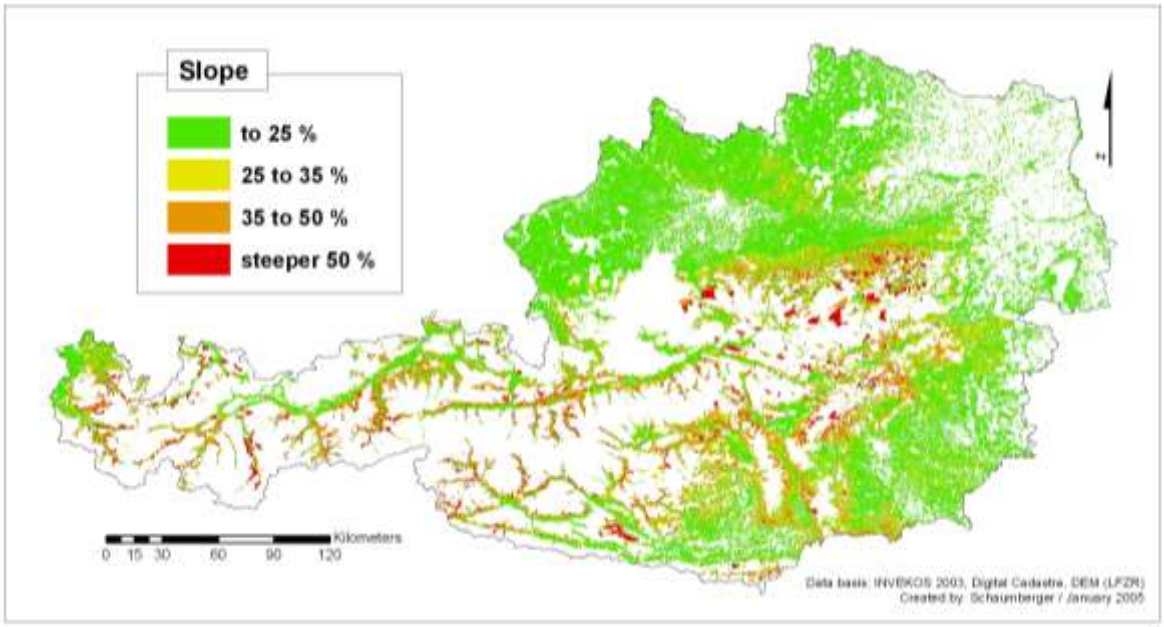

Figure 3: Distribution of grassland and ley farming areas in Austria according to the slope

About half of the total permanent grassland is used in a very extensive way with a low stocking rate and is cut or grazed once or twice a year (*Table 1*). The renewing of these permanent pastures and meadows is basically ensured by self-seeding of grasses clover and herbs. So normally there is no need for any artificial renewing measures, with the exception of sward damage caused by drought or destructive insects (grubs of common cock chafers, june bugs or garden chafers). In the year 2003 approximately 500.000 ha of grassland were negatively influenced by drought (yield reduction up to 80%) and around 15.000 ha grassland were strongly damaged by grubs of the above named chafers (Buchgraber, 2004).

Table 1: Proportion, structure and productivity of permanent grassland and ley farming areas in Austria (Buchgraber, 2004)

land use system	ha	net yield 1000 t DM	energy yield 1000 GJ NEL	protein yield 1000 t
one cut grassland	58.065	86	724	7,7
extensive pasture	80.199	114	1.008	11,9
alpine meadows/pastures	505.000	328	2.954	32,8
more cut meadows	870.568	3.835	35.805	475,4
cultivated meadows	67.749	347	3.466	49,4
permanent grassland	**1.581.581**	**4.710**	**43.957**	**577,2**
grass/clover	54.105	371	3.764	63.1
temporary grassland	69.108	429	4.276	64,3
pure clover	6.648	51	513	9,2
lucerne	7.636	63	592	11,9
ley farming areas	**137.497**	**914**	**9.145**	**148,5**
(% of permanent grassland)	(8,7 %)	(19,4 %)	(20,1 %)	(25,7 %)

Permanent grassland in more favourable regions of the mountains can be at least used three times per year (silage cut, hay cut, second cut hay or alternatively grazing in the autumn). In some very productive lowland areas even up to five cuts per year can be harvested. In this case the natural regeneration of the sward by self-seeding is not possible and therefore re-sowing measures have to be set to improve sward density and the composition of the plant community.

3. Resowing methods for alpine and mountainous grassland

The main methods and technique equipment for grassland resowing/renewing in Austria as described afterwards are offered by more than 90 machinery rings and are available for the whole country. Which method finally is selected by the farmer, strongly depends on the topographical situation and climatic conditions.

