DISTRIBUTION AND USE OF GRASSLANDS IN THE CZECH REPUBLIC AND BIODIVERSITY OF INVERTEBRATES

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Abstract

In the Czech Republic the major focus of organic farming lies in permanent grasslands management. Animal production is mostly focused on non-milk pasture beef-raising on almost the whole farm area. By contrast conventional farms do not grass sufficiently, even in areas with higher elevation. This fact is influenced by subvention programmes motivating farmers to fulfil the agroenvironmental function of agriculture using grassing, however there is no support for agriculture on arable land. Permanent grasslands are predominantly used for beef grazing. Large areas are harvested too, which affects biodiverzity. Grasslands utilized for pasture are rich in biodiversity which enhance ecosystem services. The effect of grassland management on the different taxa and assamblages is discussed. This work is focused on permanent grasslands utilization and distribution and invertebrate abundance.

Keywords

Grasslands, Structure, Distribution, Organic farming

In marginal areas the production function of agriculture is complemented, very often even substituted, by the non-production environmental function which in most cases consist in increasing the share of grasslands. Meadows and pastures affect the landscape pattern significantly, in higher elevations markedly contribute to aesthetic value of the landscape and landscape character and in alluvial planes, beside the aesthetic function, provide retentive capacity in case of floods (Šarapatka, 2002). As far as the multifunction of agriculture is considered permanent grasslands represent particularly important cultivation on agricultural land with the function of biodiverzity preservation, which is important in montane and submontane regions (Pozdíšek a kol., 2004). In LFA (Less Favourable Areas) the montane type the non-production environmental function is fulfilled well (Moudrý, jr., Konvalina, 2007). This proves also Střeleček (2002), who states , that the change to required extensive agriculture in marginal areas leads to higher quality and ecology of production. Here the crucial role plays financial support for farmers for landscape preserving farming methods (Pražan, Leibl, 2005).

At present, however, also due to this financial support for Czech organic farming the environmental function has practically retrieved the production access which is not advisable in lower elevations (Moudrý, jr. Friebelová, 2006) and farming on arable land within organic farming is minor only, whereas structure of crop rotation and diversity of cultivated plant species is not optimal. This consists with opinions by Kvapilík (1999), Šimon (1996), Moudrý, Strašil (1999) and others, who state, that in submontane regions plant production diversity should be extended and mixture of traditional and non-traditional species established.

The way of permanent grasslands utilisation and their distribution into grasslands and pastures should be monitored as well. Grazing and mowing can be applied together, there was traditional way often used consisting of mowing the first production and grazing the rest afterwards (Urban, Šarapatka 2003). Simultaneously beef-raising without milk production is less profitable and with low stocking rates it provides fewer job opportunities. This farming way on permanent grasslands requires subsidy support not only in the Czech Republic but within EU countries as well, where the animal production intensity is much higher (Kvapilík a kol., 2002).

Grasslands utilized for pasture are often botanically and zoologically diverse (New, 2005). Invertebrates are the most numerous group in grasslands. A major putative function of biodiversity in grasslands is to enhance or maintain what ecologists have termed „ecosystem service“, the multitude of largely unseen and unheralded processes, commonly involving interactions between the biota and abiotic components of the environment that assure environmental health and resilience. Services such as pollination, maintanance of soil quality, nutrient recycling and many others are significant concerns

in grasslands. Invertebrates play significant roles in many ecosystem services, but quantifying and defining those roles is often difficult and usually has not been attempted. Loss of ecosystem functions previously provided by invertebrates may need to be compensated in grasslands by costly human interventions (e.g. mulching, fertilizing, etc.). Management of grazing areas is important in biodiversity conservation. Different grazing regimes reflect different intensity of impacts and management of biodiversity. Data about the effect of grassland management on the different taxa and assamblages are still unadequate (New, 2005, Mladek et al., 2006)

Although the share of permanent grasslands within organic farming is excessive, in the Czech Republic the overall share of grasslands is still insufficient (Penk, 2001). Conventionally farming companies should take into account also the environmental function of agriculture and on the other hand organic farms in regions with lower elevation should pay more attention to production function development.

