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LANDSCAPE MANAGEMENT BY MEANS OF CATTLE PASTURAGE IN THE SUBMOUNTAIN AREAS OF THE CZECH REPUBLIC

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Abstract

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The impact of seasonal pasturage of traditional Czech Pied cattle on sward structure and plant species composition was surveyed in three submountain areas of the Czech Republic. A well integrated canopy with a total sward coverage ranging between 85 and 98% was found at all examined sites. Practised grazing intensity (0.6–1.0 LU ha^{-1}) was in agreement with estimates of production capacity of pastures based on the reconstruction of potential natural vegetation. The profitability of seasonal pasturage in terms of milk production was examined in randomly selected samples of cows. Linear regression models were applied to compare individual milk yields during 6-month grazing and 6-month housing seasons. On average cows produced an additional 1.58, 2.93 and 1.02 kg milk per day in grazing season compared with housing season at farms of 1, 2 and 3 respectively. Farms 1 and 2 with annual milk production corresponding to average national production in this breed will serve as a model for future comparative studies aimed on sustainable multifunctional cattle husbandry in submountain regions of the Czech Republic.

Key words: landscape management, submountain areas, LFA, potential natural vegetation, grazing, Czech Pied, milk production, seasonal pasturage

Introduction

As far as the production functions are concerned the submountain and mountain areas are considered as Less Favourable Areas (LFA) with lower production capacity. Permanent grasslands form a typical part of the landscape in such areas. In the Czech Republic perma-

nent grasslands make up 22.79% of agriculture land, and are located mostly in LFA (Czech Statistical Office, 2006). Cattle grazing is a traditional grassland management there, and is nearly unreplaceable by other agricultural practices. Due to selective defoliation, grazing animals play an important role in maintanance and enhancement of sward structural heterogeneity, and thus botanical and faunal diversity (Rook, Tallowin, 2003; Sanderson et al., 2004; Pavlů, 2005). More than a 50% reduction of cattle numbers in the Czech Republic in the last decade has made the management of permanent grasslands difficult. Extensive pasturage of imported beef breeds will not be sufficient to solve this unfavourable situation in grasslands management (Kvapilík, 2004). The Czech Pied husbandry, concerned mainly on milk production is able to offer solution regarding a good adaptation to local LFA and a good ability to transform green forage of this breed (Urban et al., 1997; Kohoutek, Pozdíšek, 2005). However, field data from dairy farms on the effect of the grazing on the vegetation structure are missing. Better knowledge on the impacts of grazing regarding pasture herbage is a prerequisite of multifunctional cattle management both ecologically and economically sustainable.

The objective of this study was to survey two aspects of intensive cattle grazing at submountain dairy farms: 1 – the impact on sward structure and plant species composition of the pasture and 2 – the profitability of seasonal grazing in terms of milk production. Three farms were selected for the survey and intended to serve as a comparative model for future investigations. The choice was confined to farms located in the submountain area and covering its most frequent units of potential natural vegetation where none or limited amount of artificial fertilizers had been applied. The other condition was the longterm utilisation of Czech Pied genetical potential for seasonal pasturage.

Material and methods

Field work was carried out at three farms in the south west boundary area of the Czech Republic. Sites were located in the submountain area in an elevation of 600 to 790 m a.s.l. in the vicinity of natural protected areas (Šumava National Park, Šumava Preserved Natural Area, Novohradské hory Natural park). The intensive rotational pasture of Czech Pied cattle was practised there with the purpose of milk production (Table 1). The grazing season lasted from late April or beginning of May to October when the cattle returned to stall for overwintering. Herds consisted of 124 to 148 cows of different stage of lactation (Table 2). They were kept at the pasture all day long (farms 1 and 2) or they returned to stall for nights (farm 3). Milking took place two times a day in a milking parlour nearby the pasture sites. During the grazing season cows were offered additionally green forage or hey and grain supplements while beeing milking in stall. During the housing season they were offered hey, conservated green forage (silage) and grain supplements.

