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**LIVE-STOCK BREEDING SCIENCES PhD SCHOOL**

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**„PhD DISSERTATION THESIS”**

**THE EFFECT OF ANNUAL WEATHER AND UTILIZATION SYSTEMS ON  
SALT AFFECTED GRASSLANDS IN THE KARCAG REGION**

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## 1. INTRODUCTION

Grazing animal husbandry in the Great Plain region has assured farmers a source of living for centuries. Although our grassland management development has been characterised by poor and even serious periods there have been more marked changes over the last decades than ever before. Due to the decrease in the quality of grazed animal stock populations on the utilisation of grassland products on our grasslands came to be questioned and the allocated level of most of our grasslands declined to a minimum. The native grassland area decreased from 1164 thousand hectares to 1061.2 thousand hectares and the average hay yield of our grassland researched 0.66 t/ha a year in the period from 1992 to 2001.

Present changes even worse the situation of native grassland utilisation. The European Union determined the production quota on the basis of our declined ruminant population and due to predicted changes in the cultivation branch, the area of native grassland will increase primarily in those regions with unfavourable climate and soil. The increased expectations of environmental protection work against intensive grassland management.

### *Motivation of my research*

The annual changes in the climate conditions of an arable land can seriously determinate the quality and quantity indices of grassland management. Annual weather can cause highly varied yields of the same growths of grasslands in different years because global climate change is growing more serious. Research and practice can offer more solutions to stabilise yield fluctuation caused by annual weather, such as fertilisation and irrigation. Recently intensive grassland management is getting pushed into the background world-wide and environmental protection and ecological grassland management is coming to the front because of natural protective and economical reasons. Due to species composition changes in plant population and yield fluctuation caused by the annual weather, the sheep carrying capacity of grasslands can become unbalanced. There is little exact research data on this topic. In my opinion, the reasons mentioned above point to why examinations of the sheep carrying capacities and the

yield levels of natural grasslands on one of the most drought sensitive areas in Hungary are so important.

Presently, grass harvesting machines and the quantity of the ruminant population of farms in the unfavourable climate of the Great Hungarian Plain region can seriously determinate the application of grassland management techniques. The lack of either of these two factors can cause grassland management become one-sided (only cutting or only grazing utilization). Furthermore, the grazing on grassland, chapped by the course of compensation, can outrage the farmyards so owners try to utilise the grasslands by cutting. We have to see that only the sheep keeping has remained close tied to grass management on the territory east of the River Tisza. This branch of utilization can be an important part of the utilization of the yearly renewable yield of low output capacity grasslands and the production of high biological value and chemical free animal products. Reasons mentioned above explain the necessity of the research programme planned to analyse the effect of the utilisation systems on species composition of plant population, yield production and sheep carrying capacity on extensive, salt affected grasslands.

## **2. THE OBJECTIVES OF THE RESEARCH**

The composed objectives of my research in the PhD thesis were the following:

- To analyse the effects of annual weather on species composition, yield and sheep carrying capacity of grassland types that represent the extensive sheep pastures in the Nagyikunág sub-region. It was important because only empirical experience but not exact results of the topics can be found in the area.
- To get precise results on the effects of the most characteristic grassland utilisation methods of grassland management on sward compositions, yield and sheep carrying capacity of extensive grassland types. My results may model the predictable effect of one-sided and mixed utilisation systems on the grasslands of the region.
- To give information and advice to extensive sheep farmers on the Great Hungarian Plain to be more successful in grazing farming. The research results stem from grasslands of villages in the region where sheep keeping has always been connected

to grassland management in countless ways. Research similar to that done in my study has never been published to date.

### 3. RESEARCH METHODS

I carried out my research work on extensive grasslands of Karcag in two experiments over the period between 1996 and 2000.

#### Experiment 1. – Examination the effect of annual weather

I examined the effect of annual weather on three different extensive grassland associations, representing the regional grasslands in a single factor experiment.

1<sup>st</sup> grassland type: *Achilleo-Festucetum pseudovinae*

2<sup>nd</sup> grassland type: *Achilleo-Festucetum pseudovinae poetosum pratensis*

3<sup>rd</sup> grassland type: *Agrostio-Alopecuretum pratensis*

We created two by two metre sample areas in ten repetitions per hectare at random. Sample areas uniformly represented the grassland types. We took samples three times a year (V.21-23., VII.12-14.; IX.21-23.) in the same period in every research year. The grassland management system was the same on all the examined grassland types during the research. The first growth was cut, and the second and third were grazed over one full day exactly, after the sample taking, by a population of one hundred and fifty Hungarian merino ewes.

