SZENT ISTVÁN UNIVERSITY

ESTABLISHMENT OF GRASSLAND WITH HERBS, EVALUATION THE EFFECT OF MANAGEMENT ON THE PLANT STAND

PhD thesis

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1. ACTUALITY OF THE WORK

Sward renovation of the low quality arable land and the maintenance of the grass biotope is an objective that has to be obtained according to the land use zone system of Hungary.

The supports of the grassland farming programs are regulated by The National Rural Development Plan (SZEMÁN 2005a) and the Ministry of Agriculture and Rural Development's Regulation No. 150/2004. The effect of the regulation expands to the agri-environmental support. One of the aims is to improve the state of the environment, the viability of the farms and the strengthening of the economic efficiency.

Our researches are opportune because the grassland support systems prefer the extensive range land farming both in Hungary and in the EU. Neither the complementary seeding nor the nutrient input which increase the amount of harvest is allowed.

2. AIMS

a) Planting experiment for the alternative utilization of the medicinal herbs grassland (Gödöllő). During monitoring the established grassland the following tasks and questions were described:

1. Establishing and cropping questions of grain seed of herbs and forage plants which are mixed with dicotyledon medicinal plants and other plant species increasing race richness. The proportion of the seed grain is similar, but the number of the germs is different.
2. In the established grassland the dicotyledons could be collected when we increase the number of the established germs. In case of a plant cover which is more than 20-30 % of each plant (SZEMÁN 2004) the animals do not graze it off by grazing utilization, even if the races are tasty for them anyway. In this case the plant cover is higher than the relative threshold value of weeds and the medicinal plant can be harvested in the grazed field as well.
3. Whether the planted medicinal herbs improve the feed value of the sward if we use late cutting conforming to the brooding time of the birds? (Ministry of Agriculture and Rural Development's Regulation No. 150/2004 and 131/2004.
4. Definition of the agricultural value of the established grassland from alternative point of view (NAGY 2003).

b) Long term grassland experiment analyzing the racial combination changing (Austria/Gumpenstein).

5. With this grassland experiment our aim was to establish what kind of dicotyledonous species, for example medicinal ones would be settled if they were not planted in the grassland. Our additional task was with the experiment to explore the nature-friendly states after 43 years.
6. We wanted to determine in established long term grassland experiment the proportion change of the established and settler species in consideration of dicotyledonous. Changes my take place due to the nutrient level and the utilization and handling forms which are constant but different from each other. From the data we are able to deduce the expected proportion changes of the grass established by us.
7. Whether in the long term field experiment the plant association is richer in a race number due to PK fertilization than the NPK dosage or not. We supposed that grasses will be forced back according to the PK, organic manure could condition the grassland at the same time.

3. MATERIAL AND METHOD

3.1 Position of the established grass and medicinal herbs experiment

The experiment filed was appointed in the botanical garden of the Department of Botany and Plant Physiology, Szent István University in Gödöllő. The area has sandy brown forest soil and lies 207 meters above the sea level. We examined the established grassland containing medicinal herbs and its extensive maintenance in spring and autumn of the year 2002.

3.2 The arrangement and deployment of the experiment (Gödöllő)

According to SVÁB (1981) the arrangement was Latin brick, with three treatments and in four repetitions (Table 1).

Table 1. Factors analysed during the experiment for establishment research

1. Sowing time	1.1 Spring (IV. 12.) 1.2 Autumn (IX. 19.)
2. Seed rate	2.1 5.000 seed · m^{-2} 2.2 10.000 seed · m^{-2} 2.3 15.000 seed · m^{-2}
3. Year	3.1 2002/2003 3.2 2003/2004

Establishing of pastures we have to use 8-10 thousand seeds·m^{-2} germ number according to the literary sources (BARCSÁK et al. 1978). In our experiment we decrease this proportion to 5.000 seeds·m^{-2} to develop more favourable conditions to the dicotyledonous. After all we increase the germ number to 15.000 seeds·m^{-2} to look at whether there is a difference when we increase or reduce the seed-norm (Table 2). It could be stated for every established medicinal species that they are suitable for medicinal and dual purpose planting. Grazed of in small amount it is medicinal for the animal. In a higher amount (more than 30% of plant species) the animal does not graze it off and in this manner even the collection may become possible.

Table 2. Grass-herbs mixture according to seed-norm in g m^{-2} and in percentage of total weight [Gödöllő, 2002.]