Materials and methods

There was analysed a selective group of farms to assess the distribution and utilization of permanent grasslands. This sample counts 85 organic farms from different regions all over the Czech Republic (file O1) and selective group of 278 conventionally farming companies from all over the Czech Republic (file C1). Using these files the share of permanent grasslands, their way of utilization, the share of meadows and pastures in different elevations was monitored as well as the differences between conventional and organic farming systems.

The effect of the different grazing system and different management of grasslands (continuous stocking, rotational stocking, sporadic/opportunistic grazing) on the model invertebrate groups (beetles, bugs, leafhoppers, grasshoppers) was studied using pitfall trapping, litter sifting and sweping in the submontane area of the central Europe (Southern Bohemia). Epigeic beetles (mainly carabids and staphylinids) were studied using pitfall traps (diameter 7 cm and filled with a mixture of ethylenglykol). The hemiedaphic beetles living in the litter were collected using a sifter. Bugs, leavehoppers, grasshoppers were sampled by sweping herbaceous and (where appropriate) shrubby vegetation.

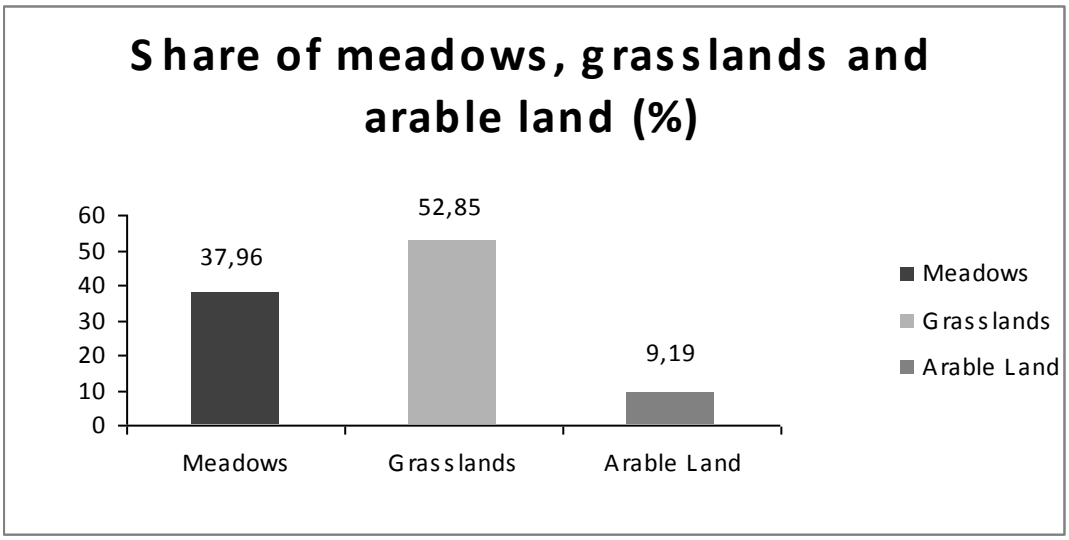
The program CANOCO version 4.51 for comparison used for the statistical evaluation of the material; graphical outputs were elaborated by the CANODRAW and CANOPOST programs (ter Braak & Šmilauer 1998). We used DCA analysis for comparison of sites and direct RCA analysis for evaluation of time effect in season and for evaluation of management effect on species. The degree of human impact was studied by finding of frequency of species of different ecological groups (Boháč, 1999).

RESULTS AND DISCUSSION

Within the Czech Republic organic farming is predominantly focused on permanent grasslands utilization. In the selective file of 85 organic farms (O1) four of them manage no grasslands only, whereas three of which are mainly specialized on grape or fruit production (vineyards, gardens). The only organic farm is focused on production on arable land and by contrast 53 organic farms from this sample manage no arable land at all. Overall share of permanent grasslands in the file O2 makes 90,81 %, only 9,19% share falls on arable land.