#### Experiment 2. – Examination of the effect of utilisation systems

I examined the effect of the most characteristic grassland management systems of the region on *Festucetum pseudovinae poetosum pratensis* grassland type in a single factor experiment. The research was managed in a three treatment, ten repetition block order on one hectare of grassland. The area size of repetitions was two by two square metres.

Treatments of my research:

##### *1. Grazing (4L)*

The research part of the grassland, after sample drawing, was grazed by a permanent population of 150 Hungarian merino ewes one full day, four times (IV.15-18.; V.21-24.;

VII.13-15.; IX. 22-24.) of the same interval a year and the repetitions of this treatment were also grazed.

## 2. *Cutting* (1K)

We put our own developed enclosure cage on each repetition treatment plot to avoid sheep grazing on it at the beginning of the experiment and we kept it there until the end of the experiment. The enclosure cage excluded the sheep from the repetition plots, which were utilized by cutting once a year in the blooming period of the first growth (V.21-24.). This treatment would represent the force utilization method which is done because of lack of grazing animal populations.

## 3. *Mixed utilisation* (1K+2L)

In the case of this experiment we protected the first growth by enclosure cage, which was removed after the first cutting (V.21-24.) to get on further the effects of grazing animals after drawing samples of the second and third growths (VII.13-15.; IX.22-24.). The number of sheep was the same as for the first treatment.

### Research methods:

- I used the climate index to determinate the quantity of the research years (VINCZEFFY, 1991) which was based on the precipitation and temperature data provided by the Karcag Research Institute of the Debrecen University Centre for Agricultural Sciences. During my research work, I had a good chance to examine extreme annual weather conditions from semi-humid to semi-desert.
- We made a sward composition investigation according to the Balázs quadrature method on each growth in the first experiment and between V.21-24 period in the second experiment on each repetition plot (BALÁZS, 1949). I analysed the ground cover of sward species according to feeding stand points (grasses, clovers, relative weeds, absolute weeds) (BARCSÁK et.al., 1978).
- In the first experiment of each growth and in the second experiment, until the utilization of V.21-24. we measured the natural sward height at three points of the diagonal lines of the plots using a measure stick which were then averaged.
- I calculated the dry mater, raw protein and NEm yield per hectare from the content value of the average samples of the treatment plots. The laboratory of the Karcag

Research Institute of the Debrecen University Centre for Agricultural Sciences did the examinations according to the Hungarian standards MSZ 6830.

- I received the results for sheep carrying capacity by comparing the yearly fodder yield of the examined ewe/60 kg sward and yearly fodder claim of ewe/60 kg, in the first 15 weeks of ewe pregnancy (KAKUKK-SCHMIDT, 1988).
- During the research of annual weather effects, I chose the most favourable climate index year 1996 as a bases for comparison in the result table, but for the research of utilization systems I chose the grazing utilisation treatment as a basic point. I evaluated the research data by variation analysis and estimating the effects of the annual weather by factor analysis.

#### 4. THE MAJOR RESULTS OF THE THESIS

##### 4.1. Effect of annual weather on examined grasslands

###### 4.1.1. Annual weather

I established the annual weather of research years on the basis of the climate index. The first table illustrates that there was an optimum climate index (0,2 – 0,25 mm/1°C) only in the year 1996, when there was little rain. This was the reason why I chose the 1996-year to be the bases for comparison in the result tables of my analysis. The most unfavourable climate index years for the production of phytomass were the dry 1997 and the arid type year 2000.

As I could compare very extreme climate index years, I had the opportunity to follow the effect of annual weather step by step.

**Table 1.: The climate indices and annual weather of the research period**

Years	Climate index, mm/1°C Yearly	Annual weather	Lack and surplus of precipitation, mm
1996	0.225	Semi-rainy	+84.16
1997	0.111	dry	-322.71
1998	0.177	Average	-84.2
1999	0.156	Semi-arid	-181.19
2000	0.068	arid	-609.69
Average of 50 years	0.13	Semi-arid	-270.4

###### 4.1.2. Effect of annual weather on the species composition of grasslands

The ground cover values of the first examined area of *Achilleo-Festucetum pseudovinae* and the third examined area of *Agrostio-Alopecuretum pratensis* grassland association were significantly higher in the optimal climate index year 1996 than in the arid year 2000. The ground cover values of the second examined area, *Achilleo-Festucetum pseudovinae poetosum pratensis* grassland association diminished in the semi-rainy and average years, due to the higher area covering rate of clover species.

