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PROIECT APUSENI

The effects of different fertilisation on the floristic composition and the forage quality of mountain meadows

Introduction

A traditional land use system in the Apuseni Mountains, Romania, and its potential for sustainable development, is currently being investigated in an interdisciplinary research project co-ordinated by the University of Freiburg. The University of Agriculture Sciences in Cluj-Napoca is also involved, together with a number of other German and Romanian partners. The study focuses on mountain villages where people continue to live principally from subsistence production, animal husbandry, forest use and wood processing.
The hay meadows were fertilised with manure and harvested using a scythe, following a traditional method, once or twice a year, according to the distance of the settlement.

Spreading manure in spring with sledge and fork

Hay making in summer with scythe and hay rake

These extensively used meadows have a remarkably rich species diversity and high numbers of rare plants. They are formed by many species with low protein contents (reduced percentage of fodder grasses and legumes), and large numbers of sklerophyllous grasses (Festuca, Nardus) and plants from other botanical families. The poor quality of the forage is due to missing or low fertilisation only with manure

The central aims of the grassland studies of the project are:

- ***Situation analysis*** of the traditional land use techniques in agriculture.
- Analysis and identification of the ***value to nature conservation*** (e.g. biodiversity, naturalness) and the site related ***yield potential*** for the different grassland types, using data from terrestrial surveys (dry matter production, botanical composition) and GIS-techniques.
- Problem orientated experimental research to analyse the ***effect of different fertilisation regimes*** on yields, the sward quality of the meadows and the botanical composition.
- Development of scenarios relating to the ***future development of mountain grassland*** under varying economic and political conditions and constraints. This modelling process will be done using the grassland module, one element of an intergraded landscape model being applied in the overall project context.
- Development of ***strategies*** and methods ***for sustainable management*** and fertilisation techniques in agriculture, through interdisciplinary and participatory processes.

Material and methods of the experimental research

A ***key problem*** facing agriculture in this region is the low efficiency of the traditional fertilisation practices resulting in low levels of hay production. The experimental research is, therefore, aimed at the sustainable improvement of hay production and feed quality in meadows. Sustainability (economic, ecological and social), including different fields of interest and conflict, which must be identified and analysed on the basis of a indicator concept.
The essential ***research object*** is the analysis of the effect of different fertilisation regimes on yield, the sward quality of the meadows and the botanical composition.

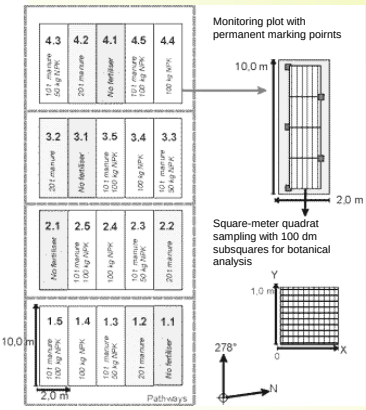
The ***research areas*** are situated in the mountain village Ghetar, at an altitude of 1150 m. The principal grass species in the area are *Festuca rubra* and *Agrostis capillaris*. The most productive society is the Centaurea pseudophrygia-Polygono-Trisetion. The experiments were carried out on a permanent plot design and time series analysis.

One fertiliser experiment is based on a design with ***different intensities of mineral and organic fertiliser***. The monitoring plots are established on three different sites (Cambisol chromic, Cambisol eutric, Leptosol), each with four replications including three fertilised plots:

- plots/ variants with NPK fertiliser: 0-, 50-, 100-, 150 kg ha^{-1}
- plots/ variants with organic fertiliser (manure): 0-, 10-, 20-, 30 t ha^{-1}

A further experimental design, established on Cambisol chromic, is a ***mixed combination of NPK-fertiliser and manure***. The arrangement of the monitoring plot is similar to the other experiment, with four replications including the following plots/variants (figure 1):

Figure 1: Arrangement of the monitoring plot



Monitoring plot with permanent marking poinrts

Square-meter quadrat sampling with 100 dm subsquares for botanical analysis

Plots/ Variants
(*the second numeral of the Plot number in the figure*)

1 = no fertiliser
2 = manure 20t ha
3 = manure 10t ha, 50kg NPK
4 = 100 kg NPK
5 = manure 10 t, 100 kg NPK

Both the organic fertiliser (manure) and the mineral fertiliser were applied in the spring, before the start of the vegetation period. The chemical composition of the manure was: N –0.4%, P –0.2-0.3%, K –0.5-0.6%.
The collection of samples for analysis was carried out at the beginning of heading phenological phase. The first cut was harvested in July and the second in September.

