# The Role of Grasslands in a Green Future

## Threats and Perspectives in Less Favoured Areas

*Edited by*

Á. Helgadóttir
A. Hopkins

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# *The Role of Grasslands in a Green Future*

## *Threats and Perspectives in Less Favoured Areas*

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*Edited by*
Áslaug Helgadóttir
Alan Hopkins

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# Foreword

One of the most important tasks ahead for agriculture worldwide is to secure sufficient food for a growing population without further straining our environmental resources. The challenge is to produce more food with less external input. At European level grassland is a valuable resource for meeting increasing demands for meat and milk from livestock systems yet at the same time competition between feed production from grassland and food production from arable land needs to be minimized. Grasslands also have to be maintained in their own right as they have an important role to play in preserving biodiversity and procuring ecosystem services at all levels. The $17^{th}$ Symposium of the European Grassland Federation therefore appropriately focuses on the role of grasslands in shaping a green future and will hopefully provide valuable solutions to the challenges facing us ahead.

Grasslands play a particularly important role in marginal regions of Europe where livestock production has been the traditional form of agriculture. With the expected climate change and increased emphasis on sustainable agriculture it can be expected that these areas will become more important for food production. The question is how agricultural production can be maintained in these areas and even improved while emphasising efficient use of local resources and minimising environmental impact. How important are grasslands for carbon sequestration in the more marginal areas and can they serve as a natural gene bank by maintaining biodiversity? Can grasslands become a valuable resource, also in these areas, as attempts to replace fossil fuel with bio-energy gain more weight? Threats to the exploitation of marginal grasslands by severe environmental fluctuations, soil degradation through loss of organic material and nutrients, acidification and soil compaction are a real concern in this context. Iceland provides an ideal setting for addressing all these questions as it certainly is a marginal environment situated just below the Arctic Circle and its agriculture is primarily grassland-based livestock production.

Many people have contributed to the making of this conference. We would like to thank all authors for their papers and presentations, numerous reviewers for their valuable remarks and Dr. Alan Hopkins in particular for revision of the English language and careful checking of all written contributions. Finally, we are grateful for the generous support of the Ministry of Industries and Innovation and we express our gratitude to all other sponsors.

We hope that the local environment will stimulate fruitful discussions during the course of the three days of the Symposium and that all participants will take back with them vivid memories from their stay in Iceland.

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General Secretary and Chairman of the Scientific Committee

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# Micronutrient levels in pastures established in the north-east of Portugal

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## Abstract

In this study we evaluate the effects of six types of fertilization: no fertilizer, lime, manure, lime + phosphorus, lime + phosphorus + boron and manure + inorganic fertilizer; and two types of pasture: spontaneous vegetation and sown pasture, on soil pH and micronutrient concentrations in herbage of pastures established in the NE of Portugal. The results showed that there were higher levels of Cu in the fertilizer treatments that promoted legumes. The 'no-fertilizer' treatment and inorganic fertilization with lime increased the percentage of grasses in the swards and herbage Mn levels.

Keywords: animal nutrition, meadows, fertilization, grasses, legumes

## Introduction

Micronutrients such as copper (Cu), iron (Fe), manganese (Mn) and zinc (Zn) are essential requirements for plants and animals, and play an important role in livestock diets as they may cause malfunctions as a result of either deficiency or of toxicity (Whitehead, 2000). Accumulation of these elements in plants depends on soil properties, total and plant-available amounts of elements, cultivation and fertilization system, climate, as well as plant properties. The objective of the present study was to evaluate the effects of six types of fertilization: no fertilizer, lime, manure, lime + phosphorus, lime + phosphorus + boron, and manure + inorganic fertilizer, and two types of pasture: spontaneous vegetation (unsown pasture), and sown pasture (sown), on the micronutrients levels of herbage in cattle-grazed pasture.