Using the file C1 it is possible to compare organic farming with conventional farming which shows that the share of permanent grasslands managed by conventional farms in lower elevations below 450 a. s. l. makes 10,51 %, even in transition elevations (450 – 600 m a. s. l.) it does not dramatically rise to 23,10 % share. The share of grasslands rises to 61,73% from elevations over 600 m a. s. l.. Organic farms predominantly farm on permanent grasslands (Tab. 1) without dependence on elevation. This is very significant difference when compared to conventional farming, where arable land management plays the main role and the share of grasslands makes about 24 %.

Diag. 1 – The share of meadows, grasslands and arable land within the selective file of 85 organic farms from all over the Czech Republic (File O1).



Tab. 1 – Percentual share of grasslands within organic and conventional farming with dependence on elevation shown on a selective file of farms from all over the Czech Republic (C1)

Farming system	The share of grasslands according to elevation		
	Below 450 m a. s. l.	450 – 650 m a. s. l.	Above 600 m a. s. l.
Organic	90,42	74,97	97,47
Conventional	10,51	23,10	61,73
Total	16,23	33,94	76,47

However the high share of grasslands brings good fulfilment of the environmental function there rise some negative effects because organic farms are wholly focused on permanent grasslands management.

The excessive share of permanent grasslands results in organic farming production function elimination, because major percentage of bio-beef production, which is the dominant bio-product, is not marketed as a bio-product due to insufficient processing capacities. Beef-raising with milk production is applied among the organic farmers rarely only.

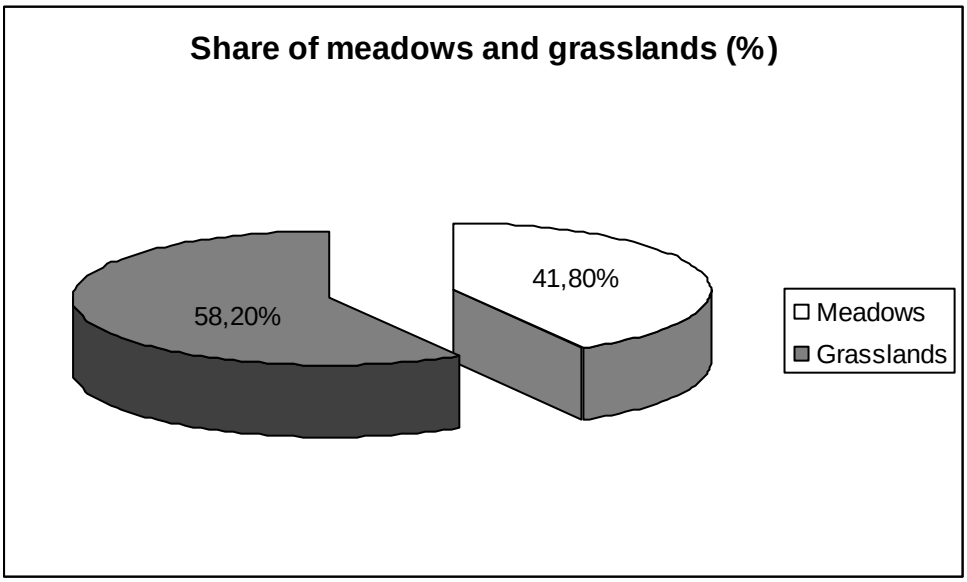
The distribution of animal production is not optimal either. Stocking rates per ha reach about 0,40 LU(livestock unit)/ha in production areas (below 450 m a. s. l.) over 0,33 LU/ha in transition areas and up to 0,50 LU/ha in elevations above 600 m a. s. l.. Organic farms feature closer relation to animal production. By contrast to this more than one quarter (25,61%) of conventionally farming enterprises reach stocking rates below 0,15 DJ/ha, i.e. stockless in fact. Although the predominant part of permanent grasslands are extensive low-production capacity growths (dry matter production of 2-3t/ha), stocking rates are relatively low and unbalanced as well. This leads to phytomass excess distributed on large area often with limited accessability. In localities with excessive cattle concentration unbalanced stocking rates lead to ground water contamination. This typically occurs in conventional farming systems predominantly focused on milk beef-raising.

