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Tough forage on alpine pastures? Nutritional value, phenology and stand structure of alpine pastures over 20 years

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Abstract

Within the project presented, running from 2015-2018, nutritional value, phenology and the development dynamics of 16 alpine pastures in or close to the national park Gesäuse (Styria, Austria) are studied. Based on data from the years 1993-1996, ripening stages and development of raw fibre content of forage harvested are compared. Together with weather data, conclusions on temporal changes of energy content are drawn and guidance for good pasturing (stocking rate, start time of pasturing, duration) in the face of climatic changes can be given, also in regard to animal welfare. For the analysis, not the macroscopic phenological stages are used, but the raw fibre content and nutritional value/energy content, which can be analyzed more exactly and describes as a sum parameter quite well local growing conditions for plants.

As the project is still running at the time of the writing, all data and conclusions are only preliminary, but give already a coherent picture.

Keywords

alpine pastures, phenology, fodder value, adaption to climatic changes, land management

Introduction

Climate parameters are a proxy for several site parameters and represent abiotic site conditions, which influence directly the local vegetation. Ongoing and expected changes in climatic conditions will cause changes both on a species and community level, especially at higher elevations (KROMP-KOLB et al. 2014). Such changes in the metabolism of plants can be monitored by their metabolites, which influence the nutritional value for animals, among other properties (ABDELGAWAD et al. 2014). In our context, the most important relationship is that the phenologic age of a plant correlates positively with the raw fibre content.

These changes have an immediate effect on the suitability of high alpine pastures with its primary use of vegetation as forage for ruminants. A well-adapted use of the resources is the basis for a sound, sustainable agriculture which is the key for our cultural landscape, protected or not.

Therefore, based on the literature, the following hypotheses were formulated as the basis for this study:
- Hot summer cause an early start of vegetation period and accelerates the development of the plants and leads to an early ripening
- This accelerated development leads to a higher content of raw fibre in plants at the end of the vegetation period, which gives a decreased nutritional value.

Based on the hypotheses, we try to answer the following research questions:
- How high is the raw fibre content and the resulting nutritional value over the years (1993-1996 and 2015-2018) on selected plots?
- How does the within-season development of raw fibre content look like?
- Are there changes in the altitudinal gradient of raw fibre content between the two study periods (1993-1996 versus 2015-2018)?

Methods

Between 1993 and 1996 factors influencing yield and forage quality were studied by our research institution (GRUBER et al. 1998). To be able to characterise changes, a similar project was started in 2016 on the exact same locations, preceded by a small pilot study in 2015.

The study area is a 16km long transect north-east orientated, between the 'Schoberpass' and the town of Hieflau in the Gesäuse (see map in Fig. 1). The study area is in Styria, Austria, halfway between Liezen and Leoben (47.494°N and 14.668°E).

The line of the transect, which was defined already for the project 1993 – 1996 ('baseline'), cuts a mountain range with siliceous bedrock in the southern half and a range with calcareous bedrock in the northern half. Plots were fenced exactly at the following altitudes: 1100, 1300, 1500 and 1700. Crossing two mountain ranges, this gives 16 plots, 8 on each range, 4 oriented south, 4 oriented north (see Fig. 2).

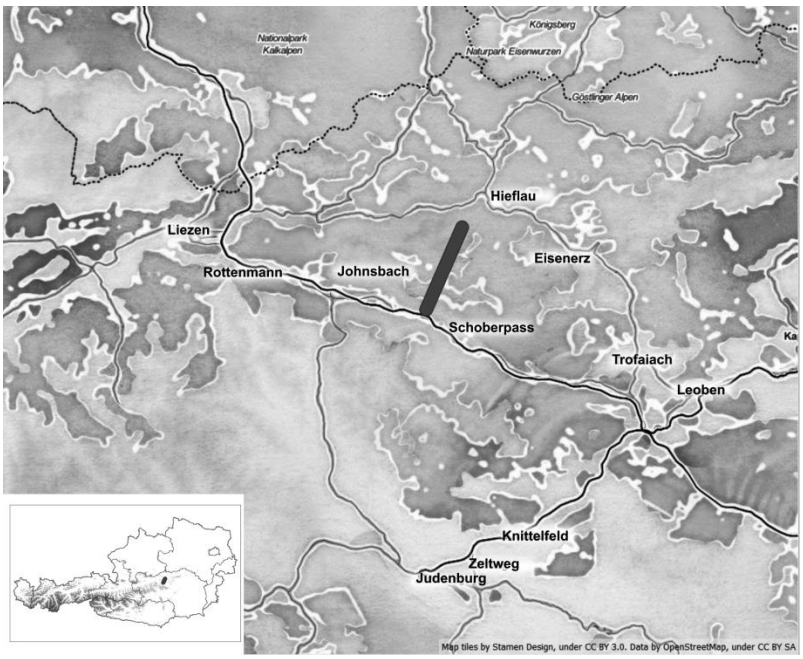

Figure 1: Location of the study area around the national park Gesäuse, Styria, Austria.