The effect of grazing on the pasture vegetation was examined using standard phytocenological methods based on scanning (Absolon et al., 1994; Moravec, 1994). Five scans, every one at area of 100 m^2, were sampled at each pasture and examined separately. The species composition, the coverage at particular sward levels and coverage of the species were surveyed. The degree of persistency of each species was determined according to Moravec, 1994. The potential natural vegetation was reconstructed according to Neuhäuslová et al., 1998. The potential primary and netto dry matter production and potential stocking rates were estimated by theoretical modelling method (Turek, Klimeš, 1981; Klimeš, 1997, 2004).

T a b l e 1. Some characteristics of the surveyed farms

	Farm 1	Farm 2	Farm 3
Altitude	600–650m	700–790m	740–780m
Duration of grazing season in 2004 (days)	187	171	174
Duration of grazing season in 2005 (days)	186	146	151
Stay at pasture sites	all day	all day	in stall during night
Supplements offered during grazing season	green forage, grain from 12 kg of daily milk production	hey, grain from 20 kg of daily milk production	green forage since July, grain from 10 kg of daily milk production
Continuity of pasturage at locality	30 years	15 years	20 years
Overseeding of sward	NO	YES at 20 % of area	NO

Groups of 35 cows of different age in 1st-5th lactation were randomly chosen in every herd for the examination of the inside group seasonal differences of the milk yields. Milk performance control data collected once per month were used for statistical analysis covering the period from April 2004 to July 2005. Individual milk yields (kg milk d^{-1}) up to 400th day of lactation were grouped into the seasonal pasturage or into the winter housing data sets according to the type of management practised in the time of control. Linear regression model analysis (R-program software package) was applied so as to find well fitting regression model, successively adding 3 variables: days from the beginning of lactation (x) , dummy 'season'variable with two values: 0 – housing period, 1 – pasturage period (z), and interaction between the two variables.

Model 0: milk yield (y) independent on x, z

Model 1: $y = a + bx$

Model 2: $y = a + bx + cz$

model 3: $y = a + bx + cz + dxz$.

ANOVA with sequence approach was used to evaluate the decline in the residual sum of squares while adding particular variables. Significance of regression coefficients given by Wald´s test served as an estimate of the difference in seasonal milk production.

T a b l e 2. Average stocking rates during grazing season in the year 2005. Herds consisted of the cows of estimated average weight 550 kg body weight. LU (livestock unit) corresponds to 500 kg body weight

	Farm 1	Farm 2	Farm 3
Number of cows in herd	124	126	148
Pasture area (ha)	168	238	171
Stocking rate (LU ha^{-1})	0.8	0.6	1.0

Results

The pasture vegetation belonged to *Lolio-Cynosurenion* suballiance (Klimeš, 1997, 1999). Good level of integration of canopy and total coverage from 85 to 98% was found at all surveyed localities. Bryophyt floor was negligeable with coverage less than 1%. Species of higher persistency (class V) are given in Table 3. The potential natural vegetation was identified as *Luzulo albidae – Quercetum petraeae, Abieti – Quercetum* at farm 1 and

Dentario enneaphylli – Fagetum at farms 2 and 3. The information on potential primary and netto dry matter production and potential stocking rates is given in Table 4.

T a b l e 3. Vascular plant species with higher persistency (class V according Moravec, 1994) at the surveyed localities

Farm 1	Farm 2	Farm 3
Agrostis capillaris *Dactylis glomerata* *Festuca rubra* *Lolium perenne* *Phleum pratense* *Plantago major* *Ranunculus repens* *Taraxacum* sp. *Trifolium pratense* *Trifolium repens* *Trisetum flavescens*	*Agrostis capillaris* *Dactylis glomerata* *Festuca pratensis* *Festuca rubra* *Lolium perenne* *Phleum pratense* *Plantago major* *Poa annua* *Poa pratensis* *Ranunculus repens* *Ranunculus acris* *Taraxacum* sp. *Trifolium pratense* *Trifolium repens* *Trisetum flavescens*	*Aegopodium podagraria* *Agrostis capillaris* *Achillea millefolium* *Anthriscus sylvestris* *Arctium lappa* *Arrhenatherum elatius* *Dactylis glomerata* *Festuca pratensis* *Festuca rubra* *Heracleum sphondylium* *Lolium perenne* *Phleum pratense* *Plantago major* *Poa annua* *Poa pratensis* *Ranunculus repens* *Ranunuculus acris* *Rumex obtusifolius* *Taraxacum* sp. *Trifolium pratense* *Trifolium repens* *Trisetum flavescens* *Veronica chamaedrys*

