

# Extensively used grassland as a basis of low input livestock systems and as a resource of energy and raw materials

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## Abstract

In many European countries the traditional agricultural use of extensive grassland seems to be no longer competitive. To avoid grassland abandonment with all its negative consequences for ecology, economy and society, as well as to keep open the cultural landscape, alternative land use concepts have to be developed and tested. Within a comprehensive research project, carried out by the Agricultural Research and Education Center Raumberg-Gumpenstein at Buchau/Styria, different agricultural and non-agricultural strategies have been investigated. Beside extensive livestock production systems with grazing heifers, suckler cows and sheep, grassland has also been considered and analyzed as a sustainable and potential resource of energy. The focus was given to the use of grassland biomass for methane production and as combustion material. Finally, different methods to keep the landscape open without any productive use have been tested with a special concentration on floristic diversity. Selected results from the first project period of 5 years will be presented.

Keywords: Permanent grassland, alternative land use, biogas production, floristic diversity

## Introduction

Grassland is a dominant part of cultural landscapes in alpine and mountainous regions of Europe. In some Austrian provinces, the proportion of permanent grassland covers more than 95% of the agriculturally used area. The maintenance and sustainable management of grassland is therefore of great interest both for farmers and the society. Structural changes in rural areas, overproduction and more cost-effective production in favourable regions have led to an increasing abandonment of grassland in disadvantaged areas. About 10 to 15 % of the total biomass growing on Austrian grassland is no longer used for traditional milk and meat production. To avoid the invasion of bushes and trees which inevitably leads to the development of forest, alternative concepts of grassland use are required. These concepts should be both practicable and sustainable considering economy and ecology.

## Material and methods

Different farming and non-farming concepts of grassland use have been studied within a comprehensive research project carried out on an extensively used grassland area of nearly 20 ha at Buchau/Styria (Table 1). The climatic conditions are characterized by a mean annual temperature of 6.0°C and an annual precipitation of 1,250 mm. In addition to low input production systems with grazing heifers, suckler cows and sheep, grassland has also been considered as a potential resource of energy. Attention was given to the use of grassland biomass for methane production and as combustion material. The methane yield of grassland with different cutting and fertilising intensities was analysed by means of batch-trials (AMON *et al.*, 2006). Fuel analyses of grass pellets were carried out considering emissions and thermal efficiency. Finally, different mulching systems to keep the landscape open without

any productive use have been tested with a special concentration on technique, labour input and operation method. All the different production systems and treatments were also assessed for soil parameters, root growth, floristic diversity and economics.

Table 1. Production systems/treatments and investigations/analyses in the grassland extensification project Buchau/Styria (2001 – 2005)

Production systems/treatments	Analyses, surveys
heifers, steers and suckler cows	yield, forage quality, weight gain, meat quality
ewes and wethers	yield, forage quality, weight gain, growing and slaughter performance
biogas production	yield, forage quality, specific methane production, methane yield
hay pellets	yield, forage quality, combustion emissions, thermal efficiency
mulching	yield, power requirement, labour input

## Results and discussion

### Yield and forage quality of extensively used grassland

Grassland yields on the experimental site ranged between 4.8 and 6.4 t of DM year<sup>-1</sup>, depending on the number of cutting and grazing frequency. There were enormous differences in forage quality varying from 6.8 MJ NEL kg DM<sup>-1</sup> for fresh grass on the pastures to 1.3 MJ NEL kg DM<sup>-1</sup> for the mulching material. The energy yield varied from 12.7 to 34.3 GJ NEL ha<sup>-1</sup> year<sup>-1</sup>, which is much lower than the productivity of meadows and pastures in favourable regions.

### Fattening performance of cattle

Without any use of concentrates, the average gain of heifers was 1,234 g day<sup>-1</sup> and that of the steers was 1,281 g day<sup>-1</sup>. There was no significant difference concerning sex and number of lactation of the dams. The carcass dressing percentage reached 56% in both groups with a significant difference in the carcass judging result between heifers (2.8) and steers (2.5) following the EUROP classification system. Although there were clear differences in some parameters of meat quality between heifers and steers, no significant differences occurred in the cooking properties and tasting results which were excellent overall. The findings indicate that even on extensively used grassland, high gain and outstanding fattening performance can be reached with a well adapted herd and grazing management.

