Ph.D. THESIS

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COMPARISON OF THE GREEN YIELDS AND NUTRITIONAL YIELDS OF DIFFERENT GREEN FODDER MIXTURES

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1. PRELIMINARIES AND OBJECTIVES OF THE STUDY

Roughage produced either on crop fields or grasslands is basic source in ruminants' nutrition. Until the 1970's the green fodder mixtures that were natural and abound in mineral matter, vitamins, and good energy-protein relation had been important for ruminant nutrition. Many farms used the "green chain", especially the well-known "Iregszemcsei forage growing System" (KURNIK, 1966).

Establishment of concentrated and specialized cattle farms and expanding demand for animal production led to using more monodietical nutrition and grain in the ratio. Under economic pressure, the majority of middle and small sized farms need to reduce their costs of feeding. Therefore, in case of semi-intensive milk and beef production, as well as heifer raising on these farms, there is a demand for a green fodder based diet during the vegetation period. In smaller plants, monodietical feeding can be changed for season dependent nutrition and a system of combined nutrition. We expect to improve the importance of the green fodder mixtures even where there aren't enough grasslands or the quality of it isn't adequate. In order to achieve a more efficient system of green feeding it is necessary to introduce new species in ruminant nutrition as green fodder, which nutritional value has not been exactly evaluated yet. In my opinion, nutrition of semi-intensive ruminant production can be cheaper, more natural and balanced.

The objectives of the dissertation and the researches carried out were to analyse:

- the nutrient content and the potential green, dry matter and crude protein yields of species in pure stands as well as in green fodder mixtures, in small plot comparison experiments of different species and types of roughage;

- in feeding experiments, the nutrient digestibility, as well as the net energy and energy dependent and nitrogen dependent metabolisable protein content of different green fodder mixtures;
- whether the yields and nutrient contents of different green fodder mixtures being used nowadays are different from those used in the years 1960 to 1970;
- which new species or mixtures can be used in green chains instead or beside of the traditional species.

2. MATERIALS AND METHODS

2.1. Small plot comparison experiments of species, types and mixtures

These experiments were carried out on species of green fodder mixtures being used in ruminant nutrition, at the Experimental and Educational Facility of the Faculty of Animal Sciences, University of Kaposvar, between 2002 and 2004. During the vegetation period, the temperature and precipitation were also recorded.

According to the OMMI recommendations, the treatments were designed in four repetitions in randomized complete block design in small plots of 1.4 m x 9.2 m. The treatments of the experiments were the different species and mixtures. *Table 1* shows the seeding figures of spring and autumn species and mixtures.

The small plots were seeded by WINTERSTEIGER for 12 cm row-distance and in 2-4 cm deep. Harvesting was done by HALDRUP at the beginning of blooming of the crop components. During the vegetation period, the development status of the plants and the date of change in the phenological phases were recorded.

Table 1:
Species, types and germ count of pure green fodders and mixtures, 2002-2004.

Nomination	Germ count pcs/ha	
	Component 1	**Component 2**
Spring seedings		
pea with barley; Annabell-Rubin	1 000	500
pea with oat; Bakonyalja-Rubin	1 000	500
spring barley; Annabell	3 000	-
oat; Bakonyalja	3 000	-
pea; Rubin	1 200	-
Autumn seedings		
keszthelyi mixture rape with rye; Matador-Valesca	2 500	4 000
keszthelyi mixture rape with rye; Protector-Valesca	2 500	4 000
keszthelyi mixture rape with triticale; Filius-Valesca	2 500	4 000
pannon vetch with rye; Matador-Beta	2 000	2 000
pannon vetch with rye; Protector-Beta	2 000	2 000
pannon vetch with barley; Nelly-Beta	2 000	2 000
pannon vetch with barley; Viktor-Beta	2 000	2 000
pannon vetch with triticale; Filius-Beta	2 000	2 000
rye; Matador	4 000	-
rye; Protector	4 000	-
barley; Nelly	4 000	-
barley; Viktor	4 000	-
triticale; Filius	4 000	-
pannon vetch; Beta	4 000	-
rape; Valesca	8 000	-

As difference was not found in the development of the mixtures, harvesting of certain experiment was always done at the same time, ensuring similar

environmental conditions. After harvesting, the green yields produced on plots were measured and the yields per hectare were calculated.

