SZENT ISTVÁN UNIVERSITY GÖDÖLLŐ
FACULTY OF AGRICULTURAL- AND ENVIRONMENTAL SCIENCES

EFFECT OF PHENOLOGICAL PHASES OF GRASSES ON QUALITY AND GRAZING SEQUENCE

PhD THESES

JULIANNA TASI

GÖDÖLLŐ

2006

Doctoral School

Name: Doctoral School of Crop Production- and Horticultural Sciences

Discipline: Crop Production- and Horticultural Sciences

Head of PhD School:
Dr. Ferenc Virányi
professor, Doctor of Hungarian Academy of Sciences
SZIU Faculty of Agricultural- and Environmental Sciences,
Department of Plant Protection

Supervisor:
Dr. László Szemán
Head of Department, associate professor,
candidate in agricultural sciences
SZIU Faculty of Agricultural- and Environmental Sciences,
Institute of Crop Production,
Department of Grassland Management

…….

Dr. Ferenc Virányi
confirmation of Head of PhD School

……

Dr. László Szemán
confirmation of supervisor

Background and aims of PhD work

The Department of Grassland Management of the Faculty of Agricultural and Environmental Sciences of Szent István University carried out long-term experiments under the leadership of Professor Dr. Zoltán Barcsák to examine the popularity of various species of grasses and legumes in grasslands. Following the analysis of plant samples taken weekly at regular intervals and the measurement of plant height, possibility was afforded *to examine the relationship between characteristics significantly influencing the quality of fodder from pasture and the phenological phase (ageing) of species of grasslands*. Data originating from the Boldva area are evaluated, where grazing experiments were carried out with Hereford F_1 cattle and where the most detailed data of all the experiments were obtained.
The objective in this matter was to determine the idea of „good quality pasture", its characteristics and extent of these characteristics, as well as the effect of these changes on influencing quality parameters as time goes by.
After evaluation of grazing experiments carried out in Boldva, *according to preferred grazing sequence established by cattle the „judgement" of animals could be analyzed on fodder, which is of good quality in our opinion.* The preference of grazing sequence was measured by the number of bites taken and its average rate/grazing hour. The most important objective was to be informed of the "judgement" of cattle on good quality fodder and to determine parameters and values, which are of great importance for cattle in making up their diet on the pasture.

According to the mentioned above, the aims of our scientific work are as follows:

1. **Effect of phenological phase on the quality of grass fodder**
   - ♦ Determining changes of main fodder characteristics (fibre-, protein content, ratio of protein and fibre, digestibility) according to phenological phase (period of utilization)
   - ♦ Statistical analysis of the rate of decline in quality
   - ♦ Determining similarities and differences in the rate of decline in quality in grass species
2. **Factors influencing grazing sequence**
   - ♦ What kind of fodder characteristics do animals prefer
   - ♦ What does the preference of various species depend on
   - ♦ What is the effect of change of fodder quality by phenological phase on grazing sequence

Materials and methods

The working group has planted *12 grasses and legumes in pure plantation for grazing experiments* in Boldva (County of Borsod-Abaúj-Zemplén). *Table 1* illustrates the location of plots and sequence of investigated species. *The basic objective of the experiment was to determine the preference of species* by grazing, so 200 m long and 21 m wide plots have been formed. 3 different levels of fertilization have been applied: 100, 200 kg/ha N, added by 40 %-40 % P and K according to previously determined optimal NPK rate and control. The *experimental site* is located in the valley of Sajó with good water-balance. Soil is clay loam concerning physical structure, floodplain type, and acidic (pH 5.46). 0.1n HCl soluble nutrient concentrations are as follows: salt content 0.34 %, humus 2.8 %, NO_3-N 26 mg/kg, P 150-, K 310 mg/kg.
Hereford x magyartarka F_1 cattle have been grazed on the pasture in the experiment. The stock was made up of 100 cattle, 10 out of those have been investigated (those were marked with