## Material and methods

The experiment was carried out in Vila Meã, (NE Portugal) at 860 m a.s.l., on a Leptosol with an initial pH (water) of 4.5. Two types of pasture were studied: spontaneous vegetation (unsown), and sown pasture (sown) consisting on a mixture of annual legumes, perennial legumes, grasses and chicory (50%, 5%, 41% and 4%, of total seeding rate, respectively). Six fertilizer treatments were applied during the experiment: no fertilizer (NF), lime (Ca), manure (M), lime + phosphorus (CaP), lime + phosphorus + boron (CaPB), and manure + inorganic fertilizer (MCaPB). The experimental design was a hierarchical completely randomized split-plot with three replicates, where pasture type was the main plot and fertilization the sub-plots. Three herbage samples were taken from each sub-plot, using 0.25 $m^2$ cages, in 2005 and 2007. No samples were taken in 2006 as this year was for natural regeneration. Three herbage samples were harvested from inside the exclosure cages, from areas of 0.25 $m^2$ within sub-plots, in spring of 2005, and 2007 (and exclude the spring of 2006, when there was no grazing in order to allow for a natural reseeding). In the laboratory, plant species were hand separated to determinate botanical composition (grasses (G) + other species (OT) and legumes (L)). The samples were dried for 48 h at 60ºC to determine dry matter (DM), and then milled to provide samples for chemical analyses. After a microKjeldahl digestion, total Cu, Mn, Zn and Fe were analysed with a VARIAN 220FS spectrophotometer using atomic absorption. Data were analysed by Principal component analyses (PCA) based on a correlation matrix for the dependent variables, followed by multivariate and univariate analyses of variance (SYSTAT 12) and mean separation (Tukey's HSD test).

## Results and discussion

PCA was significant (*P*<0.001) in the explanation of dependent variables (Figure 1). The first three PCA-axes explained 72% of the variation. PCA1 (40% of total variability) was positively related to legume percentage (L), DM yields and concentrations of Cu in the pasture, and it was negatively related to grasses percentage (G), no fertilizer (NF) and lime + phosphorus (CaP) treatments. PCA2 (17% of total variability) showed a negative correlation between Mn concentrations in pasture and manure + inorganic fertilizer (MCaPB). PCA3 (15% of total variability) showed a positive correlation between concentrations of Fe in pasture and lime fertilization (Ca).

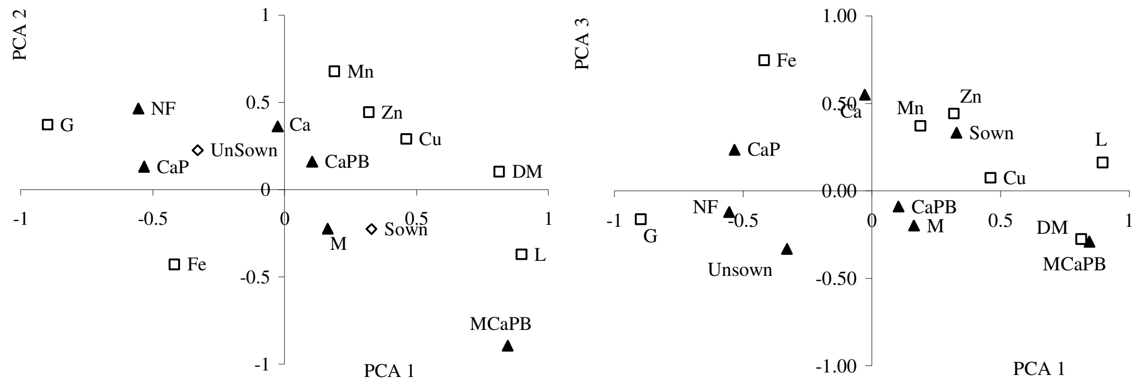


Figure 1. Loadings and scores of the first two PCAs and significant effect of pasture type and fertilizer treatment (*P*<0.05), where: ◊: pasture type (unsown and sown); ▲: fertilizer treatment (no fertilizer (NF), lime (Ca), manure (M), lime + phosphorus (CaP), lime + phosphorus + boron (CaPB), and manure + inorganic fertilizer (MCaPB)); □: dependent variables (G: % grasses and other species; L: % legumes; DM: DM yield, and mineral composition: Cu, Mn, Zn and Fe).