3.1 Simple over-seeding

This is the most used method for improving permanent meadows and pastures in Austria. Beside self-constructions, combined machines (curry-comb + seed hopper + roller), which with a special adaptation also can be used for steep grassland, are mainly used. The recommended amount of seed mixture for this kind of resowing method ranges from 12 to 15 kg/ha. The total costs (including machinery and seed mixture) amount from 80 to 110 €/ha.

3.2 Slot row seeding

This method is especially recommended for dry regions and is also used for the application of infected barley to control grubs in the soil (Poetsch et al., 1997). The total costs (including machinery and seed mixture) amount from 130 to 160 €/ha.

3.3 Band rotavator seeding
Only few machines for band rotavator seeding are available in the Austrian machinery rings, so therefore this re-sowing technique is not very common. The recommended amount of seed mixture for 3.2 and 3.3 ranges from 15 to 20 kg/ha. The total costs (including machinery and seed mixture) amount from 170 to 190 €/ha.

3.4 Ploughing up
Basically turning over of grassland is strictly limited by the Austrian Environmental Programme for Agriculture (ÖPUL). In most cases grassland is only ploughed or rotavated if there is no other way to improve the sward or to control weeds. The recommended amount of seed mixture for a blank seed ranges from 25 to 30 kg/ha, depending on the kind of utilisation (pasture, meadow, ley farming) and on specific conditions (high altitude, lucerne as part of the mixture etc.). The total costs (including machinery and seed mixture) amount from 160 to 230 €/ha (Buchgraber et al., 2004)

Beside permanent grassland, approximately 140.000 ha farmland are used for ley farming with grass, clover or grass/clover mixtures. Especially for extensive grassland farming systems, organic farms and integrated farms, biological N-fixation plays an important role for their nutrient fluxes and nitrogen budget. The development of legumes on permanent grassland and the use of legumes in seed mixtures for ley farming is an efficient strategy to save external N-input. The last mentioned aspect especially seems to be important, regarding the European wide discussion about protein substitution in feeding. Ley farming areas, including grass/clover mixtures, reseeded grassland, pure clover stands and lucerne only amount to appr. 9 % of the total Austrian grassland areas but provide around 19 % of the total net yield, 20 % of the total energy yield and 26 % of the total protein yield (*Table 1*). Although consisting of typical grassland plants, these ley farming stands are declared as arable land and completely renewed within 5 years according to the EC-ordinance 796/2004. Concerning the high costs of establishment and the ecological risks, for alpine and mountainous grassland regions the 5 years regulation should be changed and prolonged up to a period of 10 years.

4. General requirements to seed mixtures for alpine and mountainous grassland

Apart from the risk of nutrient losses via leaching and erosion, the establishment of new grassland causes some additional problems under the harsh conditions of the mountains. Deep temperatures (average annual temperature +/- 6.5°C), frost, snow (up to 120 days of snow cover), and the short vegetation period demand for a special strategy concerning the quality and the composition of seed mixtures.

4.1 Breeding and testing activities on grasses and clover
BAL Gumpenstein is nowadays the only Austrian institute, dealing with breeding activities of grasses and clover, including species for the restoration of Alpine environments (Krautzer et al. 2003, Krautzer & Wittmann, 2004). In addition to the demand of the official variety testing, the range of available varieties of forage grasses and clover is steadily tested all over Austria, for up to seven growing periods. Beside yield amount some important parameters are detected in these variety testing trials, so as weed infestation, growing height, flowering, re-growth and post winter performance, snow mould, mildew etc.. All theses criteria are used to find out the best possible varieties for the Austrian grassland.

4.2 Seed mixtures for Alpine grassland

On the basis of the variety testing for clover and grasses, seed mixtures for different utilisation on grassland are created and tested at BAL Gumpenstein. Research in Alpine regions (Austria and Switzerland) has already shown that legume-grass mixtures can be sustained and utilised for up to five years provided that more than two forage species are involved.

In contrast to intensively managed grassland in some European countries, Austrian grassland shows a very high floristic diversity, ranging up to an average of more than 50 species on mountainous meadows and extensive pastures (*table 2*).