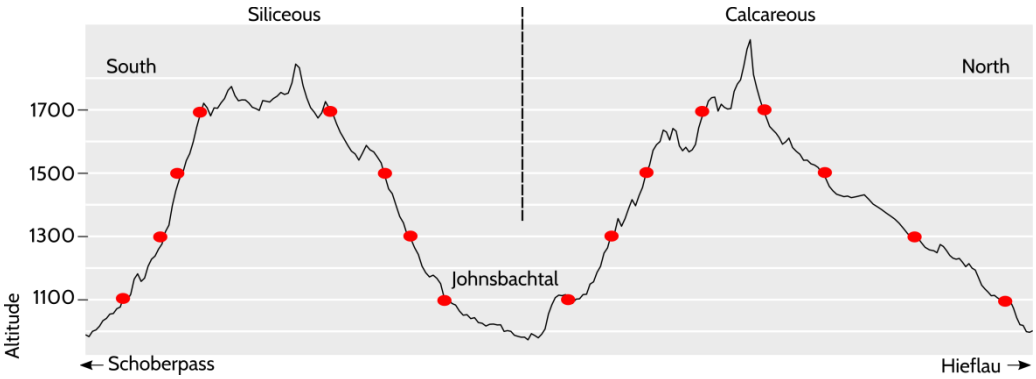

Figure 2: The transect with the distributions of plots over the two mountain ranges

During the baseline project, the plots were larger than the re-installed ones in 2016, which have now an extent of 7.5 x 7.5 m and are fenced with barbed wire. A sample is taken from an area of around 7.5 x 2.5 m (ca. 18m²). During the pilot study 2015, no fixed fences were built; just one sample on each plot was taken.

For the baseline, the main sampling date for each altitude was defined as the beginning of flowering of the characteristic grass species. To be able to monitor the development two weeks before and two weeks after this main date, additional samples were taken, overall three samples per plot. The dates were documented as the respective day of the year. The sampling starts around mid-May on the plots at 1100m and ends mid-August on the plots at 1700 m altitude.

In the current project, the forage samples are taken on the exact same days of the year (+/- 2d) on the exact same locations as during the baseline project. A botanical assessment is done just before the second sampling within the plot (on around 35m²). This gives in total 48 forage samples and 16 botanical assessments per year.
The forage samples are analysed following the method of Weender for structural substances (see KIRCHGESSNER 2011) and minerals at our research institution. The samples for the year 2017 are in the lab for analysis at the time of the writing.

Results

The raw fibre content shows relatively high amplitude and increases only marginally with altitude. Due to the small sample size and the high variation, the results split by altitude and year are not statistically significant (see Fig. 4). But together with temperature data (not shown) a clear trend between years becomes visible. Hot years like 1994, 2015 and 2016, the raw fibre content is higher than in the other years. The difference between 1994 and 2015 is at +19 g raw fibre/kg dry matter, which equals a faster development of one phenological stage (shooting stage versus start of flowering) at the same time of the year (Fig. 3) which equals to a clear loss of nutritional value as the digestibility increases.

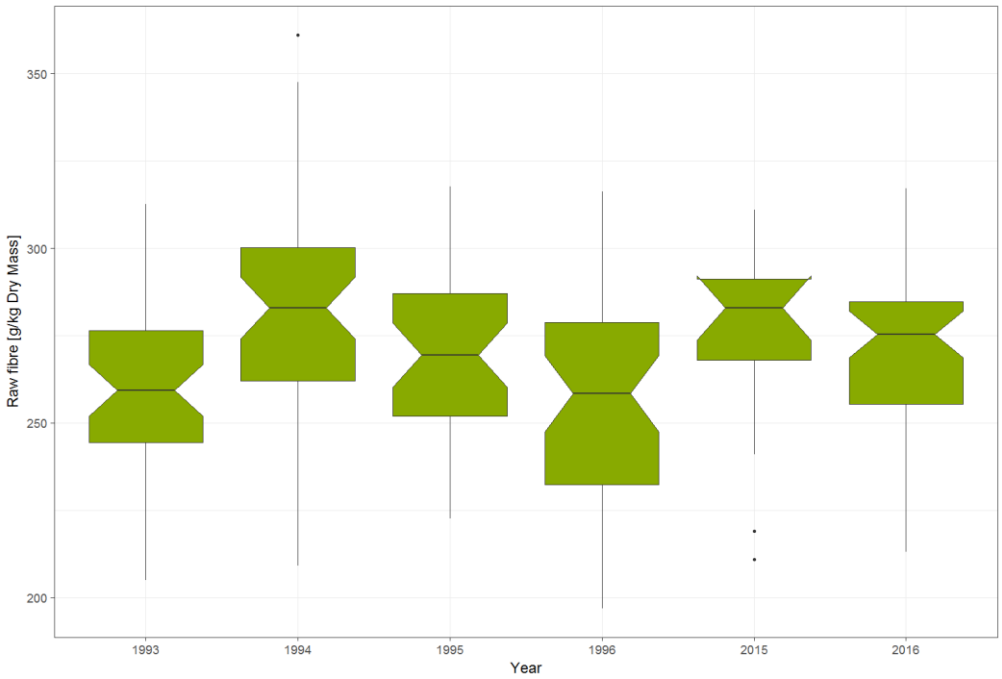

Figure 3: Raw fibre content by year. Hot years like 1994 and 2015 show a significantly higher content than the other years.