Established species	Component of the mixture	***TSW [g/species]**	**5.000 seed [seed· m^{-2}]**	**5.000 seed [g· m^{-2}]**	**10.000 seed [seed· m^{-2}]**	**10.000 seed [g· m^{-2}]**	**15.000 seed· [seed· m^{-2}]**	**15.000 seed· [g· m^{-2}]**
Established dicotyledons								
Plantago lanceolata L.	1,5	0,32	75	0,024	150	0,048	225	0,072
Thymus vulgaris L.	1,3	0,28	65	0,018	130	0,036	195	0,054
Hypericum perforatum L.	0,7	0,14	35	0,005	70	0,01	105	0,015
Achillea collina (L.) BECK.	0,6	0,13	30	0,0039	60	0,0078	90	0,0117
Origanum vulgare L.	0,6	0,12	30	0,0036	60	0,0072	90	0,0108
Salvia pratensis L.	0,2	1,62	10	0,0162	20	0,0324	30	0,0486
Dianthus giganteiformis BORB.	0,1	0,85	5	0,0043	10	0,0086	15	0,0129
Total	**5,0**		**250**	**0,075**	**500**	**0,15**	**750**	**0,225**
Established grasses								
Festuca heterophylla L.	25	0,9	1250	1,125	2500	2,25	3750	3,375
Festuca rubra L.	20	1,20	1000	1,2	2000	2,4	3000	3,6
Lolium perenne L.	7	2,0	350	0,7	700	1,4	1050	2,1
Poa pratensis L.	43	0,17	2150	0,366	4300	0,732	6450	1,098
Total	**95**		**4750**	**3,391**	**9500**	**6,782**	**14250**	**10,173**
Total plants	**100**		**5000**	**3,466**	**10000**	**6,932**	**15000**	**10,398**
Seed-norm (kg·ha^{-1})				**34,5**		**69**		**104**

*TSW=Thousandseedweight

3.3 Examination methods
3.3.1 Definition of the soil seed-bank

The soil seed-bank examination according to BENCZE (1962) was carried out with VINCZE et al. (1983) weed seed leaching method. In our opinion the occurrence of the undamaged seeds is provable, their appearance is possible in the experiment. Those seeds which were not recognized from the soil seed-bank were analyzed by hatching field and crop experiment. The established and settler species which were valuable and worthless we determined as competitor.

3.3.2 The germination test of the established dicotyledonous seed

Using germination experiment our aim was to establish the light claim of the planted dicotyledons from the viewpoint of the sowing time.

In the Justus Liebig University in Gieβen we have the opportunity for germination in climatic chamber. The factors of the experiment which was carried out four times and the analyzed species are shown in Table 3. The germination ability was set up with the value between 0–100 (=these data were not changed) we received results applying four repetitions after fifteen days.

Table 3. Variants of the germination tests

Factors	Grades
1. Light	1.1. Light 1.2. Shading (= green screening) 1.3. Darkness
2. Medium (by filter paper)	2.1. 0,2 % KNO_3 2.2. H_2O 2.3. -0,1 MPa (= PEG 2), pF 3,0
3. Heating (Stratification)	3.1. yes (3°C, 10 days in darkness) 3.2. no
4. Species	4.1. *Achillea collina* (L.) BECK. = A. c. 4.2. *Hypericum perforatum* L. = H. p. 4.3. *Plantago lanceolata* L. = P. l. 4.4. *Thymus vulgaris* L. = T. v.
5. Year of the gathering	5.1. 2001. 5.2. 2002.

*PEG=polyethylene-glycol

3.3.3 Experiment for the changing of the grassland species

The covering and the number of species of some plant group was examined separate, especially the medicinal plants which exceed the 30% covering. If the plant reaches the relative threshold value it could be collected, because the animal does not graze it.

In our experiment we emphasized the effect of the competition using the Dominance-test of BALÁZS (1949), at the same time we used altitude and yield measurement. The recording happened three times a year (spring, summer and autumn) in four repetitions except the year of the establishment. The dates are the following: on 19th July, on 12th September in the year of 2002, 13th of May, 16th of July, 6th of September in the year of 2003, 15th of May, 13th of July, 30th of August and 6th of September in The year of 2004. The altimetry using gauge stick was done day to day in May, 2003. In the paper the spring aspect was emphasized (first increment–May), because from the economical point of view the first increment is more important.

3.3.4 The classification and qualification of the settler plant species

Those species were represented which were not established in our experiment grassland. The settler plant species were classified by us into three main categories according to their sward expounded effect (stand, crop, utilization):

1. Advantageous: These are the plant species which increase the biodiversity. From the economical point of view they are not very important, they ensure habitat however, they could be collected (in case of more than 30% covering) and they could be grazed (in case of less than 30% covering). I can mention the established *Dianthus*-species as an example or the species which were settled into the established grassland, some of them are medicinal plants at the same time. They could be short or long-live grassland components. In case of covering of more than 20 % they could have an important role in the grass stand.