### Ewes, wethers and lamb performance

During the first project period, relatively high losses of lambs (19 %) occurred, mainly caused by the very extensive management system. The average daily gain of male lambs at 277 g was significantly higher than that of female lambs at 188 g day<sup>-1</sup>. There were significant differences between female and male lambs in carcass dressing percentage, proportion of fat, tallow and bones but no differences in cooking properties. The average daily gain of wethers which were kept on pastures without any concentrate supplement reached 122 g. The carcass dressing percentage of the wethers was significantly lower than that of the lambs.

### Methane productivity of extensively used grassland

The specific methane production presented in normalised litre methane per kg organic dry matter (l<sub>N</sub> CH<sub>4</sub> kg oDM<sup>-1</sup>) showed significant differences between the cutting frequencies and conservation systems. The highest specific methane production was achieved for wet and pre-wilted silage with approximately 300 l<sub>N</sub> CH<sub>4</sub> kg oDM<sup>-1</sup> and the one-cut system showed lower methane productivity with 269 l<sub>N</sub> CH<sub>4</sub> kg oDM<sup>-1</sup> than for more frequent cuts. Independent of the cutting frequency, haylage resulted in significantly lower methane production than for the silages (Table 2).

**Table 2. Specific methane productivity of grassland biomass ( $I_N \text{ CH}_4 \text{ kg oDM}^{-1}$ )**

Conservation system	one-cut grassland	two-cut grassland	three-cut grassland
wet silage	280 <sup>a, c</sup>	305 <sup>a, d</sup>	305 <sup>a, d</sup>
pre-wilted silage	285 <sup>a, c</sup>	295 <sup>a, c</sup>	300 <sup>a, c</sup>
haylage	243 <sup>b, c</sup>	253 <sup>b, c</sup>	255 <sup>b, c</sup>

<sup>a, b</sup> – indicating differences between conservation systems, <sup>c, d</sup> – indicating differences between cutting regimes

Compared with intensively used grassland and arable crops, the methane yield expressed in normalised cubic meter methane per hectare ( $\text{m}^3_N \text{ CH}_4 \text{ ha}^{-1}$ ) of semi natural grassland was significantly lower, which results in a competitive disadvantage (PÖTSCH, 2008). The most productive crop is maize which in some countries leads to high losses of grassland areas with many negative consequences for environment and landscape.

#### Hay pellets combustion

Compared with the national Austrian standards for the quality of wood pellets, hay pellets were characterized by an extremely high ash content, which requires special adaptation of the firing equipment to avoid operational problems with the heat exchanger system. Hay pellets also exceeded the thresholds of water content and abrasion properties. The heating value of hay pellets amounted to  $17.2 \text{ MJ kg}^{-1}$  which is marginally below the accepted limit of  $18.0 \text{ MJ kg}^{-1}$ .

#### Grassland mulching

Different mulching equipment was tested both on flat and steep parts of the project site. The rate of work ranged between  $0.4$  and  $1.5 \text{ ha h}^{-1}$  depending on steepness and working width. Whilst mulching is technically possible, this is a non-productive land-management-system which led to costs of up to  $\text{€}140 \text{ ha}^{-1}$  and a negative cost-benefit ratio.

### Conclusions

Extensively used grassland in mountainous regions is exposed to a strong competitive pressure. Milk and meat production, being traditional and productive land-use-systems for many generations, are increasingly given up and grassland abandonment is occurring in many regions (PEETERS, 2008). The results of this project clearly indicate that there are some practicable alternative land-use-management systems that are both productive and non-productive from an agricultural point of view. Regarding economic and ecological aspects, the use of suckling cows and sheep was significantly better than the energetic/material use of grassland biomass. Independent of costs and productivity all tested systems contributed to the preservation of extensively used grassland, which was very clearly demonstrated by the development of plant communities and floristic biodiversity.

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