Analysing the ground cover data of clover species we could establish that the ground cover values of the semi-rainy year on each grassland association were higher than in the case of semi-arid and arid years.

Studying the relative and absolute weed cover rate on the examined grassland association, I established that the measured values in the semi-rainy year were significantly less than in the case of semi-arid and arid years.

#### **4.1.3. The effect of annual weather on natural sward height**

I found that natural sward height of the examined grassland associations were significantly higher at each growth, as well as the annual average in the semi-rainy year compared to the results of dry and arid years.

There was a significant difference between the higher results of average annual weather and the lower results of arid annual weather, as well.

Droughty annual weather conditions exerted a similar sward height decreasing effect on all grassland associations of the different sample areas and plants of association.

#### **4.1.4. Effect of annual weather on fodder yields**

The fodder yield values in the semi-rainy year were significantly higher than the measured values in the dry, semi-arid and arid years of the examined sward association. A drought year caused serious yield depression in the phytomass production of sward associations.

#### **4.1.5. The effect of annual weather on sheep carrying capacity**

The sheep carrying capacity of each grassland association was significantly higher in the semi-rainy year than at the semi-arid, dry and arid years, so the serious fodder yield decrease effect of the droughty annual weather conditions did not compensate the sheep carrying capacity of a given grassland. (Figure 1-3.)



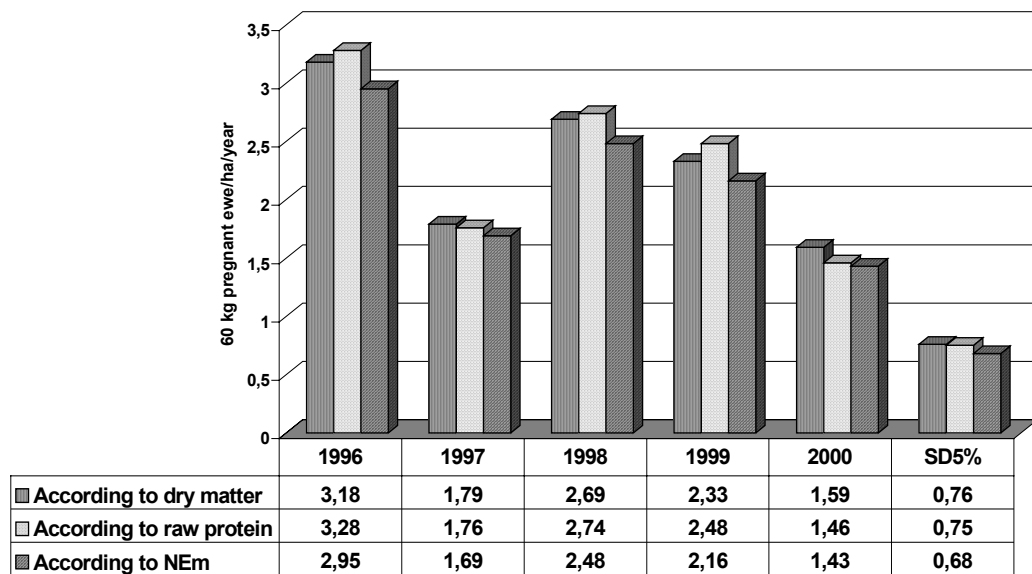


Figure 1. Effect of annual weather on sheep carrying capacity of *Achilleo-Festucetum pseudovinae* grassland association (Karcag, 1996-2000)