2.2. Laboratory analysis of fodder mixtures and the components

Average samples of 4 to 5 kilograms of the second and third repetitions were analysed to find out the nutrient content of the different treatments. After determining the dry matter and nutritive content, the percentage of crude protein, crude fat, crude fibre, crude ash and nitrogen-free extract in the dry matter was calculated; and using the figures of the yields per hectare, the dry yield and the crude protein yield per hectare were calculated, also.

2.3. Feeding experiments

In the utilisation trials, the harvest of pannon vetch with barley and pannon vetch with triticale were used that were seeded and harvested on 500 square meter fields in similar conditions to the seeding and harvesting of the experimental plots. The harvested feed was chopped and frozen. The crude nutritive content of the samples were determined both before and after freezing.

The utilisation experiments were set up in Herceghalom (ÁTK). A simple digestion trial was done with three Merino wethers that were put individually into metabolical cages **(**CZAKÓ, 1982). The animals were given 4 000 grams feed daily. Firstly, the nutrient content of samples of feed and faeces were determined; then the digestibility of crude protein, crude fat, crude fibre and nitrogen-free extracts was calculated. In the end, the net energy for maintenance, growth and lactation (NE_m, NE_g, NE_l), and the metabolisable protein dependent on nitrogen (MFN) and energy (MFE) content were defined (SCHMIDT ET AL, 2000).

2.4. Statistical tests

The statistical analysis was done with SPSS 10.0 at 5% significance level ($p \leq 0.05$). One-way analysis of variances was used to test the yield figures of the experiments and the averages of the three years of the different treatments. Homogeny of the samples was tested by Levene method; while Shapiro-Wilk test was used to analyse the normality of the data.

3. RESULTS

3.1. Small plot experiments

The weather of the experimental years resulted higher difference of the yield figures and nutrient contents than that found between the treatments within a year, in many cases. According to the phenological results, the crop components of mixtures come into harvestable phase at the same time.

Green yields of spring mixtures

In the average of the three years analysed, pea with oat gave 3.5 tons more green yield per hectare than pea with barley *(Table 2).*

Table 2:

Green yield of spring mixtures fodders and its components, 2002-2004.

Nomination	Green yield t/ha			
	2002	**2003**	**2004**	**Average**
pea with barley; Annabell-Rubin	27,2^{a}	12,2^{a}	14,9^{a}	18,1^{ab}
pea with oat; Bakonyalja-Rubin	32,3^{b}	10,9^{a}	21,7^{b}	21,6^{ab}
spring barley; Annabell	30,7^{b}	10,3^{a}	9,3^{c}	16,7^{b}
oat; Bakonyalja	36,8^{c}	15,0^{b}	19,3^{d}	23,7^{a}
pea; Rubin	26,4^{a}	11,1^{a}	24,0^{e}	20,5^{ab}
$Sz.D_{5\%}$	2,8	2,5	2,09	6,88

This difference was not significant despite of that pea with oat gave significantly higher yields in 2002 and 2004 than the mixture with barley. In the average of the three years analysed, the highest yield was given by oat and the lowest by barley. The difference was significant both in average of the three year and annually. Pea, with higher yield than barley and lower than oat, was found different from neither the crop components nor the mixtures. The green yields of mixtures were between those of their components in 2002, 2004 and in average of the three years. Pea with oat gave higher yields per hectare than pure pea, while pea with barley did so than barley. Mixtures, although, were not found different from either each other or their components.

Nutrient content, dry matter and crude protein yield of spring mixtures

In the average of three years, the dry matter content of the mixtures was similar to each other *(Table 3)* at the start of flowering. Contrary, in 2002-2003, pea with barley had 12-13 g/kg higher dry matter; while in 2004 pea with oat had 24 g/kg higher dry matter content. Despite of these, the dry matter yields were significantly different in 2002 and 2004. In the average of three years, pea with oat was better with 0.6 t/ha, which was not significant. Looking at the components, the dry matter content of barley was higher than that of oat, although the difference of the three years was not significant. Contrary, barley produced almost 1 t/ha lower dry matter yield than oat, which was due to the significantly higher figures in 2002 and 2004 in case of oat. In the average of three years, pea gave significantly less dry matter yield than oat; the difference is 1 t/ha compared to spring barley; which was due to the low dry matter content of pea.