Results of ANOVAs showed that the interaction of pasture type × fertilizer treatment was significant (*P*<0.01) on Cu, Mn and pH. The lime+phosphorus+boron (CaPB) treatment significantly increased soil pH in unsown pasture, relative to the NF and the other fertilizer treatments that also applied Ca in 2007 (Table 1). In the case of sown pasture, pH was significantly increased by Ca treatment, when compared with the NF and M treatments. Despite the positive effect on soil pH of lime fertilization, the pH remained low (4.4-5.3) and at a level that usually indicates deficiencies in the availability of nutrients (Whitehead, 2000). In 2005, the MCaPB treatment significantly decreased the levels of Cu in unsown pasture, relative to the effects of the NF, Ca and CaPB treatments (Table 1). In the same year and in sown pasture, the level of Cu was significantly increased when MCaPB was applied, as compared with the M treatment. It is known that legumes and grasses have different abilities to accumulate mineral elements, even when grown under the same conditions. Thus, concentrations of Cu are reported to be higher in legumes than in grasses (Whitehead, 2000). In our case, the different effect of MCaPB treatment on Cu levels of herbage of sown and unsown pastures could be explained by the highest percentage of legumes found in the swards for this fertilizer treatment in sown pasture, as compared with the unsown pasture (75% *vs* 25% in sown and unsown pasture, respectively) (Pires *et al.,* 2004). In contrast to the other micronutrients, Mn concentrations in grasses are often higher than in legumes (Whitehead, 2000). Our results showed that in 2005, the M treatment significantly reduced the levels of Mn in unsown pasture relative to the effects of the NF, CaP and MCaPB treatments. This effect could be explained by the fact that the NF, CaP and MCaPB treatments had higher proportions of grasses (95-100%) than the M treatment (Pires *et al.,* 2004). In 2007, the levels of Mn were significantly increased in herbage of the Ca treatment relative to all fertilizer treatments except CaPB. It is known that in acidic soils (pH 5.0-5.5) the availability of Mn for plants is higher than in very strongly acidic soils (pH 4.5-5.0) (Jones and Jacobsen, 2005) because it increases the concentration of soluble $Mn^{2+}$ (Watmough *et al.,* 2007), which is the most available form of Mn for plants. No significant differences were detected between treatments for Fe concentrations (average levels 510 and 208 mg $kg^{-1}$, in 2005 and 2007, respectively) and Zn (average levels 138 and 228 mg $kg^{-1}$, in 2005 and 2007, respectively). With regard to livestock requirements, the maximum Cu, Mn, Zn and Fe concentrations established by NRC (2000) for beef cattle were never exceeded. However, Cu and Mn concentrations were below or close to the minimum values needed for an adequate supply for beef cattle (NRC, 2000).

Table 1. Concentrations of Cu and Mn in pasture (mg $kg^{-1}$) in 2005 and 2007 and pH in 2007, on the two types of pasture (unsown and sown), and in the six fertilizer treatments: NF: no fertilizer, Ca: lime, M: manure, CaP: lime + phosphorus, CaPB: lime + phosphorus + boron, MCaPB: manure + inorganic fertilizer. Different letters indicate significant differences between fertilization treatments in the same pasture type, and in the same year ($P$<0.01). SEM: standard error of the means.

| | | Unsown | | | | | | | Sown | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NF | Ca | M | CaP | CaPB | MCaPB | SEM | NF | Ca | M | CaP | CaPB | MCaPB | SEM |
| Year 2005 | Cu (mg $kg^{-1}$) | 11a | 8ab | 4bc | 5bc | 6b | 4c | 0.88 | 2ab | 12ab | 1b | 10ab | 8ab | 13a | 0.96 |
| | Mn (mg $kg^{-1}$) | 8a | 7ab | 5b | 7a | 6ab | 7a | 0.56 | 6 | 6 | 5 | 6 | 6 | 4 | 0.87 |
| Year 2007 | pH ($H_2O$) | 4.4b | 4.6b | 4.6b | 4.6b | 5.2a | 4.6b | 0.09 | 4.4b | 5.3a | 4.4b | 5.0ab | 5.0ab | 5.0ab | 0.15 |
| | Cu (mg $kg^{-1}$) | 10 | 10 | 12 | 10 | 11 | 8 | 1.05 | 13 | 10 | 10 | 12 | 12 | 12 | 1.11 |
| | Mn (mg $kg^{-1}$) | 9 | 9 | 7 | 7 | 7 | 3 | 1.14 | 6b | 13a | 6b | 8b | 9ab | 6b | 0.91 |

## Conclusions

The manure + mineral fertilization treatment increased the concentration of Cu in pasture only when this fertilizer treatment also promoted the presence of legumes in the sward. The 'no fertilizer' treatment and inorganic fertilization with lime increased the percentage of grasses in the pasture and the Mn concentrations in the herbage.

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