2. Indifferent: These kind of plant species neither qualitative nor quantitative changes cause in the grassland. These are dicotyledonous which are short or papilionaceae species. Under the proportion of 10 % covering they have no antagonism effect, but above this proportion they are adverse.

3. Disadvantageous: among them there are monocotyledons and dicotyledonous. In higher proportion they take away the space from the valuable grassland components and they spoil the feed value. They are used neither in the agriculture nor as medicine, they are not taken into consideration.

In case their proportion reach or increase the 10% they will be unwanted in the grassland.

3.3.5 Examination of the active substance of the medicinal plant

We made the examination of the active substance content of the inflorescence (*Achillea collina*) from the samples being gathered (36 samples) in October and November in the year 2003 in the Faculty of Food Science Department of Applied Chemistry of Szent István University. Revealing whether the proportion of the herbs has an effect on the active substance content in the association was our aim with the analysis. The essential oil content was measured according to the following method: Ph. Hg. VII. (I. 398/J/c. 15.2.3.) (HUNGARIAN DISPENSARY 1993).

3.3.6 Chemical analyses of the nutritive value

The influence of the botanical composition and sowing time on the nutritive value of forage from 72 crops (grass+herbs mixture and grass samples alone) of quite extensively used pasture from Hungary at one cutting time during the primary growth was also investigated. The first mowing had to be carried out June 15th. Two types of crops were harvested on the production site. In the first case the grasses alone were harvested separately, while in the second case the grasses with herbs were harvested together for the analysis of digestibility of organic matter (DOM) in the rumen.

From the feed samples collected in the experimental period the contents of crude protein and crude fibre were determined according to the HUNGARIAN FEED CODEX (2004). The nutritive value was determined using the *in vitro* ruminal digestibility method according to TILLEY and TERRY (1963). The rumen liquor ensure from two or more different sort of beeves to equalize the difference. Forage was examined in three replicates for nutrient content and in two replicates for *in vitro* analyses. As follows were together six replicates for the estimate of representative means. The coefficient of variation for extreme values were tested, where the average deviation was estimated at the level of 3 %.

3.3.7 The alternative definition of the agricultural value

We defined the examined grassland by the model according to NAGY (2003). The method of NAGY (2003) is able to qualify the actual stage of the fodder productive grassland. We extended the method for the particular qualification of other species, which has not been featured so far, like dicotyledonous species. We classified the established herbs into the group of valuable plant species. The species that had been regarded as not valuable have become valuable plant species, which do not have to be eradicated from grasslands, as they can be collected as medical plants. We categorize these dicotyledonous species as weeds if we pursue a proper grassland management for agricultural purpose. However these species are not considered as weeds in the case of grassland usage with the aim of herbs. NAGY (2003) described several numerical values for the grasses and clover, however not for other dicotyledonous species. That is why – completed the method by NAGY (2003) – we worked out numerical values for the established dicotyledonous species in our research.

3.4 The description of the Austrian experiment and examination methods

The experiment and examinations to which this paper relate, finding and running for 43 years in the Alps region Austria, the exact experiment was established by institute HBLFA Raumberg–Gumpenstein.

Experimental site is found in the valley of the Alps region, e. g. in altitudes up to a 732 m. The precipitate is about 1043 mm (Klimastation HBLFA Raumberg–Gumpenstein 1993-2004). The soil is classified as light to medium heavy and a type of sandy forestsoil. The variation of utilizations are viewable in the Figure 1. The first mowing was begun on 3th May and the last utilization on 30. September.

The Austrian long term experiment was estimated from the sustainability point of view. Since an overall examination from the botanical aspect did not happen there in my work the institutional data from1987 and my data from 2004 were used. We watched how many percentages the seed grain of one race figured in the seed grain mix. The all grain number was taken as 100%. The calculated seed number using thousandseedweight (TSW) was used for 1 hectare (Table 4).

Table 4. Seed-mixture and seed proportion ($kg \cdot ha^{-1}$) as seeded on a permanent grassland site in Gumpenstein, Austria, 1961

Established species	**Sowing mass** ($kg \cdot ha^{-1}$)	**Thousandseedweight (TSW)** (g)	**Seed rate** ($seed \cdot ha^{-1}$)
Arrhenatherum elatius P. BEAUV.	6,0	3,50	1.714.286
Dactylis glomerata L.	2,4	0,9	2.666.666
Festuca pratensis SCHREB.	9,0	1,80	5.000.000
Festuca rubra L.	3,2	1,13	2.831.858
Phleum pratense L.	1,2	0,45	2.666.667
Poa pratensis L.	4,0	0,28	1.428.571
Trisetum flavescens (L.) P. BEAUV.)	1,0	0,31	3.225.807
Lotus corniculatus L.	4,0	1,2	3.333.333
Trifolium pratense L.	1,2	1,7	7.058.824
Trifolium repens L.	2,4	0,65	3.692.308