red ribbon). After one day of adaptation to grazing land, always two days have been evaluated. Adjusted to three-day-consumption of grass was the experimental area marked out for the period of investigation. Cattle are most picky, when supply exceeds need by 20-30 % according to scientific literature. Due to that, one-day grass consumption was increased by 40 % and the area for three day grazing was formed with an electrical fence. Grazing lasted for 3-3 hours every day in the morning and in the afternoon, it started at 7 o'clock a.m. and 15 o'clock p.m., always depended on cooler period of the day. The observers recorded the bites taken per species and per fertilizer applications (plots) in a table. In order to determine the intensity of grazing, observers started a new line in each half-an-hour interval. Data recorded were summarized during processing. There was one observer for 10 marked cattle, who recorded the bites taken per plot. Fifty bites indicated one mark, in case the cattle left plot, surplus bites were recorded in numbers. The whole stock grazed together with observed ones by regulated grazing. Out of grazing time cattle were in grid and were offered only grazed grass. Data originate from the average of the observation of ten marked cattle. On the basis of average number of bites taken per hour, the preferences for certain species in first grass growth could be created.

The investigation of grazing does not belong to the PhD thesis, so further details are not mentioned.

Samples of first growth have been taken weekly from 4th May to 9th June 1980, six different times, in three replications.

In accordance with Hungarian Standard, the collected plant samples have been investigated in order to determine the dry matter content. By Weende-analysis the most important characteristics have been evaluated. Fibre-, protein- and moisture content data of the analysis were used during biometrical evaluation. Results of in vivo digestibility by the application of insoluble 4n HCl indicator carried out in sheep-pen, as well as tannic acid and soluble sugar content data have been used. At all times of sampling, measuring of plant height per plot was done weekly and evaluated, too.

Dates of sampling and phenological phases are shown in *Table 2*.

The following species belongs to the group of long grasses *Festuca pratensis, Festuca arundinacea, Bromus inermis, Phalaris arundinacea, Dactylis glomerata and Phleum pratense*. The following species belongs to the group of short grasses *Lolium perenne, Festuca rubra and Poa pratensis*. Legumes are as follows: *Trifolium repens, Lotus corniculatus and Coronilla varia*. According to phenological phases shown in the table, in different development states (from initial leaf formation to hay) the quality of various fodders containing different plants could be determined.

In order to state the rate of introduced plants per plot, by the quadrate method of Balázs (*Balázs, 1949*), monitoring of plant cover was done at all measuring times prior to grazing. On this basis, average cover of sown plants was between 70-90 % in the 3rd year after planting. *Coronilla varia* covered only 10 %, dominant species were dicotyledonous plants.

Table 1: **Block diagram of the experimental area** (Boldva, 1978-1980)

1. Trifolium repens	100 kg/ha N
	control
	200 kg/ha N
2. Festuca pratensis	200 kg/ha N
	control
	100 kg/ha N
3. Lolium perenne	100 kg/ha N
	control
	200 kg/ha N
4. Festuca arundinacea	200 kg/ha N
	control
	100 kg/ha N
5. Bromus inermis	100 kg/ha N
	control
	200 kg/ha N
6. Phalaris arundinacea	200 kg/ha N
	kontrol
	100 kg/ha N
7. Dactylis glomerata	100 kg/ha N
	control
	200 kg/ha N
8. Lotus corniculatus	200 kg/ha N
	control
	100 kg/ha N
9. Festuca rubra	100 kg/ha N
	control
	200 kg/ha N
10. Coronilla varia	200 kg/ha N
	control
	100 kg/ha N
11. Poa pratensis	100 kg/ha N
	control
	200 kg/ha N
12. Phleum pratense	200 kg/ha N
	control
	100 kg/ha N

During the evaluation in order to get more clear conclusion, the big amount of data was reduced by taking the average of results of control, with 100 kg/ha N and 200 kg/ha N fertilized plots. The average values are reported only. Calculations, the correlation-analysis and preparing graphs were made by a Pentium PC, Microsoft Excel 97- and -2000 programs. The evaluation and analysis was carried out according to SVÁB (1981). By the analysis of various factors and quality properties multiple regression-analyses was used.