Very low share of arable land, that makes 9,19% within the file O1 only, cannot provide sufficient plant bioproduction volume, moreover when major part of this production is consumed directly on farm with relation to animal production. These conditions lead to farmers economy dependence on state support which is not sustainable from the long-term point of view.

Taking into account higher share of permanent grasslands and lower stocking rates, some areas are not grazed but mowed only. According to obtained results in the file O1, pastures still prevail (52,85%), however the share of meadows is significant (37,96%). With respect to insufficient intensity of beef-raising all over the Czech Republic, there has been a question arising: how to utilize the excessive amount of biomass. A possible solution consist in use of biomass for energy purposes.

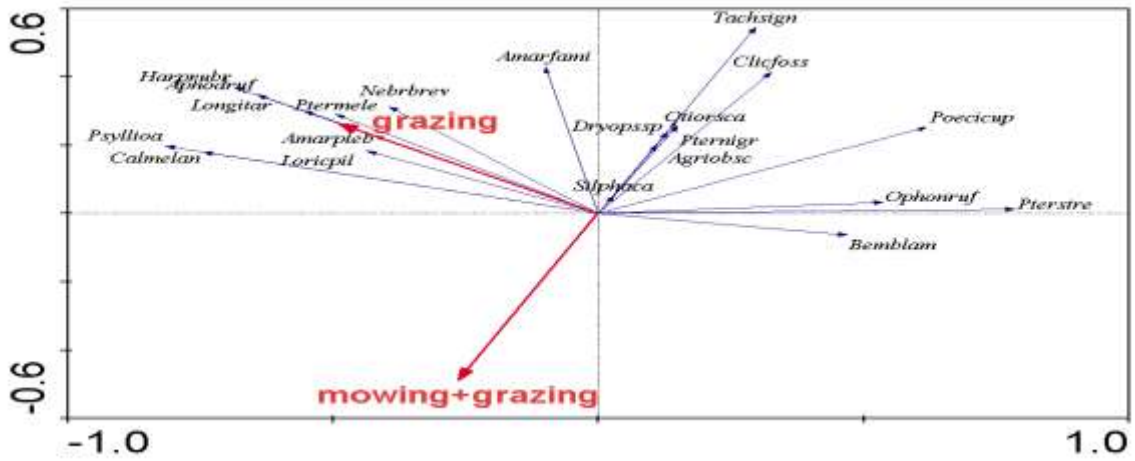
However this solution does not make sense from the economy point of view because of the biomass production is extensive and can be considered as a additional way of use only.

Diag.2 – The share of meadows and grasslands within the file of 85 organic farms all over the Czech Republic (file 01)



The effect of the different grazing activity on the biodiversity of invertebrates on studied grassland is presented on Table 1. It is evident that intensively managed grasslands with continuous stocking tend to be dominated by disturbance-tolerant arthropod species, whilst the invertebrate communities of less intensively managed grasslands (rotational stocking) tend to be more complex, mirroring the complex and varied habitat present. This result is in agreement with other authors studying both herbivorous insects (Andrezejevska, 1979, Mladek et al., 2006) and microarthropod decomposer communities (Curry, 1994).

Diag. 3 – Ordination of beetle species by PCA (activity of species is increasing in the direction of arrow). Amarfami – *Amara familiaris*, Amarpleb – *Amara plebeja*, Agriobsc – *Agriotes obscurus*, Aphodruf – *Aphodius rufipes*, Bemblam – *Bembidion lampros*, Calmelan – *Calathus melanocephalus*, Cliofoss – *Clivina fossor*, Dryopssp. – *Dryops* sp., Harprubr – *Harpalus rubripes*, Longitar – *Longitarsus* sp., Loricpil – *Loricera pilicornis*, Nebrbrev – *Nebria brevicollis*, Otiosca – *Otiorhynchus scaber*, Poecicup – *Poecilus cupreus*, Psyllioa – *Psylliodes affinis*, Ptermele – *Pterostichus melanarius*, Pternigr – *Pterostichus nigrita*, Pterstre – *Pterostichus strenuus*, Silphaca – *Silpha carinata*, Tachsign – *Tachinus signatus*.