T a b l e 4. The potential natural vegetation, estimated primary dry matter production of the sward, estimated netto dry matter production of the sward (i.e. accesible to grazing animals as a forage) and estimated potential stocking rates during grazing season (providing that grazing herbage would be only accesible forage for cows)

	Farm 1	Farm 2	Farm 3
Potential natural vegetation	*Luzulo albidae – Quercetum petraeae, Abieti – Quercetum*	*Dentario enneaphylli – Fagetum*	*Dentario enneaphylli – Fagetum*
Potential primary DM production (t ha^{-1})	2.9	2.1	2.0
Potential netto DM production (t ha^{-1})	2.2	1.6	1.5
Potential stocking rate during grazing season (LU ha^{-1})	1.3	1.1	1.0

The average annual milk production per cow at farms 1 and 2 did not much deviate from the average national production in this breed (Table 5). At farm 3 the milk production rested more expressively behind the national average (nearly 21%). A negative linear relationship between milk yield and duration of lactation was found in examined groups of cows (Figs 1–3, Table 6). The model 2 with two explanatory variables (duration of lactation and seasonal variable) fitted the data well (Table 7). Adding a variable of interaction between the two variables revealed ineffective in the improving the model. Regarding the statistical significance of regression coefficients (Table 8), we conclude that the individual milk yields were on average 1.58 kg, 2.93 kg and 1.02 kg higher in grazing season compared with housing season at farms 1, 2 and 3 respectively.

T a b l e 5. Average annual milk production of Czech Pied at farms in the year 2005 and the comparison with average milk production of this breed in the Czech Republic in the same period (5960 kg cow^{-1}; data of Czech Moravian Breeders'Corporation)

	Farm 1	Farm 2	Farm 3
Average annual milk production (kg cow^{-1})	5613	6260	4724
Comparison with national average (kg cow^{-1})	- 347	+ 300	- 1236
Relative comparison with national average (%)	94.18	105.03	79.26

T a b l e 6. Regression relationships between the days in lactation and the individual milk yields in examined groups of cows at three surveyed farms in pasturage and housing season. R^2 – coefficient of determination; N – number of cases

	equations	R^2	N
Farm 1 – pasturage	y = 28.86 – 0.047x	0.58	198
Farm 1 – housing	y = 27.93 – 0.051x	0.49	208
Farm 2 – pasturage	y = 28.71 – 0.037x	0.36	196
Farm 2 – housing	y = 26.06 – 0.038x	0.55	220
Farm 3 – pasturage	y = 25.33 – 0.053x	0.48	212
Farm 3 – housing	y = 24.67 – 0.055x	0.57	178

T a b l e 7. Results of testing the particular models by ANOVA with sequence approach. Res. Df. – residual degrees of freedom, RSS – residual sum of squares, F – testing statistic with achieved level of significance P > 0.1 n.s., P < 0.05* , P < 0.001***

	Farm 1			Farm 2			Farm 3		
	Res.Df.	RSS	F	Res.Df.	RSS	F	Res.Df.	RSS	F
Model 0	405	16637.9		415	14884.1		397	16429.0	
Model 1	404	7898.4	459.0***	414	8000.4	397.0***	396	7907.6	430.3***
Model 2	403	7665.7	12.2***	413	7146.8	49.2***	395	7805.5	5.2*
Model 3	402	7654.9	0.56n.s	412	7144.6	0.13n.s.	394	7802.0	0.18n.s.

T a b l e 8. Parameters of the regression model 2 with two explanatory variables characteristed by relation y = a + bx + cz, where: y – individual daily milk yield (kg cow^{-1} d^{-1}), x – days in lactation, z – dummy variable with two levels, 0 – housing period, 1 – grazing period. Statistical significance of regression coefficients a, b, c was evaluated by Wald's test (P < 0.05*, P < 0.001***). R^2 – coefficient of determination

Regression coefficients	a	b	c	R^2
Farm 1	27.61 t = 57.24***	-0.049 t = -21.56***	1.58 t = 3.50***	0.54
Farm 2	25.91 t = 50.23***	-0.038 t = -18.15***	2.93 t = 7.02***	0.52
Farm 3	24.50 t = 46.78***	-0.054 t = -20.90***	1.02 t = 2.27*	0.53