Table 2: **State of development of the surveyed grasses at different sampling times**
(Boldva, 1980. V. 4.-VI. 10.)

Date of sampling	Typical phenophases	
	Long grasses	Legumes
1. 4-5 May	initial leaf formation	leaf-stage
2. 12-13 May	filling	budding
3. 19-20 May	heading-beginning of flowering	beginning of flowering
4. 26-27 May	flowering	full flowering
5. 2-3 June	seed formation	seed formation
6. 9-10 June	seed filling	seed filling

Results and conclusions

1. Concerning the subject of factors influencing the quality of pasture and the ageing rate of plants our most important achievements are as follows:

♦ During 35 days of development (1st growth), it was proved statistically, that in the case of 9 grasses and 3 legumes very close linear correlation was found between ageing (development state) and plant height, rate of fibre and crude protein content, rate of protein-fibre, as well as between the digestibility of organic matters.

♦ In the case of 12 investigated grass species was proved, that increasing fibre content had quite negative effect on digestibility of organic matter. 1 % increase of fibre content caused 2-2,5 % decline in digestibility by the investigated plants. The less than 2 % decline in digestibility of *Phleum pratense* and *Trifolium repens* meant an exception. Between decreasing crude protein by ageing and decreasing digestibility could not be proved in all investigated species. 1 % decrease in crude protein content has led to 1,5-2,5 % decrease in digestibility.

♦ In the case of 12 investigated species sequence-functions describe the rate of change of various nutrients and properties, which was varying by species. By sequence-functions the ageing rate of species can be determined, so the species can be classified to groups. *Bromus inermis, Phalaris arundinacea, Dactylis glomerata*, and concerning protein loss *Phleum pratense* were proved to be ageing fast.

♦ On the basis of sequence-functions and linears the optimal period of grazing of different species could be stated, compared the linears to linears of good quality fodder (according to scientific literature). According to protein-, fibre-, and digestibility of organic matter:

a) *Poa pratensis* and *Festuca rubra* in neither grazing period was in the category of good quality. *Festuca arundinacea, Phalaris arundinacea, Dactylis glomerata* and *Festuca pratensis* in the first decade of May (in initial leaf formation), *Phleum pratense* and *Bromus inermis* till the end of second decade (heading), *Lolium perenne* till the middle/end of third decade (flowering) could be grazed in good quality.
b) Legumes till the last date of measuring, *Lotus corniculatus* from the third decade of May; *Trifolium repens* from the end of May could be grazed in good quality.
c) From the beginning of June only legumes stayed in the category of good quality.

♦ By cluster analysis the similarities of investigated grass species can be determined on the basis of the connections of all properties.

2. On the basis of grazing behaviour of cattle and judgement on quality our most important achievements are as follows:

♦ On the basis of grazing behaviour of Hereford F_1 cattle, closest significant relationships were shown between number of bites taken, fibre- and protein content, protein-fibre ratio and digestibility of organic matter.

♦ On the basis of total correlations of all investigated characteristics, the dry matter- and tannic acid content of fodder, as well as the digestibility of organic matter have influenced mainly the number of bites.

♦ According to statistical correlations, there is an optimal range of quality for the animals, which was reached by several species, but was not preferred equally by the cattle.

♦ Hereford F_1 cattle regardless the changing quality of fodder (phenological phase) preferred *Phleum pratense* and *Lotus corniculatus,* generally preferred *Lolium perenne* and *Bromus inermis* species.

♦ Animals intended to graze grass of optimal quality in each grazing period; therefore their diets consisted of 4-6 species. The digestible nutrient content of most important species in cattle's diet always insured optimal and good quality of fodder.

♦ Grazing behaviour and making up diets totally suited the possible grazing sequence, which is in connection with the ageing sequence of plants and high quality nutrient content according to scientific literature.

♦ According to Hereford F_1 cattle, regarding first growth, the optimal quality pasture is: 12-20 % crude protein, 20-27 % fibre, 7-13 % sugar, 1,4-2,3 % tannic acid. Protein-fibre rate is between 1:1,2-2,3, digestibility of organic matter was between 61-78 %.