Table 3:
Dry matter and crude protein content and yield of spring mixtures, 2002-2004.

Nomination	Dry matter content g/kg feed				Dry matter yield t/ha			
	2002	**2003**	**2004**	**Average**	**2002**	**2003**	**2004**	**Average**
pea with spring barley; Annabell-Rubin	201	238	169	203^{ac}	5,46^{a}	2,90^{a}	2,52^{a}	3,6^{a}
pea with oat; Bakonyalja-Rubin	189	225	193	202^{ac}	6,10^{b}	2,44^{ac}	4,18^{b}	4,2^{ab}
spring barley; Annabell	240	275	259	258^{b}	7,36^{c}	2,83^{a}	2,40^{a}	4,3^{ab}
oat; Bakonyalja	204	241	229	225^{ab}	7,50^{c}	3,62^{b}	4,41^{b}	5,2^{b}
pea; Rubin	161	197	145	168^{c}	4,24^{d}	2,18^{c}	3,47^{c}	3,3^{a}
Sz.D$_{5\%}$	-	-	-	39,7	0,56	0,59	0,29	1,37
Nomination	**Crude protein content g/kg feed**				**Crude protein yield t/ha**			
	2002	**2003**	**2004**	**Average**	**2002**	**2003**	**2004**	**Average**
pea with spring barley; Annabell-Rubin	161	176	175	171^{a}	879^{a}	510^{a}	441^{a}	610^{ab}
pea with oat; Bakonyalja-Rubin	147	167	150	155^{b}	897^{a}	407^{b}	627^{b}	644^{a}
spring barley; Annabell	107	132	127	122^{c}	787^{b}	374^{b}	305^{c}	489^{b}
oat; Bakonyalja	111	128	119	119^{c}	832^{ab}	463^{ab}	525^{d}	607^{ab}
pea; Rubin	199	215	205	206^{d}	844^{ab}	469^{ab}	712^{e}	675^{a}
Sz.D$_{5\%}$	-	-	-	15,9	79	92	61	153,8

The dry matter content of the mixtures was between that of the components. The difference was significant between spring barley and pea with spring barley. Thus the dry matter yield of the mixtures was lower than that of the grain components and higher than that of pure pea. The differences found were not significant.

In the average of the three years, the crude protein contents of the mixtures and the components were different. Pea with spring barley had significantly higher (+16 g/kg) crude protein content than pea with oat. Contrary, the crude protein yields of these mixtures were similar in 2002. In 2003, pea with spring barley and in 2004 pea with oat gave significantly higher crude protein yield. Spring barley and oat on their own had almost the same level of crude protein, while pea had significantly higher (with more than 80 g/kg) crude protein content, in the average of the three years. Thus, pea gave more than 30 kg and 65 kg more crude protein yield per hectare than pea with oat and pea with spring barley, respectively. Although, there was not significant difference found. Thus, almost similar crude protein yield per hectare can be achieved with these mixtures to pure pea. Further, mixtures gave higher crude protein yield than the grain components. The difference was only 37 kg/ha between oat and pea with oat, due to the relatively high green yield and dry matter content of oat. Between pea with spring barley and spring barley, the difference found was much higher: 121 kg/ha; however it was not significant, due to the large difference between the experimental years. Concluding, during the three years analysed, pea proved to be a good component in spring barley or oat mixtures – even in extreme whether conditions. Thus it contributed to ensuring the success of production and yield security.

Nutrient content and yield of autumn mixtures

Mixtures with rape did not give reliable results in any years of the experiment. It was caused by the development status of the plant during wintertime. It was found that mixtures of rye and those of barley gave similar green and dry matter yields. Compared to these, pannon vetch with triticale gave significantly higher green and dry matter yield; although its crude protein

yield did not differ statistically from that of pannon vetch with barley. Mixtures of pannon vetch with rye had similar green and dry matter yield to barley with hairy vetch, although the crude protein yield of the previous was significantly lower.

The dry matter content of pannon vetch and triticale was similar to that of pannon vetch with barley, with lower crude protein content. Its crude fibre content was dependent on the weather; with lower (247 g/kg) figure in arid period and higher in humid years (306 g/kg) volt. Vetch is a good component in triticale mixtures; and it can be successfully produced both in humid and arid conditions.