Discussion

The units of potential natural vegetation identified at the surveyed areas are typical for the submountain regions of the Czech Republic. They provide suitable conditions for grazing management with *Lolio-Cynosurenion* plant community cover (Klimeš, 1999). The pasture herbage composition is strongly affected by a system of cultivation and utilization. Among others the stocking rate plays a key role in botanical composition and structure of the grazed sward (Bullock et al., 2001; Watkinson, Ormerod, 2001; Pavlů, 2005) Low grazing intensity leads to a selective defoliation resulting in creation of patches where the undesirable succesion of the pasture stands may progress. The high stocking rate causes a disruption of herbage cover and a desintegration of sward canopy due to the intensive trampling. The grazing intensity practised at surveyed farms (0.6–1 LU ha^{-1}) reflected well the potential stocking rates estimated on the basis of potential natural vegetations (1–1.3 LU ha^{-1}). This is in agreement with findings on sward cover which was well preserved at all the farms. In praxis the size of grazing herd is to a great extent influenced by conditions of state subsidies for environment friendly agriculture practices. The limits of daily stocking rate are minimum 0.44 LU and maximum 1.16 LU per hectar of pasture area (recalculated:1 LU = 500 kg body weight, 1 cow = 550 kg body weight) in agri-environment program for favourable grasslands management (Anonymous, 2006). The evaluation of the effect of such stocking rates on sward characteristics in more detail demands further study allowing for the local environmental conditions at experimental sites.

Modelling the regression relationships which included the stage of lactation as an explanatory variable enabled us to identify the seasonal trends in milk performance in groups of cows of different stage of lactation. A positive effect of grazing in terms of individual milk yields was found at all the surveyed farms. This findings fills the expectations of a good adaptation of Czech Pied on grazing conditions The average annual milk yield of

the herds at farms 1 and 2 corresponded well with the national average of this breed This indicates a good efficiency of grazing management at these farms apart from different altidude conditions (aproximatelly 100 altidude meter difference). At farm 3 the total milk production rested more expressively behind the national everage (nearly 21%). The reasons might have been in both the nutritive characteristics of the sward or in pecularities of breeding management and they are not detectable on the basis of this study.

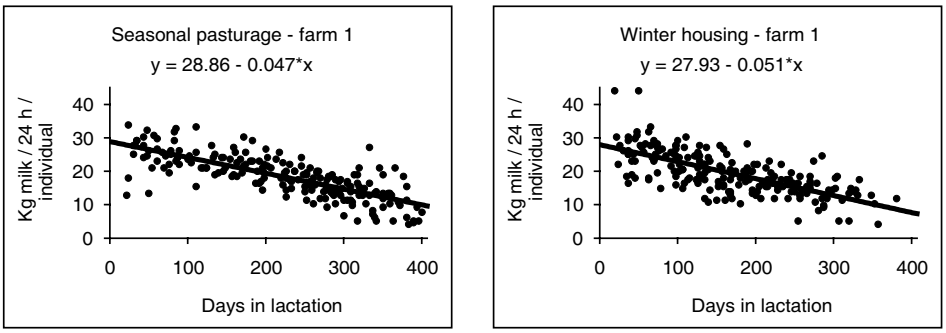

Fig. 1. Linear regression relationships between the days in lactation and individual milk yields (kg milk d^{-1}) in examined group of cows at farm 1 during grazing season (in the left) and housing season (in the right). For coefficients of determination and numbers of cases see Table 6.

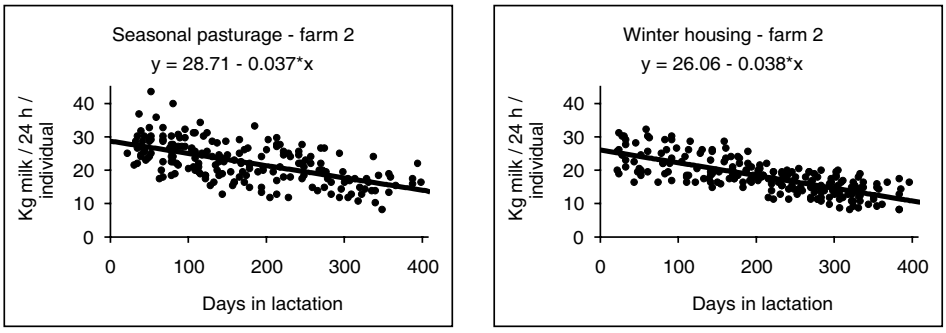

Fig. 2. Linear regression relationships between the days in lactation and individual milk yields (kg milk d^{-1}) in examined group of cows at farm 2 during grazing season (in the left) and housing season (in the right). For coefficients of determination and numbers of cases see Table 6.