Table 2: Number of plant species on different grassland types in Austria (Poetsch & Blaschka, 2003)

type of grassland	n	∅	median	min.	max.	variation	s
alpine meadow	4	**43,3**	41,5	34	56	22	9,64
alpine pasture	39	**39,2**	33,0	21	115	94	18,14
mountainous meadow	5	**52,6**	49,0	37	75	38	14,93
one cut meadow	235	**49,0**	46,0	8	91	83	16,07
two cut meadow	693	**39,4**	38,0	14	88	72	10,38
three cut meadow	328	**33,2**	32,0	13	58	45	8,53
four cut meadow	28	**28,6**	27,5	7	52	45	8,03
ley farming areas	15	**32,0**	33,0	23	48	25	6,60
extensive pasture	120	**54,4**	55,0	6	111	105	19,33
cultivated pasture	73	**45,7**	44,0	24	86	62	12,83
moor land	6	**26,5**	27,0	4	48	44	16,99
mowing pasture	105	**38,0**	38,0	18	64	46	9,64
fallow grassland	27	**27,0**	27,0	7	60	53	14,23
litter meadow	50	**40,7**	43,0	9	62	53	13,82

Several grass and clover species (a number of up to ten) have been used for such seed mixtures with special consideration of productivity and forage quality (digestibility of organic matter and energy value). Such diverse seed mixtures also reduce the risk of unforeseeable problems with unfavourable weather conditions. In terms of the harsh climatic conditions in alpine regions, aspects of persistence, endurance and winter hardness are of great interest. There are different seed mixtures available for permanent grassland (meadows and pastures), for reseeding activities and for ley farming areas. For the last mentioned mixtures, the content of legumes (white clover, red clover, Swedish clover and lucerne) amounts to 65%, depending on the length of the utilisation period. All these seed mixtures have a very high quality level compared to the European standard (double rumex control, higher germinative capacity, seed purity etc.).

To improve the competitive power of grass-clover mixtures, they mostly are grown as an under-seed or with a covering crop and used for a longer duration to compensate the costs of establishment and relatively low productivity in the first year. Only the best varieties of the different grass and clover species should be used for such quality seed mixtures - the official procedure of variety-testing in Austria has therefore been prolonged to six or even seven years to identify the top varieties.

In Austria, a seed production of different species of grasses and legumes for quality seed mixtures has been established during the last decade. Mainly varieties of BAL are now being

produced on approximately 1.000 ha. The average usage of grass and clover seed in Austria amounts to 7.200 t/year, of which 75% is imported – in 1995 the import rate was nearly 90%. The yearly consumption of seeds for permanent grassland, temporary grassland and ley farming areas amounts to 1.800t (*table 3*), for landscape restoration and the establishment of lawns 2.400t are used. Another 3.000t of grass/clover seeds are used for fallow land planting and catch crops.

Table 3: Seed consumption for permanent grassland, temporary grassland, ley farming areas and the potential share of organic seeds

land use system	seeded area (ha)	yearly seed consumption (t)
permanent grassland	35.000	550
ley farming areas	36.000	900
temporary grassland	15.000	350
total	**86.000**	**1.800**
thereof:		
organic grassland	6.500	100
organic ley farming	10.000	250
total organic	**16.500**	**350**

At the moment some selected Austrian seed mixtures are tested in comparison with international seed mixtures (CH, G, I, DK, NL) on eight different locations. The preliminary results clearly indicate the advantage of those mixtures, which are well adapted to the alpine conditions.

5. Requirements to seed mixtures and resowing techniques for special usage

5.1 Seed production for organic farming

Austria has been playing a leading role in organic farming with nearly 20.000 farms, which manage approximately 10% of the total agricultural land. According to the EU-ordinance 2092/91 and the planned regulation AGRI/02/61449, organic farmers have to use organically produced seed and seed mixtures from the year 2003 on.

There are some general rules existing for organic seed production:

- Seed production is only allowed at an authorised organic farm under observance of all rules for organic production
- Basic seed must also be organic or if not being organic must not be treated with fungicides
- Basic seed must not be genetically modified
- Beside the normal standards for seed production concerning germination and purity the organic seed must be kept separate and traceable all the way from the field to the farmer

In practice there are some general problems with the production and therefore with the availability of organic seed for grassland and ley farming areas. Apart from a higher production risk with significant lower yields and worse seed quality, there is only a limited number of species and varieties available for seed propagation and for the composition of seed mixtures. As a consequence of these aspects, the price for organically produced seed mixtures is distinctly higher compared to conventional products.

At present the total area for organic seed production in Austria amounts to 160 ha, where red clover, lucerne, Italian ryegrass, annual ryegrass, bastard ryegrass, meadow fescue, oat grass and timothy are propagated. 43t of organic seed mixtures, at least consisting of 3 organically produced species were sold in the year 2004, mainly used for ley farming areas. There is the need for building up an efficient structure, regarding seed propagation and marketing to fulfil the criteria of the above named EU- regulations.

