

Grassland Statistical Yield Modelling with Focus on „Dry“ Seasons

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Introduction

Grasslands used for forage production or as pastures compose a significant portion of Austrian territory (22% or 1.9 mil. ha) and play an important role in the landscape as well as part of the agriculture production system. Most of the yield variability is caused by the climatic factors and their interactions with soil conditions, sward composition and management. In order to satisfy the need for reasonably accurate meadow yield forecasts, a simple approach relying on the established statistical linkages between limited number of daily or seasonal variables has been applied by the authors.

Material and methods

The main study aims can be formulated as follows: 1) To derive a reliable statistical model for meadows under various management regimes and 2) To evaluate performance of such statistical model during “dry” years. Long-term field data were collected at experimental stations “Gumpenstein” (1961-2001), “Piber” (1971-2001) and “Admont” (1977-1999). The meadows at all experimental sites were dominated by perennial grasses with relatively high proportion of herbs and significant presence of white clover. Our study presents and evaluates the *GRASSland* statistical Model (GRAM) that could be eventually applied at meadows or grazed grasslands. The model itself is based on the approach originally proposed by Han et al. (2003) that has been significantly modified to suit Austrian conditions (Trnka et al., 2005). GRAM assumes that the grass growth depends on the soil water content in the active root zone as well as water stored in the plant tissues. Compared to the original method proposed by Han et al. (2003) the ratio of ET_a and ET_r calculated by the FAO model (Allen et al., 1998) was applied. One of the advantages of using ET model over the originally proposed approach is that it takes into account influence of the soil conditions on the water balance. In the final step it was necessary to quantify the relationship (using multiple regression and neural network models) between the dry matter yield and set of independent variables that included effective accumulated temperature, effective accumulated solar radiation, cut duration; dose of mineral nitrogen; cut number and in some cases also number of snow days during preceding cold season. Each dataset used in our study was randomly split into two groups regardless of the site with the first sample used for model calibration and the second one for model verification with the independent data set. The data from Admont station were used only for model verification.

Results and discussion

The analysis of the GRAM model performance over verification data set during years characterized by the “dry” weather (i.e. accumulated Standard Precipitation Index < -

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1.0) showed approximately the same value of explained variability as over the whole dataset (Fig 1). Also the systematic and random errors were very similar to with differences smaller than 1.5% and application of F and t-tests did show no statistically significant difference between GRAM performance during „dry“ and “normal” years. The overall performance of the model under the dry conditions of 2003 has been explored in the spatialized GRAM version, which is presented at this conference by Schaumberger et al. The results of this study confirmed that productivity of meadows in Austria is highly dependent on the combination of available soil water, global radiation, air temperature, dose of nitrogen and management regime (i.e. number of cuts per season). These factors can explain up to 78% of yield variability can be used to determine production potential of selected sites. The GRAM has proven as a suitable tool for utilisation of these strong linkages and thus may be used for various practical purposes. It has been shown that GRAM is capable to reproduce yield variation during extreme seasons and thus could be applied in the assessment of possible impact of dry or extremely wet years on the meadow dry matter yield. In combination with stochastic weather generator GRAM proved to be an effective tool for issuing yield predictions early in the season and has been embedded into the GIS environment for spatial analysis of dry matter yields.

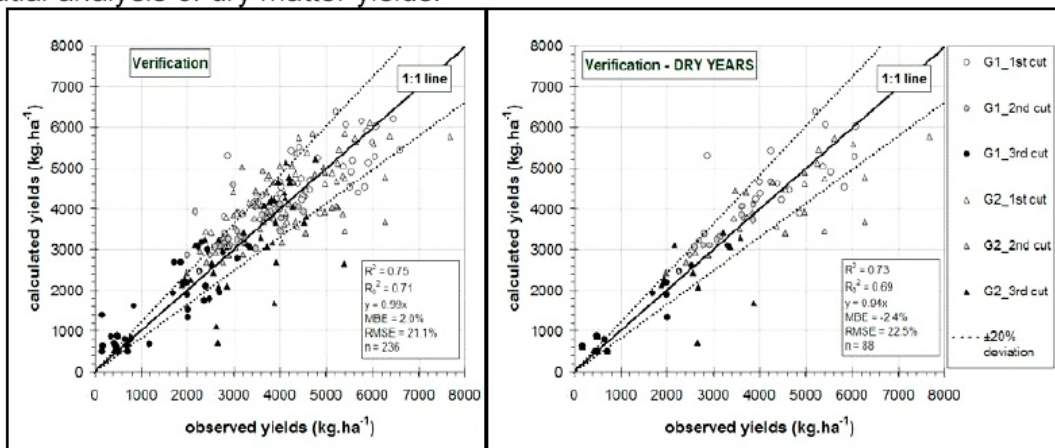


Fig 1: Results of the GRAM model verification runs (left) using experiments that were cut 3 times per year (total $n = 468$). The circles represents results obtained at Gumpenstein experimental station while triangles symbolize Piber station data. Performance of the GRAM model during dry years is given at the right figure. Dotted lines presents $\pm 20\%$ deviations lines. The symbols in the text fields stands for: R^2 - variability explained; R_0^2 - variability explained by linear function forced through 0; MBE - mean bias error of the model predictions; RMSE - root mean square error; n - number of observations.

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