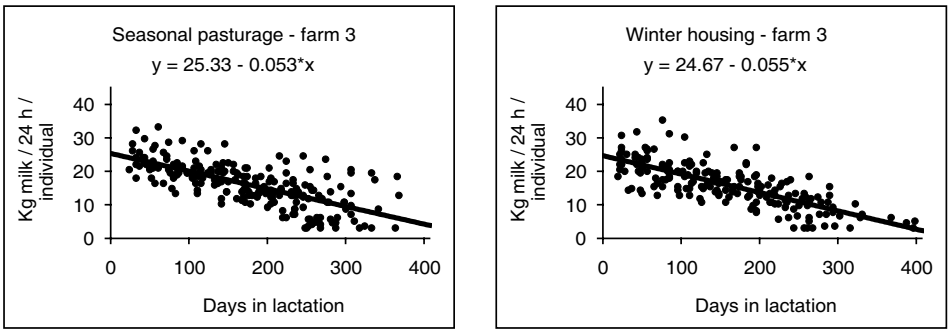

Fig. 3. Linear regression relationships between the days in lactation and individual milk yields (kg milk d^{-1}) in examined group of cows at farm 3 during grazing season (in the left) and housing season (in the right). For coefficients of determination and numbers of cases see Table 6.

Conclusion

Pasture and forage land of Šumava Mts and Novohradské hory Mts are of a great interest from ecological and cultural point view. This study concerns the contribution of traditional Czech Pied cattle pasturage to creation and maintanance of this landscape. At three surveyed dairy farms a rotational intensive pasturage at stocking rates 0.6–1 LU ha^{-1} resulted in a well integrated canopy and a total sward coverage from 85 to 98%. New data on the effect of seasonal pasturage on milk performance of this breed are presented. The higher individual milk yields in the grazing season were identified compared to the housing period at all surveyed farms. On the basis of these findigs the pasturage of the Czech Pied is suggested as a convenient way of landscape management in respect of both the productive and nonproductive functions of grassland ecosystem. Farms 1 and 2 with annual milk production corresponding to average national production in this breed will serve as a model for future comparative studies aimed at sustainable multifunctional cattle husbandry in the submountain regions of the Czech Republic.

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Frelich J., Pecharová E., Klimeš F., Šlachta M., Hakrová P., Zdražil V.: **Údržba krajiny pastvou skotu v podhorských oblastech České Republiky.**

V podhorských oblastech jižních a západních Čech byl sledován vliv sezónní pastvy Českého strakatého skotu na strukturu a botanické složení pastevního porostu. Na všech třech sledovaných lokalitách byla zjištěna dobrá zapojenost porostu s celkovou pokryvností od 85 do 98%. Zatížení pastviny (0,6–1,0 DJ ha^{-1}) odpovídalo produkční kapacitě pastviny odhadnuté na základě rekonstruované potenciální přirozené vegetace. U 35 dojnic náhodně vybraných v každém stádě byl sledován vliv pastvy na produkci mléka. Denní dojivost sledovaných krav během šestiměsíčního pastevního období a během mimopastevního období ustájení byla porovnána použitím analýzy regresních modelů zahrnujících dobu v laktaci jako jednu z vysvětlujících proměnných. Dojivost byla na jednotlivých farmách v průměru o 1,58, 2,93 a 1,02 kg vyšší během pastevního období než během ustájení. Farmy 1 a 2 s celkovou mléčnou produktivitou stáda odpovídající celostátnímu průměru pro toto plemeno budou použity jako modelové farmy pro budoucí srovnávací studie zaměřené na uplatnění multifunkčního chovu skotu v podhorských oblastech.