3.2. Feeding experiments with autumn green fodder mixtures

Nutrient content

Based on the results obtained *(Table 4),* the dry matter content of the two mixtures analysed was similar (222 g/kg, 223 g/kg, respectively). Pannon vetch with barley gave 28 grams more crude protein and 43 grams less crude fibre in 1 kg dry matter than pannon vetch with triticale. The neutral detergent fibre content of the mixture Pannon vetch with barley is higher; while its acid detergent fibre and especially the acid detergent lignin content are lower, compared to the mixture of triticale and hairy vetch.

The nutrient content of the mixtures analysed was compared to the figures of other autumn green fodders found in the literature and to green and fermented roughages. According to the literature, autumn wheat mixtures with pannon vetch and that with hairy vetch have better nutrient values than the mixtures analysed in our experiments. Contrary, pannon vetch with rye had higher crude fibre content than pannon vetch with barley, higher dry matter level and lower crude protein level, even compared to pannon vetch with

triticale. Pannon vetch with barley had higher dry matter and lower crude protein content and more than 50 g/kg higher crude fibre content than the mixture of pannon vetch and barley analysed in the experiments. Feeding rapes and green alfalfa with flower buds or at start of flowering had higher crude protein content than the analysed mixtures. While the crude fibre, as well as the dry matter content of rapes were almost the half of those of pannon vetch with barley. Maize silages had lower crude protein and crude fibre and significantly higher NFE level than those of the pannon vetch with barley and with triticale.

Table 4:

Nutrient content of mixtures used in utilisation trials

Dry matter and nutrient content									
Nomination	**Dry matter**	**Crude protein**	**Crude fat**	**Crude fibre**	**Crude ash**	**NFE**	**NDF**	**ADF**	**ADL**
	g/kg feed	**g/kg dry matter**							
pannon vetch with autumn barley	222	165	18	304	78	435	586	348	39
pannon vetch with triticale	223	137	20	347	76	420	542	406	58

Digestibility

The digestibility of crude protein and crude fibre was 5 and 8 percent lower, respectively, than those of the barley mixture *(Table 5)*. The smallest difference was found in case of the digestibility of crude fat of the mixtures (2%). The nutrient digestibility of the mixtures analysed was better with 1-1 exception than the figures of other green fodder mixtures and of those found literature. The digestibility coefficients are shown in *Table 5*.

Table 5:

Digestibility of nutrients of analysed mixtures and other green and fermented fodders

Nomination	Crude protein	Crude fat	Crude fibre	NFE
	%	%	%	%
pannon vetch with autumn barley	78	52	73	75
pannon vetch with triticale	73	50	65	70
pannon vetch with rye	71	34	37	60
pannon vetch with autumn barley	70	66	47	67
pannon vetch with wheat	63	49	56	60
hairy vetch with wheat	70	48	51	75
green alfalfa with flower buds	79	45	51	74
alfalfa prebloom fresh	73	41	44	65
rape	77	55	70	78
maize silage milk stage	56	71	66	68
maize silage dough stage	55	75	64	74

HEROLD (1977); VÁRHEGYI ET AL, IN KAKUK - SCHMIDT, (1988); SCHMIDT ET AL, (2000)

Net energy and metabolisable protein content

Table 6 shows the net energy and the MFE and MFN contents of pannon vetch with barley and pannon vetch with triticale, in comparison with similar parameters of other green and fermented fodders published in literature. Due to the better digestibility found, the net energy and metabolisable protein content of pannon vetch with barley were higher than those of the mixture pannon vetch with triticale. The MFE and MFN content of pannon vetch with barley

were 13 g/kg and 19 g/kg dry matter higher, respectively, than those of the triticale mixture.