♦ According to grazing behaviour of cattle by the progress of time the ratio of grass species decreased and legumes increased in the fodder consumed (ratio was at the beginning of May 80:20 % and beginning of June 60:40 %).

♦ It was proved, that for beef cattle mixed grass ensured the best and optimal fodder quality, too.

Novel scientific results

1. In the case of 9 grasses and 3 legumes in pure plantation very close linear correlation was found in the first growth between phenological phase and plant height, rate of fibre and crude protein content, rate of protein-fibre, as well as between digestibility of organic matters. I classified species according to utility, on the basis of similarities and differences found in the rate of quality change.

2. By the application of sequence-functions (on the basis of change in quality by phenophases) I determined the range of optimal fodder quality and theoretical grazing period of 12 investigated species.

3. On the basis of statistically proved relationships, there is a range of optimal fodder quality. I stated that animals intended to graze grass of optimal quality in each grazing period; therefore their diets consisted of 4-6 species. The digestible nutrient content of most important species in cattle's diet always insured optimal and good quality of fodder. These species individually amounted to 10-20 % of number of bites taken and the digestible nutrient content always insured optimal and good quality of fodder.

4. Hereford F_1 cattle regardless the changing quality of fodder (phenological phase) preferred *Phleum pratense* and *Lotus corniculatus,* rest 2-4 preferred species were different regarding various phenophases.

5. On the basis of total correlations of all investigated characteristics, the dry matter- and tannic acid content of fodder, as well as the digestibility of organic matter have influenced mainly the number of bites. The influence of dry matter content was highest till the time of stooling, later tannic acid content and concerning withered species digestibility had high importance.

6. According to Hereford F_1 cattle, regarding first growth, the optimal quality pasture is: 12-20 % crude protein, 20-27 % fibre, 7-13 % sugar, 1,4-2,3 % tannic acid. Protein-fibre rate is between 1:1,2-2,3, digestibility of organic matter was between 61-78 %.

7. It is a methodological result, which for complex analysis of preference and characteristics of species in grasslands and determining similarities, the K-median analysis of cluster analysis is suitable. In order to select characteristics mostly influencing number of bites taken, multiple linear regression analysis is an acceptable method.

Recommendations

By drawing up mixtures of grasses it is advisable to take into consideration the results of grazing behaviour of beef cattle. Consequently, in the case of pasture of beef cattle:

1. First rotation lasts from middle April to end of May. In the beginning *Dactylis glomerata* can ensure dry matter-, and fibre-content needed, so it should be applied in 20 % at least in those pasture areas, where the grazing period is intended to be started.
2. Planting of *Bromus inermis* is advised, because in the second decade of May it takes over the role of *Dactylis glomerata*. In areas with good water-balance Festuca *pratensis* instead/beside could be mentioned as well.
3. *Lolium perenne* should be part of mixtures in ratio of 15 %, at the end of rotation with legumes can ensure appropriate fodder quality.
4. *Phleum pratense* – on areas, where dawn dew ensures its ecological requirements – must be a very important component of mixtures, because animals prefer consuming in all phenological phase.
5. Legumes – mainly *Lotus corniculatus* and *Trifolium repens* – recommended in ratio of 20-30 % primarily on pastures, where grazing is finished by that time, because in that period only these species can ensure appropriate digestibility.
6. In whole grazing period mixtures afford best quality fodder for beef cattle, too. By drawing up mixtures, the wonder of nature when creating species with different development rate must be taken into account. Mixture consisting species of different development rate or oversowing of pastures with other species ensures animals about grazing a good quality fodder in whole grazing period.
7. Organizing of grazing in advance is an important question. It worth keeping fewer legumes coverage (around 10 %) on areas of pasture, where grazing period is starting, because in the beginning the quality does not meet the requirements of animals. On areas, which are grazed in the second decade/end of May (aged grasses) the ratio of legumes should be higher. By increased rate of consumption of these species, animals can compensate the lower quality and digestibility of grasses by this time.
8. For researchers investigating preference of grass fodders, I advise the investigation of 3 phenophases definitely and for statistical evaluation multiple methods – a K-median analysis and multiple linear regression analysis – application.