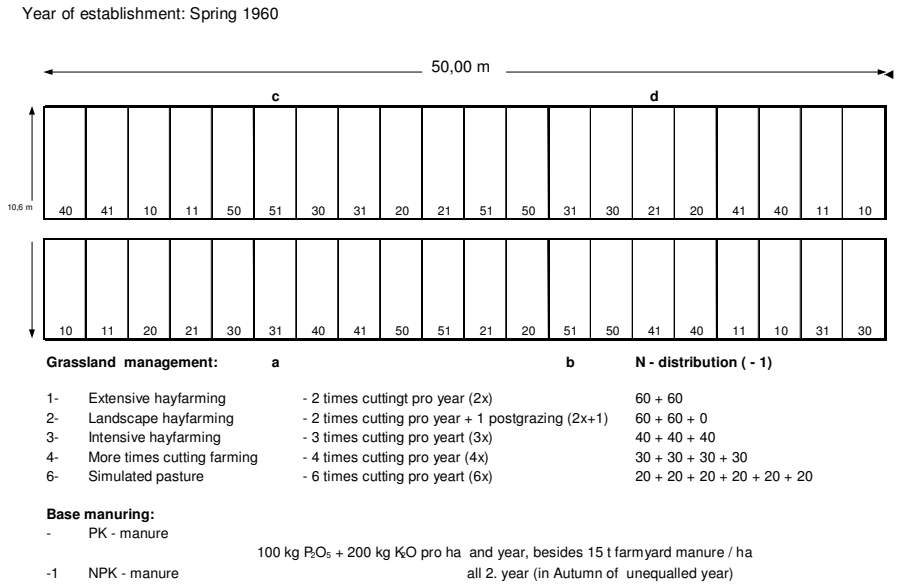

Figure 1. Trial map of Gumpenstein site with information on grassland management and N-distribution

In case of the utilization variations the beginning of the utilization was on 3rd of May and the last utilization happened on 30th of September. In the long term experiment the grazing was simulated by removing the vegetative parts. There was no absolute, the PK fertilization gave the control to the N.

3.4.1 The effect of the maintenance onto the phytocenology features of the long-term experiment

I compared the holistic botanical materials from 1987 of the Austrian institute with the results of my botanical survey made in 2004. There was no chance for the accomplishment of other examinations, because from an examination with a depth like this more data did not stand for a provision. The plant sociological inventory of the grass stand was made according to SCHECHTNER (1958) in the habitat of Gumpenstein.

The plant groups were estimated on the score of covering proportion of the bottom grasses using diverse cutting prevalence and nutrient supply. If the race proportion on parcels supplied with a NPK treatment was bigger than the PK treatment, we ascribed this to the N effect then. When we found identical plant due to the differing nutrient supply, but different ones according to the number of mowing we supposed that it is caused by the grazing-mowing effect. The 5th table below shows our assessment method.

Table 5: Matrix of the effect of nitrogen- and pasture–meadow

	Pasturing	**Mowing**
PK	Plant species ∧	> Plant species ∧
NPK	Plant species	> Plant species

We examined the changes in the number of species in the last 43 years.

We distinguished three groups by the assessment of the species number (Table 6).

Table 6: Aspect of the evaluation of plant species

Established species	a) disappeared from the plots, b) remained on the plots
Settler species	c) settled species to the plots

3.5 Statistical analysis

Data were statistically evaluated with program SPSS/Win 12.0 (ANOVA, Bonferroni-test, Pearson-correlation). According to the regression equation by digestibility of organic matter we can regularly estimate the energy contents (NE_l) too.
The ruminal N-balance (RNB) was estimated by digestibility of crude protein [ABB in %], ruminally undegradable crude protein [UDP in % of Dry Matter (DM)], usable crude protein [nXP in $g \cdot kg^{-1}$ DM] and the metabolic energy [ME in $MJ \cdot kg^{-1}$ DM].
Digestibility of crude protein (ABB_XP) was estimated based on the database of DLG–FUTTERWERTTABELLEN-WIEDERKÄUER (1997).
UDP = (100 – ABB_XP)/100 * XP
nXP = (11.93 – (6.82 * (UDP / XP))) * ME + 1.03 * UDP
RNB = (XP – nXP)/6.25 (LEBZIEN et al. 1997).
Net energy of lactation (NE_l) was estimated the regression factors from the database according to DLG–FUTTERWERTTABELLEN-WIEDERKÄUER (1997).
(NE_l) (Grass fodder 1. growth) = dOMD * 0.0125344 – 2.20899
(NE_l) (Grass fodder 2. and following growth) = dOMD * 0.0136031 – 2.84447
dOMD = digestible Organic Matter in Dry Matter [$g \cdot kg^{-1}$ DM]