Inventory data and environmental indicators:
Vegetation and yield data were sampled on each plot. Additionally, a soil sample was taken at a depth of 10 cm in each plot and the following parameters were analysed: ph of H2O, phosphorus, potassium, soil organic matter and nitrogen levels. For the analysis of the interdependencies between economic and ecological indicators, the following data is collected in all experimental plots:

Sampling methods	variables and indicators
• **Phytomass**	Dry matter production: yield of the fertilised variants
• **Chemical Analysis (organic matter)**	Feed quality (chemical composition)
• **Floristic composition**	Feed value numbers (KLAPP, 1965)
Species inventory	Proportions of grasses, legumes and other plants
Species cover	Number of species and diversity indices
Species frequency	Number of rare and endangered species
	Indicator values according to ELLENBERG, 1992)
• **Phenological data** (DIERSCHKE 1989)	Changes of the phenological and structural development of the canopy
• **Vertical and horizontal structure**	

The development of indicators for the sustainable development is a interdisciplinary process and the choice of key indicators is the next step in this project.

The indicators have the following functions:

- ***Environmental assessment*** of the effects of fertilisation are founded on economic and ecological indicators.
- Indicators are necessary for the ***appraisal of environmental risks*** and threshold variables for sustainable development.
- Indicators are required for the ***calculation of input and control variables*** in the grassland module for the development of future scenarios relating to different land use regimes.

Results and discussion

The experimental areas must be investigated for several years in order to get significant statistical results and trend data showing changes in production and floristic composition under different nutrient regime. The ***trend analysis*** is based on an indicator concept. The conflicting economic and ecological objectives will be described using indicators and exemplary trade off functions.
The results of the environmental assessment and the scenarios of different land use regimes will lay the foundations for the development of strategies for sustainable management techniques in agriculture.
After the first period of investigation we can only present a provisional ***data set.*** The following results and interpretations relate to the second experiment on Cambisol chromic, using the combination of NPK-fertiliser and manure.

Changes in the ***botanical composition*** can only be estimated after several observation years. The different proportions of the plant groups in the fertilised plots for the year 2002 in Figure 2 pointed to this botanical development. The results of the fertilised (NPK) plots reveal an increase in the percentage of the grasses and a decrease in the number of plants from other plant families .
The botanical analysis were carried out using CANOCO (TER BRAAK 1998).

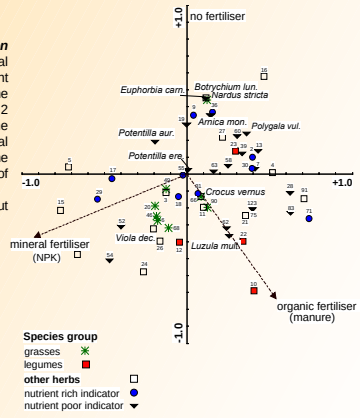


Figure 2: Results of the redundancy analysis carried out on the vegetation réleves of the experimental variants with organic, mineral and no fertiliser on Terra rossa (Cambisol chromic) - vegetation type: *Violo declinatae-Nardetum*. The Biplot indicates the relationship among species and environmental variables (fertiliser application).

Figure 3 shows the ***dry matter production*** for the cuts in July and September in the first observation period. The yield level of the second cut and the difference in production between the first and second variant (no fertiliser and 10 t ha $^{-1}$ manure) is remarkable small

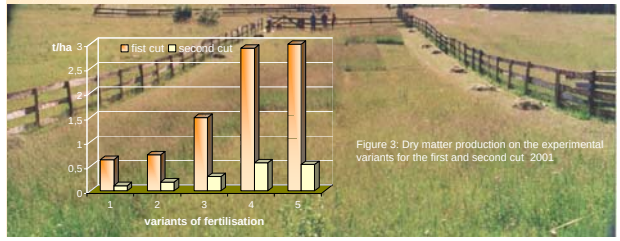


Figure 3: Dry matter production on the experimental variants for the first and second cut 2001

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