Further scientific conclusions could be afforded, if mineral content of plant was investigated, as well. Surveying of nutrient content and preference of other species (mainly weeds) of natural grasslands might affect the account of quality of pasture, as well as by synthesizing existing results concerning this subject.

List of scientific publications with relevance to the PhD thesis (fodder quality, preference and tastiness of grass species)

Scientific articles

In Hungarian journals with impact factor:

1. *Tasi J.,* Barcsák, Z. (2000): Gyepnövények kedveltségének és néhány minőségi paraméterének összefüggése. Növénytermelés, Tom. 49. No. 6. 651-660. p.
2. *Tasi J.,* Barcsák, Z. (2001): Néhány gyepnövény fejlődési fázisa és takarmányminőségének változása közötti összefüggések vizsgálata. Növénytermelés, Tom. 50. No. 1. 31-42. p.
3. Tasi J. (2004): Pázsitfűfélék és nem fűféle gyepalkotók makroelem-, szelén- és nehézfémtartalma. Növénytermelés, Tom. 53. No. 4. 375-387. p.

In foreign languages, in lectored journals:

1. Z. Barcsák, B. Benyovszky, T. Kispál, L. Szemán, J. *Tasi* (1999): Methodik der Erfassung des Selektions- und Freßverhaltens von Weidetieren. Zeitgemäße Weidewirtschaft. 5. Alpenländisches Expertenforum, Gumpenstein. BAL BERICHT 1999/2. 49-53. p.
2. *Tasi* J., Barcsák Z. (2005): Selektions- und Fressverhalten von Weidetieren. AWETH (Animal welfare, ethology and housing systems) Vol. 1. 32-50. p. Elérhetőség: http://www.animalwelfare.szie.hu
3. Tasi J. (2005): Heavy metal, macro- and microelement content of grass species and dicotyledons. Acta Agronomica Hungarica, Tom. 53. No. 3. 349-352. p.
4. Opitz von Boberfeld, W., K. Banzhaf, F. Hrabe, J. Skladanka, S. Kozlowski, P. Golinski, L. Szemán, J. Tasi (2006): Effect of different agronomical measures on yield and quality of autumn saved herbage during winter grazing – 1st communication: Yieldand digestibility of organic matter. Czech Journal of Animal Science. Megjelentetésre elfogadva.
5. Opitz von Boberfeld, W., K. Banzhaf, F. Hrabe, J. Skladanka, S. Kozlowski, P. Golinski, L. Szemán, J. Tasi (2006): Effect of different agronomical measures on yield and quality of autumn saved herbage during winter grazing –2nd communication: Crude protein, energy and ergosterol concentration. Czech Journal of Animal Science. Megjelentetésre elfogadva.

In Hungarian, in lectored journals:

1. Barcsák Z. -Worku A. –*Tasi J.* (1990): Különböző gyepnövények takarmányainak (zöld, széna, szilázs) emészthetősége. Állattenyésztés és Takarmányozás. No. 5. 473-480. p.
2. Bajnok M., Rostás M., *Tasi J.* (2000): Néhány legelő és rét növényzetének értékelése a takarmányozás szempontjából. Állattenyésztés és Takarmányozás, Tom. 49. No. 3. 247-256. p.

3. *Tasi J.,* Barcsák Z., Kispál T., Szemán L. (2004): Legelő állatok takarmányválogatási viselkedése. (Forage selecting behaviour of grazinganimals) Állattenyésztés és Takarmányozás (Hungarian Journal of animal production), Vol. 53. No. 4. 373-383. p.
4. Szemán L, Barcsák Z, *Tasi J.* (2004): Gyepalkotó fajok és fajták válogatási sorrendje, anyajuhok legelési viselkedése alapján. (Preference order of grassland species and varieties based on the grazing behaviour of ewes) Állattenyésztés és Takarmányozás (Hungarian Journal of animal production), Vol. 53. No. 4. 385-393. p.