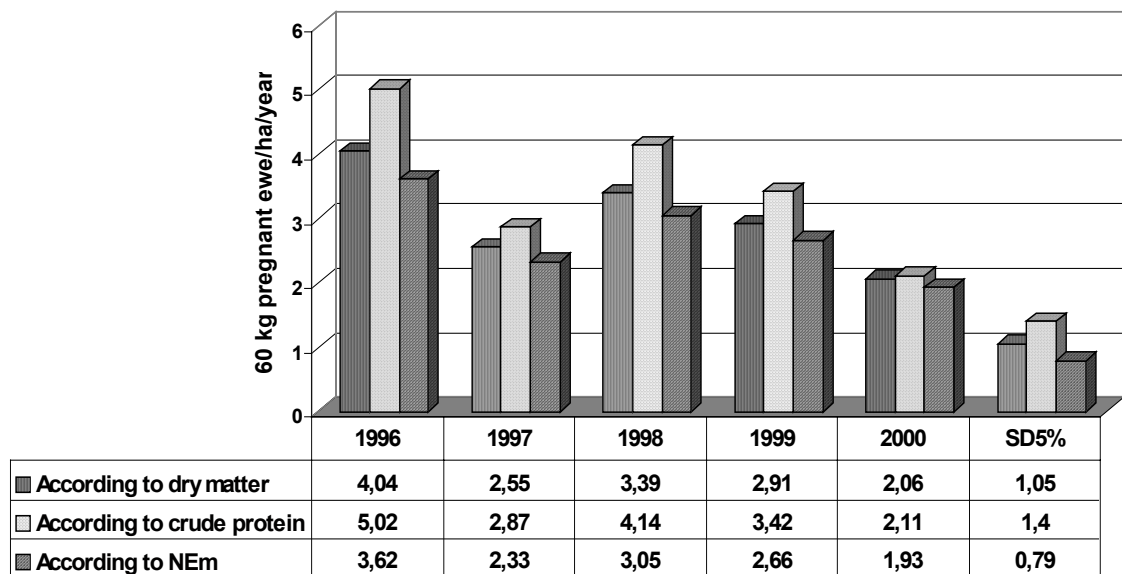


Figure 2. Effect of annual weather on sheep carrying capacity of the *Achilleo-Festucetum pseudovinae poetosum pratensis* grassland association (Karcag, 1996-2000)

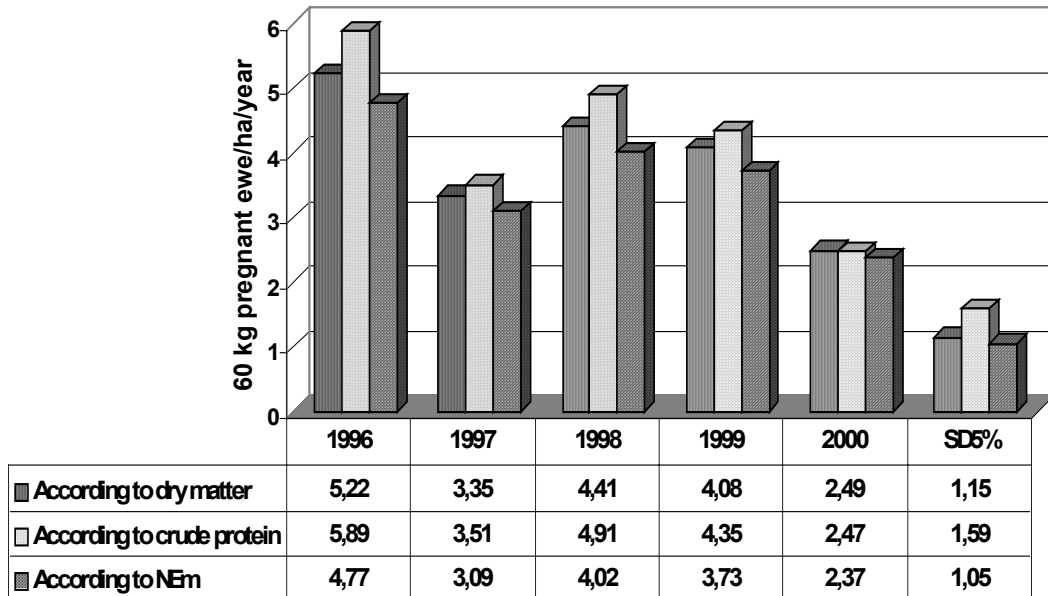


Figure 3. Effect of annual weather on the sheep carrying capacity of the *Agrostio- Alopecuretum pratensis* grassland association (Karcag, 1996-2000)

## 4.2. The effect of utilization methods on the examined grassland utilisation

### 4.2.1. The effect of utilization methods on the sward composition of grassland

In the annual average of the results during the research period, I did not find any significant difference in ground covers between the single and mixed utilizations methods. But having examined the ground cover of tall grasses in the cutting utilization, system they were found higher than the values in the case of grazing and mixed utilizations.