Tab. 2 – The effect of the different grazing practices on the biodiversity of main groups of invertebrates in grasslands.

Mode of grazing/ The effect on the biodiversity of main groups of invertebrates	**Continuous stocking**	**Rotational stocking**	**Sporadic/opportunistic grazing**
Herbivorous insects (beetles, bugs, leafhoppers, grasshoppers, etc.)	The biodiversity is affected by the grazing activity of cattle avoid some plant species (e.g. nettle, thistly, sorrel, etc.). The biodiversity is low. The dominant species are ubiquitous and mainly polyphagous.	The biodiversity is high due the mosaic of more or less intensively grazed plots with different height of growth. Frequency of oligophagous species is increasing.	The biodiversity is high due the presence of high-grown plant species. Some oligophagous species present.
Coprophilous and saprophagous insects (beetles, flies)	The biodiversity is high due extensive presence of excrements.	The biodiversity is medial. Species migrate on plots with new excrements.	The occurrence of coprophilous species is low due the absence of excrements of the different age.
Predators (e.g. carabid beetles)	The biodiversity is low. The dominant species are ubiquitous and tolerant to desiccation. The percentage of polyphagous species is increasing.	The biodiversity is medial. The dominant species are both ubiquitous and stenotopic.	The biodiversity is high. The dominant species are both ubiquitous and stenotopic. Hygrophilous species present.
Hemiedaphic beetles (staphylinids)	The activity of cattle affect the cementation of upper soil layer and its deterioration. The biodiversity is low. The dominant species are ubiquitous and tolerant to desiccation.	The biodiversity is higher. The dominant species are both ubiquitous and stenotopic.	The biodiversity is high. The dominant species are both ubiquitous and stenotopic. Hygrophilous species present.

The number of beetle species discovered by pifallall trapping on pastures with the different management was practically the same – 76 (pasture with less intensive grazing) and 74 (pasture with more intensive grazing). Intensive grazing on pasture resulted in the extinction of some stenotopic and hygrophilous species (e.g. some ground beetles and staphylinid beetles). The percentage of polyphagus species increased in pasture with more intensive grazing (43 %) in comparison with the other plot (26 %). The invasive species of beetles were found on the pasture with the more intensive grazing (e.g. staphylinid beetle *Philonthus* spinipes). The effect of less intensive grazing with lower number of cows resulted in the mosaic of vegetation which is perspective for some stenotopic epigeic beetles (e.g. some great species of the ground beetle, e.g. *Carabus granulatus*). Some rare species living in dung (e.g. staphylinid beetle *Philonthus marginatus*) present on both pastures with the different grazing presure and management.

Ordination of beetle species by PCA (Fig. 3) indicates the dominance of coprophagous species (e.g. species of genera *Aphodius* and *Cercyon*) and eurytopic species (e.g. species of genera *Bembidion, Amara, Philonthus* and *Quedius*) on pastures with more intensive grazing. The hygrophilous species and species with preference of shadow biotopes are characteristic on pasture with less intensive grasing (e.g. carabid beetle *Chlaeinus nigricornis*, staphylinids *Quedius fuliginosus, Ocypus tenebricosus*).

CONCLUSIONS

Although the area of grasslands in the Czech Republic is still insufficient and their environmental function is fulfilled well, it is possible to state, that permanent grasslands very negatively affect production functions of organic farming systems. Moreover where the stocking rates are insufficient resultant overproduction of biomass is difficult to be effectively utilized for energy or other purposes. On the other hand within the conventional farming systems the share of permanent grasslands is still inadequate and should be increased. Organic farms are strongly focused on beef-raising without milk production. Taking into account poor processing capacities on one hand and limited alternatives for grassland phytomass utilization on the other, there would be advisable to change structure of animal production within organic farming system with the accent put on rise of number of cows with milk production.