Table 6:

The nutrient value of different green fodders, as expressed in MJ per kg dry matter and in the percentage of the pannon vetch with barley

Nomination		Ne_m		Ne_g		Ne_l		MFE		MFN	
		MJ/kg d. m.	%	MJ/kg d. m.	%	MJ/kg d. m.	%	g/kg d.m.	%	g/kg d.m.	%
pannon vetch with barley	1	6,72	100	4,19	100	6,31	100	95	100	97	100
pannon vetch with triticale	2	6,04	90	3,59	86	5,83	92	82	86	78	80
pannon vetch with rye	3	4,21	63	1,91	46	4,50	71	-	-	-	-
pannon vetch with barley	4	5,65	84	3,23	77	5,77	91	-	-	-	-
pannon vetch with wheat	5	5,18	77	2,81	67	5,42	86	-	-	-	-
hairy vetch with wheat	6	5,97	89	3,53	84	5,94	94	-	-	-	-
green alfalfa prebloom fresh	7	5,58	83	3,17	76	5,71	90	97	102	126	130
green alfalfa prebloom fresh 2-00-181	8	5,48	82	3,10	74	5,77	92	-	-	-	-
green alfalfa prebloom fresh 2-00-181	9	5,9	88	3,47	83	5,95	94	-	-	-	-
green alfalfa early bloom 2-00-184	10	5,48	82	3,10	74	5,62	89	-	-	-	-
rape	11	6,51	97	4,01	96	6,34	100	101	106	131	135
rape early bloom 2-03-867	12	7,98	119	5,03	120	7,51	119	-	-	-	-
rape fresh 2-03-866	13	7,48	111	4,84	116	7,09	112	-	-	-	-
maize silage milk stage	14	6,12	91	3,65	87	5,90	94	66	69	57	59
maize silage dough stage	15	6,78	101	4,24	101	6,42	102	73	77	55	57
maize silage milk stage 3-02-818	16	5,90	88	3,47	83	5,73	91	-	-	-	-
maize silage dough stage 3-02-819	17	6,65	99	4,22	101	6,27	99	-	-	-	-
maize silage few ears 3-28-245	18	5,74	85	3,35	80	5,63	89	-	-	-	-
maize silage well ears 3-28-250	19	6,82	101	4,31	103	6,46	102	-	-	-	-
maize silage immature <25 % DM 3-28-247	20	6,19	92	3,72	89	5,69	90	-	-	-	-
maize silage normal 32-38 % DM 3-28-248	21	6,57	98	4,06	97	6,07	96	-	-	-	-

[3;5;6] VÁRHEGYI ET AL, IN KAKUK - SCHMIDT, (1988); [4]MI-08-0350-1989; [7-10] SCHMIDT ET AL, (2000); [8;13;16;17] ENSMINGER ET AL, (1990); [9;10;12;18-21] NRC, (1985,2000,2001)

Pannon vetch with barley and with triticale[1;2] had higher net energy content than the other green fodders, with an exception of the mixture hairy vetch with wheat[6] its NE_l content was only 0.11 MJ/kg dry matter higher than that of the pannon vetch with triticale[2]. The difference was the most eye-catching between the mixtures of pannon vetch with barley[1] and pannon vetch and barley[4], which is interesting.

4. CONCLUSIONS

- The development of spring and autumn mixtures seeded at the same time was similar in the experiment; the mixtures seeded at the same time become harvestable at the same time. Therefore, harvesting can be well scheduled, depending on the timing of seeding.

Green fodder mixtures seeded in springtime

- In case of a late spring seeding (end of April) a better development of pea could be seen compared to the grain components; which is proved by the dry matter and crude protein content of the mixtures. Thus, besides of climatic conditions, the ratio of the components is highly influenced by the timing of seeding, as well. This needed to be considered when the germ count and the germ proportion of the components are set up.
- The potential for draught resistance of the components and the competition for water highly influence the yield and nutrient content of the green fodder mixtures. In the experiment, a depressed yield was seen in case of both components of the mixtures due to the dry weather. The depression was even higher in case of mixtures with increased germ count, which results are not included in the dissertation. In extreme weather conditions, it is

recommended to apply lower germ count per hectare, thus the yield security can be better and the compensating potential of the components can be used. It was found that even mixtures with lower germ count exploited the cropping field, which was proved by the small plot results obtained in 2002 and 2004.