4. RESULTS AND DISCUSSION

4.1 Ecological test examinations of the dicotyledon seeds, results of the climatic chamber

We received the following results from the experiment carried out in the climatic chamber of Justus Liebig University in Giessen. We drew the following interference with the ecological test examination focusing on the general growing circumstances:

1. The plant species had to go over on the effects written down in order for their germination to be successful, neither of the races need furthering treatment for their germination however, only for those which are shown by the ecological indicator values of BORHIDI (1993, 1995);
2. The races do not demand a darkness effect which could prove that it would be necessary to work them into the soil totally, but they need surface, shallow cultivation as well as the established herbs;
3. All the species were suitable for the spring and summer and planting.

We established with this examination that taking the conditions of the experimental area into consideration all races have good establishing opportunity although single races germinate more satisfactorily between certain circumstances and it is evident that we may achieve a better effect by using fresher seed in the course of planting.

4.2 The effect of the soil seed-bank onto the racial combination of the established stock of plants

When we determined the races of the soil we did not find seed of races among those that we sowed into the experiment. So the actual soil seed bank did not influence this experiment. We drew the conclusion based on this that a potential regeneration could only happen from the soil seed-bank if the races can be found in the neighborhood that we established in the experiment. We manifested that the so-called T_4-species are in majority in the soil seed-bank of the experiment.

We established that representatives of weed plant families were ready for germination in the soil that was represented with a high value of grain number for example *Portulacaceae* (25.167 seed·m^{-2}), *Brassicaceae* (9.139 seed·m^{-2}) and the *Amaranthaceae* (4.014 seed·m^{-2}). We have to mention the *Chenopodiaceae* which had 292 seed·m^{-2} in the soil.

Near half of the seeds which were determined from the soil were C_4 photosynthesis type races. We found seeds in the soil of the parcels from the *Asteraceae* family.

Analyzing the soil seed-bank we established that the one by one aggregated weed seed content of the soils the amplitude of the soil number is little. (It is between 54.000 and 58.000 seeds). The fourth sample is exception, in which nearly half of the high number of seeds was amounted by *Sinapis arvensis*.

So for the experimental area there was no difference in the seed bank from which heterogeneous patches were not deduced. This means that neither of the samples from each part of the experimental area consists of high seed number value, so the soil seed bank may not have influenced the fester of the established races.

4.2.1 Plant covering examinations of races of the soil seed-bank

The settler dicotyledonous of the grass was grouped whether they remain in the grass or after one year they disappear from the experimental area or their effect is beneficial or harmful for the grass establishing. According to this the following categories were made for the experimental plant species:

1. **<u>Beneficial for the establishment:</u>**
   - at fester (annual): *Capsella bursa-pastoris* (Th), *Oenothera biennis* (TH).
   - in the grass (perennial): *Dianthus giganteiformis* (H), *Plantago media* (H), *Taraxacum officinale* (H).

The *Capsella bursa-pastoris* only came out by establishment, but it did not stay in the grass. It is a medicinal herb that influences the success of the establishment. It is medicinal herb when it is collected, but it reaches the biodiversity only for one year. Its newer individuals may appear in the later years from time to time.

<u>2. Indifferent for the establishment:</u>
   - at fester (annual): *Stellaria media* (Th), *Portulaca oleracea* (Th), *Medicago lupulina* (Th-TH).
   - in the grass (perennial): *Polygonum aviculare* (H-Ch).

<u>3. Harmful for the establishment:</u>
   - at fester (annual): *Bromus japonicus* (Th), *Digitaria sanguinalis* (Th), *Conyza (Erigeron) canadensis* (Th-TH), *Setaria viridis* (Th).
   - in the grass (perennial): *Rumex acetosa* (H), *Rumex obtusifolius* (H), *Solidago canadensis* (H).

We established with fester examination from the soil seed-bank that spring planting and dolling of soil ensure better circumstances for the plants lying in the soil. The cover percentage of the appeared races was the largest in the year of the establishment (22%) this decreased gradually in the following years.