5.2 Restoration of Alpine ecosystems

Restoration activities at high altitudes, following terrain corrections in the course of constructing ski runs, forest and alpine-meadow trails, measures for the improvement of tourism infrastructure or torrent and avalanche barriers are a special challenge. Only the combination of highly qualitative plant or seed material, well adapted to the site, with optimum restoration technique ensures sustainable success.

The conventional “high-zone mixtures” available on the market mainly comprise high-growing non-site-specific lower plants originally bred for grassland economy in valley locations or as grasses for sporting events. These species are adapted to lower, warmer locations and are generally not suitable for restoration in high zones (Florineth, 1992).

Site-specific subalpine and alpine plants are adapted to an optimum degree to the high-zone climate. They produce little biomass, but with an appropriate choice of species, they do produce high-quality feed. Seeding with site-specific seeds generally require only slight amounts of nutrition, and short-term management measures lead quickly to natural, generally extensive self-maintaining grass, which has high persistency against subsequent uses for tourism and agriculture. With the use of site-specific seed mixtures, the required sowing volumes commonly used in practice can be lessened from 200 to 500kg per hectare to 80 to 160 kg per hectare. Grasses and clover were selected within the sphere of several international research projects, which are suitable for seed production in valley locations and can be used in various site-specific alpine seed mixtures (Krautzer *et al.*, 2003). In the meantime, the ecological species suitable for high zone restoration will multiply over a broad area, graded according to altitude, original rock and usage in high-quality restoration mixtures and brought to the market. The use of such site-specific seed mixtures (e.g. www.saatbau.at) should be obligatory when sowing in high zones.

References

BMLFUW, 2004.
Grüner Bericht 2004. Bericht über die Situation der österreichischen Land- und Forstwirtschaft im Jahr 2003.

Buchgraber, K., 2004.
Auswirkungen der Trockenschäden für Grünland- und Viehwirtschaft. 10. Wintertagung für Grünland und Viehwirtschaft „Unternehmertum in der Land- und Forstwirtschaft als Chance einer erweiterten Europäischen Union“. Ökosoziales Forum Österreich

Buchgraber, K., E.M. Poetsch & B. Krautzer, 2004.
Wie können Trocken- und Engerlingschäden am Grünland regeneriert werden? Der Fortschrittliche Landwirt „Grünlanderneuerung“, Info 4/2004

Florineth, F., 1992.
Establishment of greens in high altitudes in Southern Tyrol, Rasen-Turf-Gazon 3

Krautzer, B., 2002.
Biosaatgut für Dauergrünland und Feldfutterbau – Probleme und Möglichkeiten. Bericht über die 53. Tagung der Vereinigung der Pflanzenzüchter und Saatgutkaufleute Österreichs, BAL Gumpenstein

Krautzer, B. & H. Wittmann, 2004.
Restoration of Alpine ecosystems. In: Restoration Ecology: the new frontier. Edited by J. van Andel & J. Eronson, Blackwell Publishing, Oxford, in print

Krautzer B., G. Peratoner & F. Bozzo, 2004.
Site-specific grasses and herbs. Seed production and use for restoration of mountain environments. Food and Agriculture Organization of the United Nations, Rome

Krautzer, B., G. Parente, G. Spatz, C. Partl, G. Perathoner, S. Venerus, W. Graiss, A.Bohner, M. Lamesso, A. Wild & J. Meyer, 2003.
Seed propagation of indigenous species and their use for restoration of eroded areas in the Alps. Final report CT98-4024, BAL Gumpenstein, Irdning.

Poetsch, E. M., H. Strasser & H.K. Berger, 1997.
Was Sie über tierische Schädlinge am Grünland wissen sollten. Der Fortschrittliche Landwirt, Heft 6/97

Poetsch, E.M. & A. Blaschka, 2003.
Abschlussbericht über die Auswertung von MAB-Daten zur Evaluierung des ÖPUL hinsichtlich Kapitel VI.2.A „Artenvielfalt“, BMLFUW

Schechtner, G., 1978.
Auswirkungen von Düngung und Nutzung auf die botanische Zusammensetzung von Dauerwiesen und Dauerwiesenneuanlagen im Alpenraum. Bericht über die internationale Fachtagung „Bedeutung der Pflanzensoziologie für eine standortgemäße und umweltgerechte Land- und Almwirtschaft, BAL Gumpenstein

Schechtner, G., 1993.
Unveröffentlichtes Vorlesungsskriptum an der Universität für Bodenkultur, Wien – BAL Gumpenstein

Taube, F., M. Wachendorf & H. Trott, 2002.
Future challenges in grassland cultivation in Germany. Grassland resowing and grass-arable crop rotations. International Workshop on Agriculture and Environmental Issues, Wageningen