- It was also found that the individual components of mixtures have comparative advantage when are produced in mixtures, in case of both the grain and legumes components. Pea with barley and pea with oat gave at least the same or higher green yield and crude protein yield than the pure population of the components. The reason for it – agreeing with KURNIK (1966) LÁNG (1966) and HEROLD (1977) – is that the water and nutrient content of soil are better used by mixtures, the cropping field can be better used, while competitive inhibition does not emerge or only in extreme conditions.
- The potential yield and the protein content per dry matter kg of oat and vetch mixture are lower according to the literature figures than it was found in the small plot experiments done with mixtures of pea and barley and pea and oat. This reflects on that during the three years of the trial, pea was a reliable component in barley and oat mixtures even in extreme weather conditions. Pea improved the success of production and the yield reliability. In spring mixtures with barley or oat, the vegetative types of pea are recommended as leguminous component instead of using the “traditional” vetches, with special regard to the crude protein content.

Green fodder mixtures seeded in autumn

- The analysed mixtures with rye, autumn barley and triticale produced significantly higher crude protein yield per hectare than the components in pure stand. This obviously shows the comparative advantage of mixtures on pure stands.
- The higher crude protein yields achieved by mixtures can be explained by a staking effect of the grain components; which is favourable for the growth of pannon vetch. The experiments proved that without staking plants, the moisture micro climate of the soil surface kills the lower leaves of the vetch.
- In the feeding trials done with the mixtures of pannon vetch with barley and pannon vetch with triticale it was found, that the nutrient content, especially the crude protein content of the mixture is metabolisable at a higher extent than it is published in the literature. Feeding these mixtures provides well balanced energy – protein content and good dietetic feed for ruminants.
- Despite of a relatively higher crude fibre content, the digestibility of the nutrients and the net energy content of the analysed mixtures were better than those of green fodders with similar or lower crude fibre level published in literature; which is an opposite of numerous authors' statements.

5. NEW SCIENTIFIC RESULTS

- In small plot trials, in 2 to 1 germ proportion at seeding, I have determined the green yield, dry matter and crude protein yields and dry matter and nutrient content per hectare of green fodder mixture of pea and barley, with a variety composition Annabell-Rubin that have not been analysed yet, harvested at the beginning of flowering.
- In small plot trials, with given germ count and germ proportion (2 to 1), I have determined the green yield, dry matter and crude protein yields and dry matter and nutrient content per hectare of green fodder mixture of pea and oat, with a specie composition Bakonyalja-Rubin that have not been analysed yet, harvested at the beginning of flowering.
- In animal feeding trials, first time in Hungary, I have defined the digestibility of the nutrients and the net energy, energy and nitrogen dependent metabolisable protein contents of the mixture pannon vetch with triticale with a variety composition Filius-Beta, at flowering stage.
- In animal feeding trials, I have defined the digestibility of the crude nutrients and the net energy, energy and nitrogen dependent metabolisable protein contents of the mixture pannon vetch with barley with a variety composition Viktor-Beta that have not been analysed yet, at flowering stage.
- Contrary to the findings published in literature, the digestibility of the nutrient content of the analysed green mixtures of pannon vetch with barley with a variety composition Viktor-Beta and pannon vetch with triticale with a variety composition Filius-Beta did not decrease above 28 percent crude fibre content (30.4% and 34.7%, respectively).

6. RECOMMENDATIONS

- Based on the results obtained in the experiments, the production of pea with barley beside of pea with oat is an obligate perspective. Using this mixture, the variety available at spring time widens; and with a periodic cropping, these can be fed even till the second decade of July.
- Based on the results obtained in the experiments, the range of autumn green fodder mixtures can be widened by species or mixtures – mentioned previously only in a few TKI reports – such as pannon vetch with triticale. In my opinion, the feeding period of autumn mixtures can be expanded till even the first decade of June.
- The nutritional value found in case of pannon vetch with barley and pannon vetch with triticale highly differs from those of other green fodders mentioned in literature; therefore, it is necessary to determine the digestibility coefficients, net energy and crude protein contents (MFE, MFN) of as many green fodders as possible.
- In my opinion, a greater emphasis should be laid on the production of further alternative green fodders in the future, such as spring triticale with pea, to ensure a continuous feed supply in summertime.
- Based on the yield and nutritive content of green fodders analysed in the experiments, these can be alternative feed for not only dual purpose cattle. Where not sufficient size of pasture is available for heifer raising, the possibility for using green fodder mixtures produced on crop fields arises. Similarly to heifers, dry milking type cows also can be fed with green fodder mixtures. When feeding green forage, the costs of fermentation and storing can be reduced. If we can not feed up the entire amount, the

remaining of the cropping can be used for making good quality hay or fermented feed if it was harvested at appropriate time.