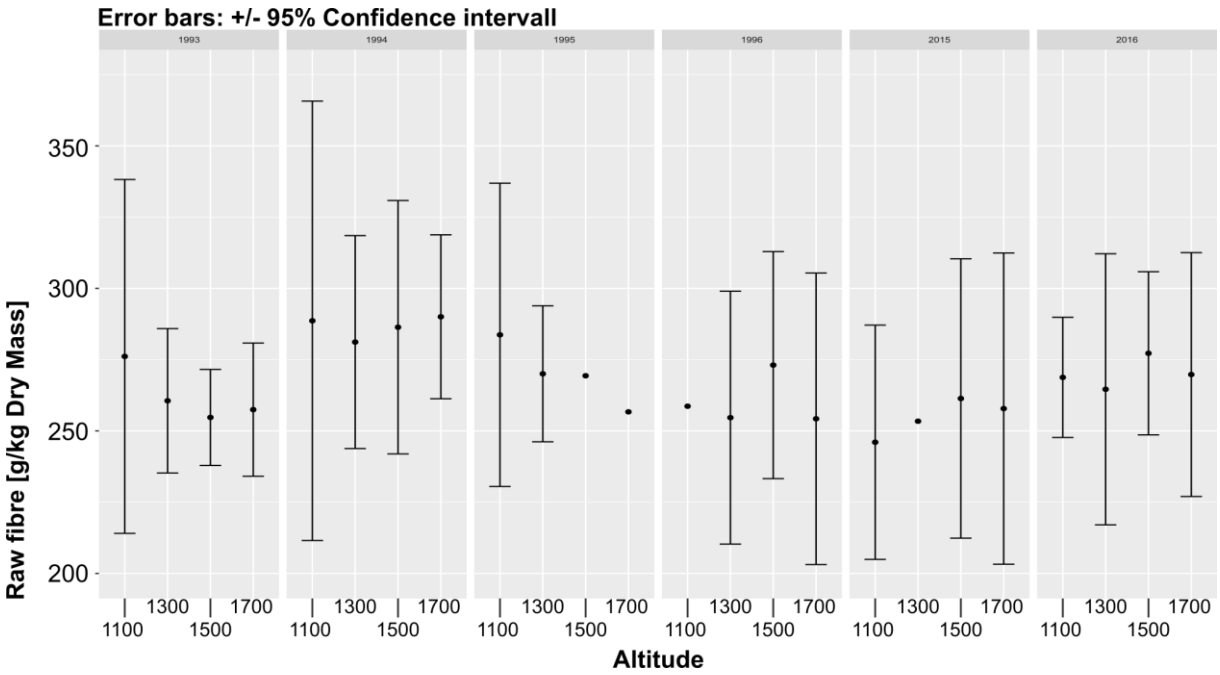

Figure 4: Raw fibre content by year and altitude. The differences are more complex, and due to small sample sizes no statistical significant effect can be shown.

Discussion

As the project is still running at the time of the writing, all data and conclusions are only preliminary, but give already a coherent picture.

The results clearly show a negative development of nutritional value of forage on alpine pastures in the study area during hot summers. What was found in 2015 and partly in 2016 was there already 1994, which was also one of the hottest years until then. The question if there are more hot summers than in earlier times was not part of this study. A hot summer leads to an earlier ripening of the forage available, by up to around two weeks. The longer vegetation period brings no advantages, as no fresh growth is coming. This is a challenge for all ruminants on alpine pastures, as with less energy the sometimes rough conditions on high pastures pose a serious threat, which touches also animal welfare questions. If there is a hot year, the altitudinal gradient in raw fibre content is also mostly flat, meaning there is a higher increase and bigger effect on the lower lying plots (1100 and 1300 msm) than on the higher ones (see Fig. 4).

Conclusion

In the course of history and the resulting traditions connected to alpine pasturing, dates for turn out and putting animals on pastures at different altitudes developed and proved useful, being site adapted and helping to avoid over use and damage to the pastures. These traditions get under pressure, be it because of a changing climate (like shown with our results) or other recent developments in the agricultural practice.

It is time for an evaluation of those traditional processes and management systems. Only with well adapted practices a sustainable, site adapted extensive land use will be possible in the future, which also helps to protect the co-developed biodiversity of our cultural landscape.

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