Other publications:

1. Tasi J. (2005): Néhány juhlegelő biodiverzitása. Magyar Juhászat, 14. évf. 2005/3. X-XI. p.

Conference proceedings:

In foreign languages:

2. Kispál, T., Barcsák Z., Szemán L., *Tasi* J. (1994): Palatibility examinations on unmix sowed and natural pasture. "The Future of Tropical Savannas, Managing resources and resolving conflicts", CSIRO Townsville, Australia, July 17-22 1994. XVII. International Grassland Congress. Proceedings 20-22. p.
3. Kispál, T.-Barcsák Z., Szemán L., *Tasi*, J.(1996): Diet selection techniques in natural grasslands. CSIRO Australia. The Future of Tropical Savannas: An Australian Perspective. Proceedings 20-21.p.
4. Barcsák, Z., Szemán L., *Tasi* J.(1996): Preferencia Examination Grazing on Pasture Stands of Established Pastural Plants. Grassland Management Meeting at the Hungarian Academy of Science, Debrecen. 315-320.p.
5. Barcsák, Z., Kispál T., Szemán L., *Tasi* J. (1997): Zuckergehalt und Schmackhaftigkeit einiger Gras- und Kleearten in Reinsaat. Proceedings of the conference on nutrition of domestic animals „Zadravec-Erjavec Days", Radenci. 73-82. p.
6. Kispál, T., Barcsák Z., *Tasi J.* (1998): Palatability examination of natural grasses using sheep. Proceedings of the 17th General Meeting of the European Grassland Federation 235-238. p.
7. *Tasi*, J., Czinkota I., Kispál Z., Füleky Gy. (1998): Einfluß von Boden und Pflanzenbestand auf Grünfutterqualität des Grünlandes in Ungarn. 110. VDLUFA Kongress in Giessen. Kongreßband 353-357. p.
8. Kispál, T., *Tasi J.* (1998): Effect of a natural ranglands botanical composition to the sheep selection activity. Fifth International Symposium on the Nutrition of herbivores. Texas Agricultural Experiment Station. 235-239.p.
9. Barcsák, Z., *Tasi J.* (1998): Vergleich der Futterqualität einiger Dauergrünlandarten als Frischfutter und als Konserve (Silage und Heu). Proceedings of the conference on nutrition of domestic animals „Zadravec-Erjavec Days", Radenci. 22-29.p.

10. *Tasi, J.,* Kispál T., Barcsák Z. (1999): Über den Rohfasergehalt einiger Grasarten in unterschiedlichem Alter, sowie dessen Einfluß auf die Schmackhaftigkeit des Futters. Proceedings of the conference on nutrition of domestic animals „Zadravec-Erjavec Days", Radenci. 21-31. p.
11. *Tasi,* J., Póti P., Kispál T., Füleky Gy. (2001): Einfluß des Schwermetallgehaltes von Böden und des Weidefutters auf die Qualität von Schafmilch. Proceedings of the 10th Conference on Nutrition of Domestic Animals "Zadravec – Erjavec Days". 216-222. p.
12. *Tasi,* J., Barcsák Z. (2003): Relationship between the phenological phase of grass and the quality of fodder. Proceedings of the 12th conference on nutrition of domestic animals "Zadravec-Erjavec Days". 205-216. p.
13. Tasi J. (2004): Macroelement, microelement and heavy metal content of grass species and dicotyledons. EGF Luzern, Svájc. Proceedings Volume 9. Szerk. Lüscher A., B. Jeangros, W. Kesler, O. Huguenin, M. Lobsiger, N. Millar, D. Suter. 1002-1005. p.
14. Tasi J. (2004): Trockenresistenz einiger Gras- und Kleearten in Abhängigkeit der Erntezeit. Zbornik Predavanj, 13. Proceedings of the 13th conference on nutrition of domestic animals "Zadravec-Erjavec Days". Radenci, Szlovénia. 106-115. p.