It was found that the ground cover results of clovers were the highest with grazing utilization, these plants in all probability obtained more sunlight and excrement. Investigating the mean figures of the experiment period I measured significantly higher relative weeds cover at cutting utilization than for the grazing and mixed utilizations. The lack of zoogenic effects can result in an undisturbed seed yield of these plants in summer and autumn periods. I proved that absolute weed cover was the highest with the grazing utilization, and it was the least with cutting utilization. In my opinion, the explanation is that the harvest of absolute weeds happens only with cutting utilization, as does the partial prevention of seed yield. (Figure 4.)

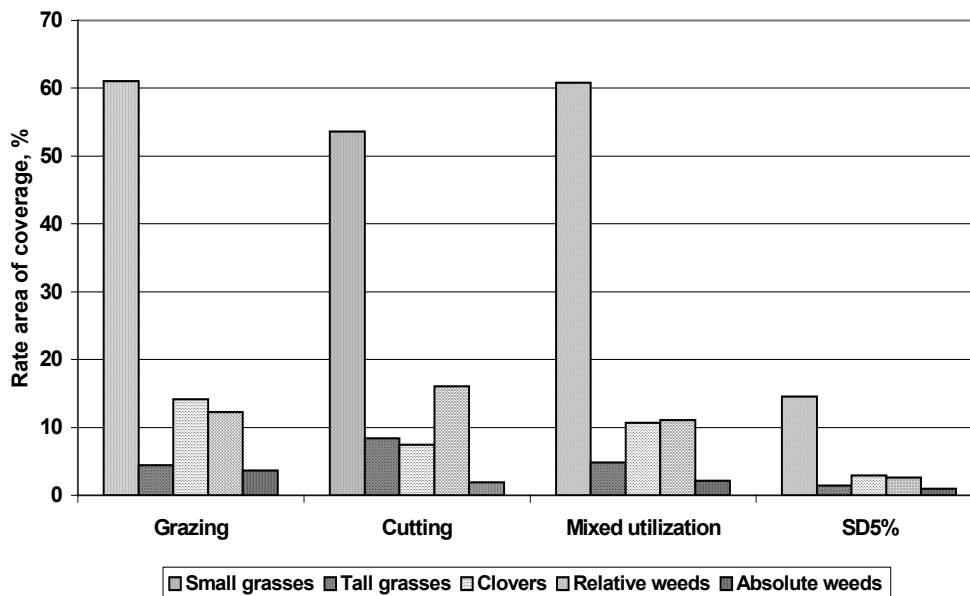


Fig. 4. Effect of utilization system on species composition of *Achilleo-Festucetum pseudovinae poetosum pratensis* grassland association (Karcag, 1996-2000)

#### 4.2.2. The effect of grassland utilization methods on the utilized fodder yields

On average I measured higher dry matter yields with mixed utilization, although these were the least with cutting utilization due to the yearly single utilization. I did not find significant difference between grazing and mixed utilizations as for utilized crude protein and NEm yields, but I measured that the yields of cutting utilisation were lower than for the other utilization methods investigated.

#### 4.2.3. The effect of utilization methods on the sheep carrying capacity

The sheep carrying capacity on the basis of dry matter yield was higher with mixed utilization, but it was also higher with grazing utilization than with one – direction cutting utilization. There was no significant difference regarding the sheep carrying capacity on the basis of raw protein and NEm yields between grazing and mixed utilization methods, but the sheep carrying capacity was higher than for the result of the cutting utilization method (Figure 5.).

