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Assessing risks from drought and heat stress in productive grasslands under present and future climatic conditions

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Grasslands cover the majority of the world's agricultural area, provide the feedstock for animal production, contribute to the economy of farms, and deliver a variety of ecological and societal services. Assessing responses of grassland ecosystems to climate change, in particular climate-related risks, is therefore an important step toward identifying adaptation options necessary to secure grassland functioning and productivity. Of particular concern are risks in relation to drought and extreme temperatures, on the one hand because grasslands are very sensitive to water stress, on the other hand also because global warming is expected to increase the occurrence and intensity of these events in many agricultural areas of the world.

In this contribution we review findings of ongoing experimental and modelling activities that aim at examining the implications of climate extremes and climate change for grassland vegetation dynamics and herbage productivity. Data collected at the Jura foot in western Switzerland indicate that water scarcity and associated anomalous temperatures slowed plant development in relation to both the summer drought of 2003 as well as the spring drought of 2011, with decline in annual yields of up to 40%. Further effects of drought found from the analysis of recent field trials explicitly designed to study the effects of different water management regimes are changes in the functional composition and nutritive value of grasslands.

Similar responses are disclosed by simulations with a process based grassland ecosystem model that was originally developed for the simulation of mixed grass/clover swards. Simulations driven with historical weather records from the Swiss Plateau suggest that drought and extreme temperature could represent one of the main reasons for the observed yield variability in productive systems. Simulations with climate change scenarios further reveal important changes in ecosystem dynamics for the current century. The results show that herbage growth could basically benefit from increasing temperatures and CO_2 concentrations, which promote in particular the development of clover. However, productivity is found to decline in the long term on the background of a projected decrease in summer precipitation. This has implications for future grassland production across Europe and in other agricultural area of the world, and calls for the adoption of adaptation measures.