In Hungarian:

1. *Tasi J.* (1991): Néhány gyepnövény termésének alakulása különböző fejlődési stádiumban. A legelő az emberiség szolgálatában. Tudományos tanácskozás, Debrecen, 54-60. p.
2. *Tasi J.* (1992): Különböző gyepnövények termésének értékelése eltérő fenofázisban. Természetes állattartás. Tudományos és Termelési Tanácskozás. Szolnok, 189-199. p.
3. *Tasi J.,* Szőke Sz. (2001): Gyepnövényzet minősége néhány termőhelyen. Debreceni gyepgazdálkodási Napok 17. Gyepgazdálkodásunk helyzete és kilátásai. Tudományos konferencia. Debrecen, 88-92. p.
4. *Tasi J.,* Szőke Sz. (2001): A gyep növényzetének összetétele és minősége néhány termőhelyen. Innováció, a tudomány és a gyakorlat egysége az ezredforduló agráriumában. Tudományos konferencia. Gödöllő-Debrecen, 107-111. p.
5. Tasi J. (2002): Pázsitfűfélék és nem fűféle gyepalkotók makro- és mikroelem tartalma. Innováció, a tudomány és a gyakorlat egysége az ezredforduló agráriumában. Tudományos konferencia. Debrecen-Gödöllő, 294-301. p.
6. *Tasi J.*, Szőke Sz., Kovács M. (2003): Különböző növényállományú gyepek takarmányminősége. III. Növénytermesztési Tudományos Nap, Proceedings, Budapest. 270-275. p.
7. Barcsák Z., Szemán L., *Tasi J.* (2003): Fűízletességi (preferencia) vizsgálat Limousine és Hereford húsmarhákkal. EU konform mezőgazdaság és álelmiszerbiztonság, SZIE Gödöllő-DE Debrecen. Proceedings, I. kötet 260-267. p.
8. Barcsák Z., Szemán L., *Tasi J.* (2003): 21 féle gyepnövény ízletességi (preferencia) vizsgálata juhokkal. Új eredmények és tendenciák az animal welfare, a környezet és az etológia területén. Gödöllő, 53-60. p.

9. Tasi J. (2005): Néhány juhlegelő biodiverzitása. Gyep-Állat-Vidék-Kutatás-Tudomány. DE, Debrecen, 225-230. p.

Abstracts, posters:

In foreign languages:

1. *Tasi*, J., Czinkota I., Kispál T., Füleky Gy. (1998): Einfluß von Boden und Pflanzenbestand auf Grünfutterqualität des Dauergrünlandes in Ungarn. 110. VDLUFA-kongress in Giessen. Kurzfassungen der Vorträge. 219. p.

In Hungarian:

1. Barcsák Z., Szemán L., *Tasi J.* (1986): A műtrágyázás hatása a gyepek termésére, táplálóanyag tartalmára és ízletességére. A VII. ötéves terv kutatási eredményei. Tudományos ülésszak, Gödöllő, 73-74. p.
2. Tasi J.(1988): A potenciális termőképesség jobb kihasználásának lehetőségei célirányos gyeptelepítéssel. Mezőgazdasági Tudományos Napok, Gödöllő, 44. p.
3. Barcsák Z., Szemán L., *Tasi J*. (1996): Tisztán telepített gyepnövények legeltetéses preferencia vizsgálata. Gyepgazdálkodási Szakülés előadásai, Debrecen. 83-84. p.

Books, -chapters, editing:

1. Környezetvédelmi Lexikon I-II. Főszerkesztő: Láng István, Akadémiai Kiadó, Budapest. 1993
2. Tasi J. (2000): A gyepgazdálkodás minőségszabályozása. In: Minőségbiztosítás az agrárgazdaságban. Műszaki Könyvkiadó, Budapest. Könyvrészlet. 173-188. p.
3. Környezet- és Természetvédelmi Lexikon I.-II.(2002) szerk.: Láng István, második, átdolgozott, bővített kiadás, Akadémiai Kiadó, Bp.

Alltogether: 43 publications