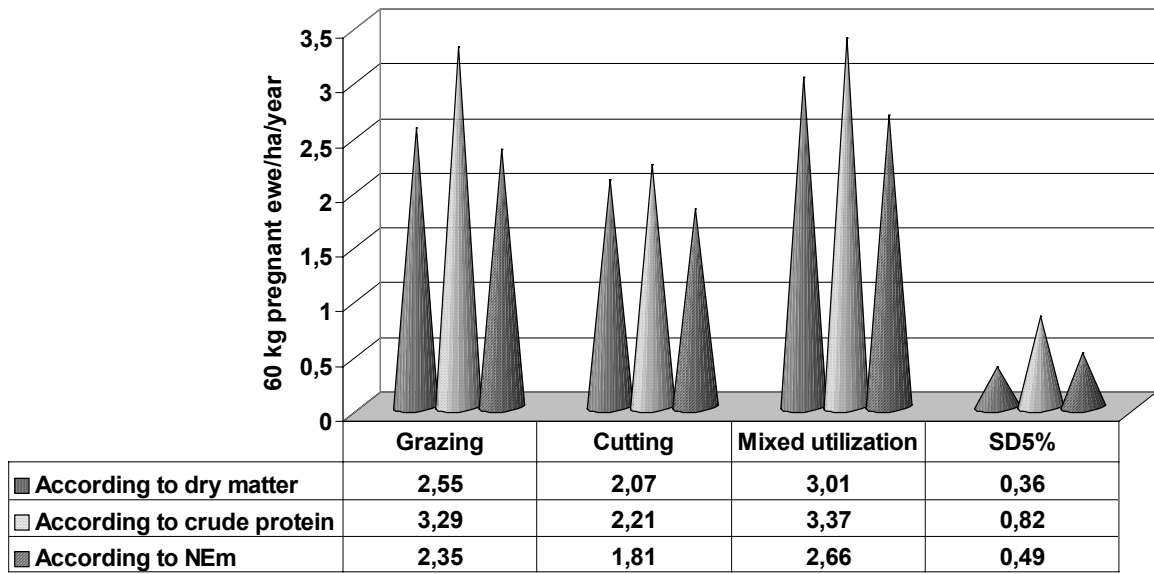


Figure 5. Effect of utilization system on sheep carrying capacity of Achilleo-Festucetum pseudovinae poetosum pratensis grassland association (Karcag, 1996-2000)

## 5. NEW AND NOVEL RESULTS OF THE DISSERTATION

The results, presented in my dissertation useable both for science and practise are summarized as below:

### 5.1. New results of the dissertation

- a) Analysing the yields of salt affected grassland associations utilized by mixed (1K+2L) utilization system, I established that measured yields of semi-rainy years are significantly higher than yields of semi-arid, dry and arid years on the basis of climate index among extensive cultivation conditions. The sheep carrying capacity values on the basis of annual weather were between 1.43-3.28 ewe/ha on *Achilleo-Festucetum pseudovinae* grassland association, 1.93-5.02 ewe/ha on *Achilleo-Festucetum pseudovinae poetosum pratensis* grassland association and 2,37-5,89 ewe/ha on *Agrostio-Alopecuretum pratensis* grassland association.
- b) In the case of single cutting utilization (1K) under extensive farming conditions the ground cover values of tall grasses and relative weeds of the *Achilleo-Festucetum pseudovinae pratensis* grassland association on salt affected soil had the highest values because of the utilization system changing from the mixed (1K+2L) to a single cutting (1K) in the research period. However the ground cover values of clovers and absolute weeds were the highest in the case of the grazing utilization system (4L) because of the zoogene effect.

### 5.2. Further result of dissertation

- a) On basis of climate index, the ground cover values of grasses and covers are significantly higher and the ground cover values of relative and absolute weeds are significantly lower in the semi-rainy year than in the arid year, on salt affected grassland association.
- b) I proved by exact yield data the advantage of the mixed grassland utilization system (1K+2L), in contradiction to the use of single utilization systems (4L and 1K) of *Achilleo-Festucetum pseudovinei petosum pratensis* grassland association on salt affected solonetz soil under extensive cultivation conditions. I measured the lowest yield values in the case of the single cutting utilization system (1K), that proved the importance of the effects of grazing animals.

## 6. THE RESULTS THAT CAN BE MADE USE OF IN PRACTICE

- a) The results of my research provide data based on the sward composition and yield of characteristic grassland associations of the arid Trans – Tisza region, so farmers can get supplementary information on planning the animal carrying capacity of grasslands with similar conditions.
- b) With my examinations, I proved that the one – direction extensive grazing utilization spread absolute weeds, and the one – direction cutting utilisation spread relative weeds in the *Achilleo–Festucetum pseudovinae poetosum pratensis* grassland association, therefore one – direction grassland utilizations can be applied only with careful circumspection in this grassland association.
- c) With the results of my research, I proved that one – direction extensive cutting utilization means giving up on the fodder yields of second growths, so this points out the value saving necessity of grassland exploitation by sheep grazing in the examined grassland association.  
The results of the experiments support the present practice of sheep farmers in this region.
- d) As chemical-free, naturefriend farming has been going on in the examined grasslands for 17 years, my results serve as a point of reference for farmers who choose the aid for farming supplied by the National Agricultural Environmental Project.

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