4.3 Analyzing of the planting and maintenance of medicinal herbs

Using cluster-based analysis due to the three seed-norm grouping cannot be established in the year of 2002. The established dicotyledons were able to attained higher proportion of covering after two years of the establishment and in spring planting. Increasing the seed-norm the total number of species will decrease gradually. We established that using raised seed-norm treatment the covering the biggest was. This means that with increased seed-norm the covering grows, but the total number of species decrease at the same time. The planting of the dicotyledons and the utilization of seed-mixture that stands from the same seed of plant species but containing it in different proportion determined changes in the number of species. Another reason for the decreasing number of species is the increasing number of the planted species which eliminated the 1-2 year old seed rising weeds. Weed propagation from the weed seed of the soil does not appear. The planted dicotyledon species competed with the weed races successfully since the planted grasses were forced back until 2004 so the dicotyledonous ones did not have to compete with them already. There were only a few weed species left until 2004 what shows it clearly, that the planted dicotyledonous ones, what we applied in a little percentage in the seed grain mix, the weed races were able to oppress. The *Origanum vulgare* and *Hypericum perforatum* reaches low covering proportion, although their proportion increased by the progress of the years gradually, the largest cover value was attained in the year 2004. As *Achillea collina* increased its cover for the third year, the proportion of *Plantago lanceolata* decreased. Among the planted races *Dianthus giganteiformis* ' slight proportion in the first half of the experiment was increased as the time went by. By autumn planting the species number is smaller and the parcels are less weedy at the same time, than by spring planting. Summing up the results it could be stated that by Hungarian relations the planting time has got an importance, because the establishment of the planted dicotyledon medicinal herbs was more successful in case of spring planting. We could establish based on the results concerning all of the examined years: as the proportion of the planted dicotyledons grew, the proportion of the settler ones decreased. We saw this from year to year.

4.4 The assessment of gas-chromatography analyses

The essential oil content of the *Achillea collina* was generated in the biggest amount according to the highest seed-norm both in spring and in autumn planting. The seed-norm indirectly influenced the essential oil content in the examined grassland.

4.5 Digestibility and nutritive value of late mowed grassland

During the observation of changes in botanical components we found a higher dicotyledonous proportion on plots established in spring than in autumn. However the influence of established herbs on the nutritive value was not significant, because the herbs in the pasture were not given a proportion which would have favourably changed the forage value of late mowed pasture.

Nutritive value of a fodder from extensive established pasture was tested. The nutrient content was measured by the WENDEE-analysis and by *in vitro* ruminant digestibility method. Results of former experiments showed that the nutritive value of an extensive established pasture in the case of late outdoor growing is low. In our results the highest crude protein content was in the year 2002, while in 2003 can be observed a steep decline, which showed in 2004 further decrease. The crude protein values were the highest in case of middle seed-norm. The nutritive values of these pastures provide just supply for the demand and it was declined due to the negative N-balance in the rumen. Our results showed that the samples from the year of establishment could possibly be used for preserved feed (6.01 MJ $NE_l \cdot kg^{-1}$). The crop from all other years and sowing times did not reach a value of 5.00 MJ $NE_l \cdot kg^{-1}$, but approach a level of 4.4 to 4.5 MJ $NE_l \cdot kg^{-1}$, thus they would not be suitable for preserved feed. It can be recommended that this late season crop should rather be used for grazing of livestock than as preserved feed.

4.6 The agricultural value of established grassland with herbs according to sowing time and seed rate

The agricultural value of pasture established from grass-herb seed-mix was examined from 2002 to 2004, using the same species and three seed rates (5000, 10000, 15000 seed$\cdot m^{-2}$). We observed if there was a relationship between the selected seed rates and appearance of species, or the species established because of random effect. The agricultural value of the examined grassland has been determined with a model described by NAGY (2003).

It was shown: engaged seed-numbers or sowing times influenced significantly the agricultural value of this pasture. In autumn establishment the agricultural value was higher in the first year than in the case of spring establishment. The highest agricultural value was achieved in 2003. Our results showed the lowest agricultural value occured in 2002 (4,40–5,63), similar values were also observed in 2004 (in spring establishment: 4,11–6,71; in autumn establishment: 7,65–7,96). The highest agricultural value was due to the effect of the highest seed rate. With our estimates we confirmed: established dicotyledonous are not dominant in the first year, the weed cover is higher in the spring establishment than in autumn and the seed rate influenced the agricultural value of grassland with herbs. All in all, the effect on the agricultural value is positive from the aspect of herbs and grassland usage too, where in the first case not the seed rate predominates but the sowing time. In the aspect of a grassland usage the method according to NAGY (2003) is express, however the established species have income productive facility, which are represented by our numbers of value.

4.7 Influence of cutting frequency and fertilization on the plant composition in a permanent grassland

The plant stand in cutting-frequency experiment Gumpenstein show according to nutrient management and cutting-frequency smaller or stronger differentiation. Manuring with nitrogen effected by comparable cutting-intensity an increasing in the proportion of forbs, where the more extensive cutting frequency was given only small different in the proportion of forbs. The grass cover degree was between 23 and 38 % with PK-manure, but grasses were between 45-53 % with NPK-treatment. Cover of *Leguminosae* was 18-24 % by PK-manure. A N-manure decreased the *Leguminosae* cover to 2-7 %.