Management of grasslands is important in invertebrate conservation. Different grazing regimes reflect different intensity of impacts and management of more or less altered communitiers. Grazing affects floristic composition, and features such as sward height may be critical for particular invertebrates, so that management of pastures can influence a wide variety of taxa and assemblages. Intensive grazing on grasslands resulted in the extinction of some stenotopic and hygrophilous invertebrate species. The percentage of polyphagous and eurytopic species increased in this grassland. The effect of less intensive grazing with lower number of animals resulted in the mosaic of vegetation which is perspective for some stenotopic invertebrates (e.g. some great species of the genus *Carabus*). Some rare species living in dung (e.g. staphylinid beetle *Philonthus marginatus*) present on both grasslands with the different grazing presure and management. Invasive species were found on the grasslands with the more intensive grazing.

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BIBLIOGRAPHY

1. Andrezejevska L. (1979) Herbivorous fauna and its role in the economics of grassland ecosystems. 1. Herbivores in natural and managed meadows. Polish Ecological Studies, 5: 5-44.
2. Bohac, J. (1999) Staphylinid beetles as bioindicators. *Agriculture, Ecology and Environment*, 74, p. 357-372.
3. Curry J. P. (1994). Grassland invertebrates. London, Chapman & Hall.
4. Kvapilík, J., Vaněk, D., Nová, V.: Trvalé travní porosty a chov přežvýkavců v ČR v kandidátských zemích a v EU. In: chov polygastrů v méně příznivých oblastech a možnosti naplňování zásad evropského modelu multifunkčního zemědělství. Rapotín 2002, s. 48 – 61
5. Mladek J., Pavlu V., Hejcman M. and Gaisler J. (2006) *Pasturing as a management for grasslands in protected areas*. Research Institute of Crop Protection, Prague, 104 pp.
6. Moudrý, J., Strašil, Z. : Pěstování alternativních plodin, skripta, Jihočeská univerzita v Českých Budějovicích, Zemědělská fakulta, 1999, 165s
7. Moudrý, J.,jr., Friebelová, J.: Analysis of farming in marginal areas and prediction of expected progress. Lucrari Stiintifice vol. 49, Seria Agronomie, Universitatea De Stiinte Agricole Si Medicina Veterinara “Ion Ionescu De La Brad”, Iasi, 2006, p 91 – 98
8. Moudrý, J., jr., Konvalina, P.: Differences between organic and conventional farming systems in Czech Republic. Lucrari Stiintifice vol. 50, Seria Agronomie, "Ion Ionescu de la Brad" University Press, 2007, p. 282 – 289
9. New T. R.: Invertebrate conservation and agricultural ecosystems. Cambridge University Press, Cambridge, New York, Melbourne, Madrid, Cape Town, Songapore, Sao Paolo, 2005, 354 pp.
10. Penk, J.: Mimoprodukční funkce zemědělství a ochrana krajiny. Institut výchovy a vzdělávání Mze, Praha, 2001, 64 s.
11. Pozdíšek, J., a kol.: Využití trvalých travních porostů chovem skotu bez tržní produkce mléka. Zemědělské informace, ÚZPI, Praha, 2, 2004, 103 s.

12. Pražan, J., Leibl, M.: Možnosti využití ekologického zemědělství v chráněných krajinných oblastech (CHKO)., http://www.agris.cz/vyzkum/detail.php, 2005 (date of browsing: 15.9. 2005) (In Czech)
13. Střeleček, F.: Srovnávací analýza ekonomických výsledků zemědělských podniků v produkčních a horských oblastech. In: Sborník z mezinárodního vědeckého semináře. Předvstupní strategie českého zemědělství na cestě do EU, 9., Praha, Praha - Průhonice, 2002, s. 115-123
14. Šarapatka, B.: Ekologické zemědělství a biodiverzita, Farmář 12, 2002, s. 6-9
15. Šimon, J.: Střídání plodin – nejlevnější agrotechnické opatření. Úroda, 1996, č. 12, s. 10-11
16. Ter Braak C. J. F. & Šmilauer P. (1998) CANOCO Release 4. Reference manual and user`s guide to Canoco for Windows: Software for Canonical Community Ordination. Microcomputer Power, Ithaca, NY. 1998
17. Urban, J., Šarapatka, B. a kol.: Ekologické zemědělství. 1. díl, MŽP Praha, 2003, 280 s.