- Precise feed formulating can only be based on the information on digestibility coefficients and nutritional value of the green fodder mixtures. From production-physiology and economic approaches, formation of a new “up-to-date green chain” and the comparison with the monodietical feeding system can be based only on this information.
- Based on experiments done in the dissertation, I have recommended to insert the mixtures analysed in the experiments into the model of “traditional” green chain of the Feed Crops research Institute, Iregszemcse *(Figure 1)*.

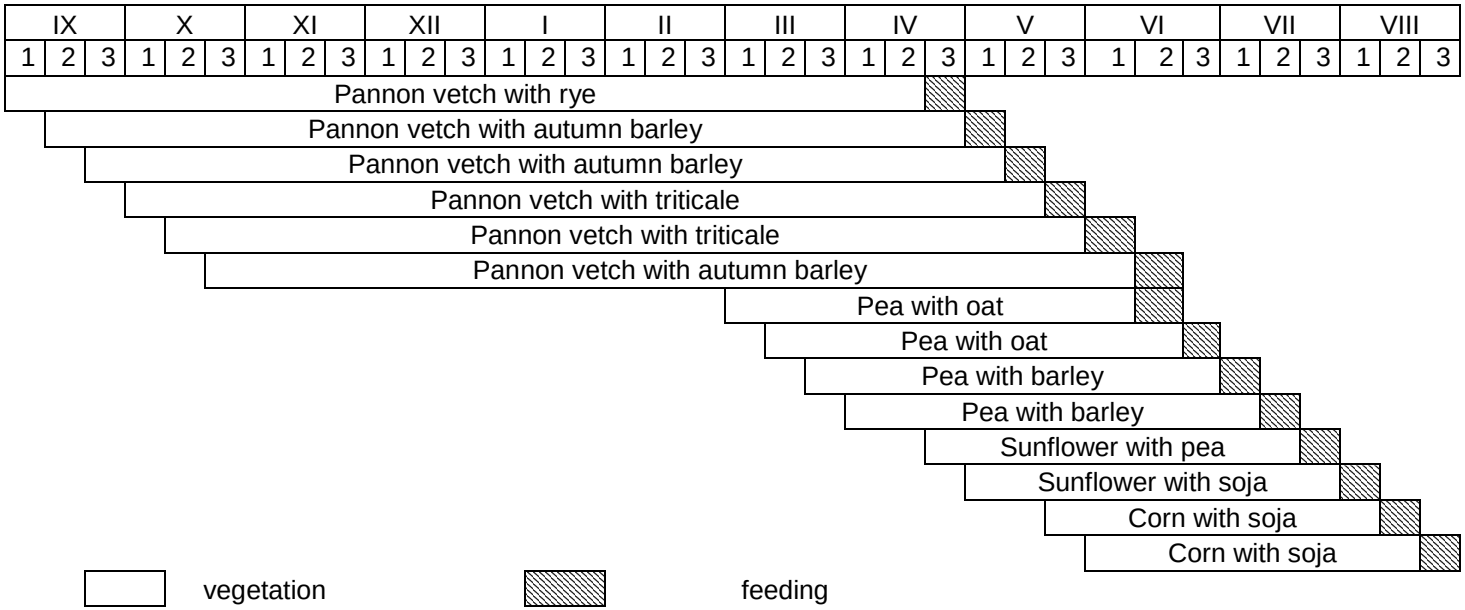

Figure 1: *A possible model of green chain in the South Transdanubian region*

7. PUBLICATIONS IN THE FIELD OF THE DISSERTATION

Publications in foreign languages (3):

Hoffmann, **R.,** Dér, F.: Yield of different green fodder crops in pure stand and mixtures Part 1. barleys (Hordeum vulgare) peas (Pisum satívum) and vetch (Vicia ssp). Agriculturale Conspectious Scientificus. 2003. 68. 4. 275-280.

Hoffmann, R., Dér F., Fábián T.: Yield comparison of different green fodder crops mixtures. Acta Agriculturae Slovenica. 2004. Suppl. 1. 227-231.

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