Grass proportion increased by the added N-manure more significant than the forbs. Here show also a changing effect between the grouped species. Grass structure grew stronger by the nutrient added. When the grass proportion declines in the stand so nitrogen added support the occuring forbs. By higher N-manuring especially in form of easily soluble N-manure get in the *Leguminosae* clearly.

The undergrasses like *Poa pratensis*, *Poa trivialis* and *Festuca rubra* could establish into the stands permanently stronger by growing cutting frequency. If this three species were of 6 % in extensive meadow, so they could appear with a proportion of 11 % in the meadow mowing three times, 20 % with four times mowing and 27 % in the simulated pasture. By more intensive fertilization and grassland management increasing cover proportion of undergrasses to 38 %. Expansion of species *Poa trivialis* is not expected, because it has got in the fodder a typical after-taste, which isn't preferred by animals. By this strong grass structure by PK-manure across the undergrasses can not optimally develop the species *Leontodon hispidus* and *Taraxacum officinale*. The species *Achillea millefolium* was developed to 13 % cover degree on the two times cutting plots however with a higher cutting frequency it decreased to a cover degree of 1-2 %. By a nitrogen manure with a more intensive utilization increased the species *Leontodon hispidus* and *Taraxacum officinale* to 29 % cover degree on the plots mowed three times, such on a plot has got also *Taraxacum officinale* the biggest expansion. With an effect of different utilization and PK-manure showed species *Achillea millefolium* a significant expansion, however by permanently increase of nitrogen manure could not influence significantly the utilization forms the appear of species *Achillea millefolium*.

If the aim is to reach a species rich respectively forb rich stand, it demand to apply the extensive hayfarming with two mowing pro year, because this utilization lead to an increase in herbs. Such a plant developing dominantly by extensive farming if in the stand are robust dicotyledons. We could establish this in the case of species *Achillea millefolium* too. This doesn't effect the fodder quality negative but the biodiversity too. This plant stands riched in forbs show in generally a lot of gaps in the grassland, which is by *Poa trivialis* especially in the case of a good nutrient circulation.

While the cover degree of grasses is increased strongly by N-fertilization and a higher cutting frequency, it will be expected lower cover of forbs particularly by intensive utilization.

From the aspect of biodiversity show sites limited in nutrient show a higher proportion of forbs and this extensive flowering meadow contribute to the beauty of culture landscape.

5. RECENT FINDINGS

1. We examined with ecological models what kind of factors influence the dicotyledons germination in spring and in autumn. I proved using light, filtered light, darkness, potassium nitrate, water and polythene glycol that the light factor has positive significant effect to each plant species in the experiment. The light for germination is necessary for the fruitful planting. The selected dicotyledons races were suitable for the spring and summer end planting as well. The necessary circumstances were shallow sowing, light and rainwater.

2. As a result of the raised number of the germ the competition was considerable; therefore the proportion of other dicotyledons within the establishing weeds was low. In spring planting the appearance of annual weeds resulted in stronger initial competition to the planted dicotyledons than that caused by a high proportion of monocots in the seed mixture. After all the spring planting of the dicotyledons was more successful.

3. Summer end planting medicinal herbs which grew taller were not forced back (*Achillea collina*, *Hypericum perforatum*, *Origanum vulgare*) however they were to expand in a smaller measure, than the spring planting ones. This effect disappeared by the third year.

4. The cover of the parcels which were planted with three different seed-norm does not differ from each other after the third year.

5. Increasing the seed-norm the proportion of the plant groups to each other have changed. Due to a bigger grass cover the essential oil content of the *Achillea collina*'s inflorescence have increased. The planted bottom grasses were not shading.

6. I supported with the results of the *in vitro* rumen digestibility experiment that the food energy value of hay made of old herbs do not improve reliably by using resettled dicotyledonous species. The hay grew old as a result of the late mowing which was made according to the sustainable grassland farming program's regulations.

7. Through the estimated agricultural value we have also proved that the grass established in autumn grows more vigorously than the dicotyledonous species. I pointed out that seed-norm of 15000 seed·m^{-2} has the highest agricultural value by the grasses. I also pointed out with the calculated agricultural value, that the established species have the ability to create income which is expressed by the values given by us.

8. Analyzing the data of decennial international grassland farming's long term field experiments I established that the diversity of the sowed grassland could be maintained in the long run by using extensive farming and mowing technology used by us.

6. NOVEL RESULTS

1. In both planting times only the annual weeds made the grass weedy. Those weeds which appeared after the planting were oppressed by the herbs and planted dicotyledonous. The decrease of the number of weed species decreased the total number of the species.

2. I tested the applicability of the seed-mixture for the planting with provocative planting experiment. In this experiment we used species which not suit to the plant community. During the composition of the seed mixtures I considered the relative ecological value number of BORHIDI (1993, 1995). The seed-mixture consisted of Hungarian planted species.

3. The weed community made of bottom grasses made it possible for the *Thymus vulgaris* to be settled.

4. The grasses do not suppress the dicotyledonous in spring after 1-2 years of the planting, but the dicotyledonous suppress the herbs. The equalization of the interaction could happen after the 3rd year of planting, because the herbs show intensive development at the time of stem elongation and they only withdraw in the next changing period when the blooming flowers get a chance to raise their inflorescence.

5. The grass stand itself and planting mixed with medicinal dicotyledonous do not give more favorable feeding value when the cutting time is after the 15th July. I verified at the same time that *Achillea collina* and *Plantago lanceolata* races gave a yield which can be marketed without using artificial fertilizer. In this case there was an opportunity for the collection, so the dual purpose utilization would have been solved.

6. In the mixture of grass and dicotyledonous the energy content is not bigger significantly than in grass stand itself. According to our expectation the largest growth rate could be demonstrated by the mixture of grass and dicotyledonous. This difference in the dry matter growth rate was proven statistically at the herbs with spring planting. The planted dicotyledonous compared with the grasses were able to contribute to the development of yield in low amount.

7. The energy-content of the grass is lower if the sowing time is in spring than in autumn, because of the sweep of the dicotyledonous.

8. I extended the formula applied to the calculation of agricultural value according to NAGY (2003). According to the alternative utilization claim analyzing the planted dicotyledonous they will have alternative economical value, so the agricultural value will be positive.

7. CONCLUSIONS AND SUGGESTIONS

1. Our examinations prove that with increasing seed-norm the overall number of species will gradually decrease. Due to the seed-norm of 104 kg·ha^{-1} the herbs will have high covering, so the competition will be considerable, therefore the proportion of settler dicotyledons would be low. This observation offers two opportunities for the practice:
2. If the aim is to decrease the proportion of the absolute weeds then the application of the raised seed-norm (104 kg·ha^{-1}) is recommended. If we want to increase the proportion of the planting dicotyledons then the average seed-norm (69 kg·ha^{-1}) is worth using without the changing of the proportion of the population mixture.
3. It was proved again that with decreased seed-norm we provide a settling surface for other, not sowed races. In that case the danger of weed propagation increases. At the same time this gives a basis that with late harvesting the planted dicotyledon races just as well as herbs will be presented steadily at the stand by their seed performance continuously renewing the planted sward.
4. We saw that the smallest cover of the planted dicotyledonous took shape with the use of the raised seed-norm. With the planting of the medium seed-norm we insured herb-dicotyledon seed-mixture that is suitable for grassland farming and alternative utilization as well. At the same time we gave the opportunity for the appearance of other plant species that support the spreading of diversity without the existence of weeds. This medium seed-norm is advisable for the sward renovation of set aside arable land that became weedy. The mixture helps the spread of species that increase the diversity.
5. This grass stand could be use due to several aims from the viewpoint of grassland management. The grazing could be carrying out until the 30% covering proportion of the dicotyledons above this percent the collection of the medicinal herbs could be solved. If the utilization is not the grazing then the stand of plants does no good to graze down more expedient the medicinal plant collection. At this time it is recommended to categorize the grassland as medicinal herb grass, because it has no agricultural value. Because of the lag of the medicinal plant collection and due to the plants, which grow taller the screening effect, reduces the essential oil content of the *Achillea collina*. Because of this it is not expedient to collect from the stand at this time, however it is necessary to make the seed rolling possible due to the extensive regulations and for the following years the collection of the medicinal plants.
6. As the planted mono- and dicotyledons oppress the weeds there is an opportunity for regenerating the planted races with seed rolling in this manner. This especially true in the regulated extensive farming, where the first harvesting postpones after the 15th of June. We recommend seed rolling in 3-5 years so the stand does not grow old. We may deduce the deficiency of the seed rolling from the stand's change. The old stand of plants is spoiling powerfully from the viewpoint of the fodder value.
7. In case we sow herb-dicotyledon mixture in spring we receive an almost identical crude fiber value as with the autumn planted.
8. By the definition of the agricultural value we have an opportunity for the continuous monitoring of grassland. Based on vocational visitation it could be decided when these extensive grasslands are suitable for animal production or alternative utilization.

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