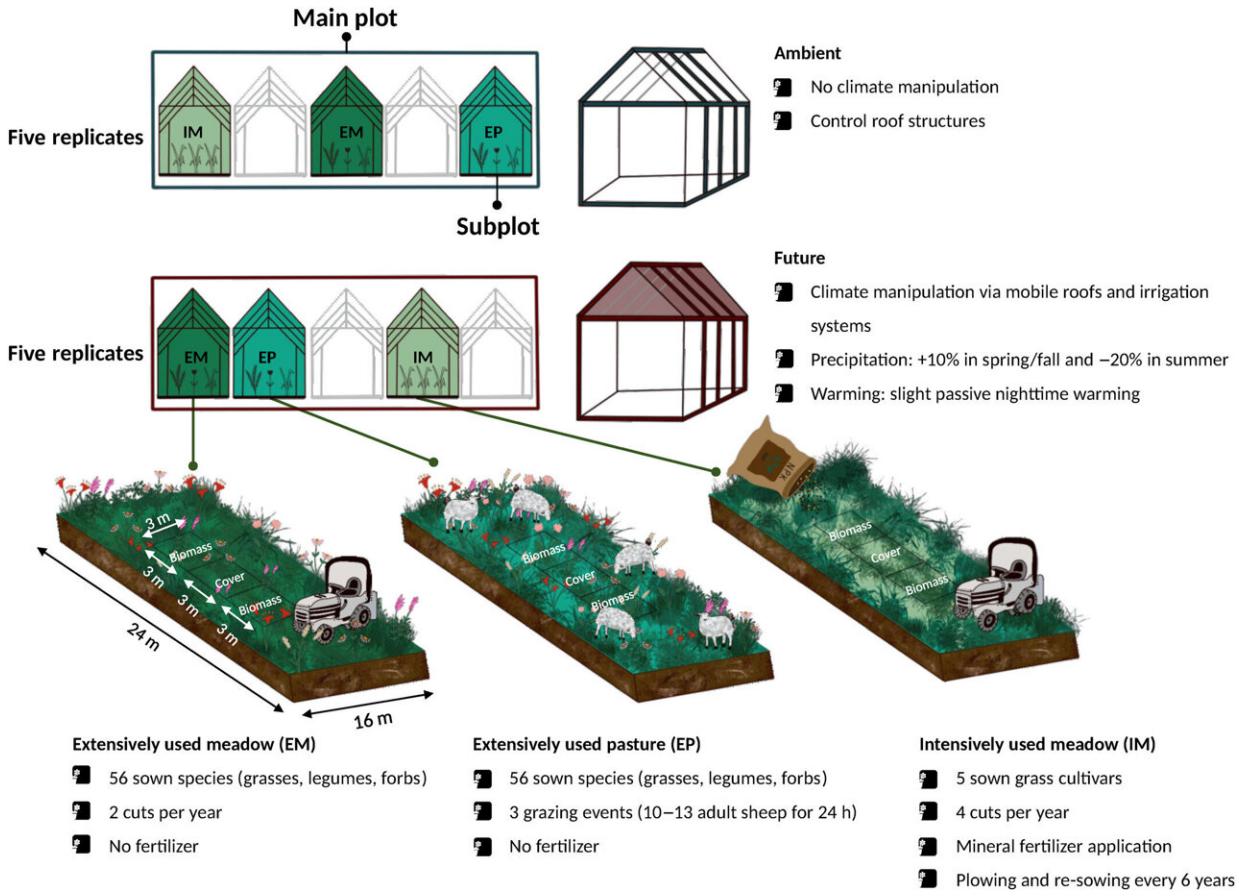
Low-intensity grassland is better able to withstand the consequences of climate change

July 22 2024



Most important features of the design and the treatment structure of the experiment. Based on a split-plot design, the main plots reflect the two climate scenarios (ambient climate and future climate). The future climate scenario is based on regional climate models that predict seasonal shifts in precipitation patterns and an increase in temperature. Climate manipulation is achieved via mobile roofs and irrigation systems. The subplots correspond to five different land-use types, of which only the three grasslands are considered in this

manuscript (extensively used pastures, extensively used meadows, and intensively used meadows). The grasslands differ in management type, intensity as well as sown species diversity. Credit: M. Milanović

Climate change will have a considerable influence on the biodiversity and productivity of meadows and pastures. However, according to the results of the large-scale climate and land use experiment, the extent of these changes depends on the land use. A team of researchers from UFZ and iDiv has found that grassland optimized for high yield responds much more sensitively to periods of drought than less intensively used meadows and pastures.

According to an article recently published in *Global Change Biology*, this can certainly have economic consequences for the farmers affected.

Grassland is one of the most important and most widespread ecosystems on earth. Such open landscapes with grasses and herbs not only cover more than one quarter of the entire land surface but also store at least one-third of the terrestrial carbon, are crucial for food production, and can be extremely species-rich in a relatively small area. But what is the future of these habitats? The study provides new insights into this question.

It has long been clear that two environmental changes are threatening the world's grasslands. Particularly in Europe, grasslands are now fertilized much more heavily, mowed more frequently, and grazed more intensively. In addition, farmers often sow only a handful of grass varieties that promise a particularly high yield. This intensification of land use is fundamentally changing the species composition and functionality of meadows and pastures. The same applies to climate change. For Germany, climate change will result in a shift in the seasonal

distribution of precipitation as well as an increase in hydrological extremes (e.g. heavy rainfall and droughts), among other things. It is considered the second largest threat for these ecosystems.

When both changes come together, they can reinforce each other. However, nobody yet knows exactly what will happen. Most experiments on this topic have so far focused on either the climate or land use.

"What makes our study unique is that we investigated the interaction of both factors," explains first author Dr. Lotte Korell, biologist at iDiv and UFZ.

This was made possible by the large-scale and long-term experiment of the UFZ in Bad Lauchstädt near Halle, the Global Change Experimental Facility (GCEF). It consists of 50 plots, each measuring 16 × 24 m; these are used with varying degrees of land use intensity. Temperatures and precipitation levels can also be manipulated with the help of mobile roof systems. For example, some plots receive 10% more precipitation in spring and autumn and 20% less in summer than the untreated control plots. This roughly corresponds to the conditions that climate models project for central Germany.

An eight-year data series from this experiment has now been compiled for the new study. The researchers analyzed the biodiversity and productivity of the plants on the differently used plots between 2015 and 2022.

"This period includes three of the driest years this region has experienced since beginning of records," recalls Korell. These droughts apparently had a much stronger effect on the plants than the experimentally simulated climate change.

However, in both cases, the trend pointed in the same direction: species-

rich grassland that is only rarely mown or sparsely grazed withstood the heat and drought much better than the intensively used high-performance meadows.

"Among other factors, this is probably related to the diversity of species," says Korell. This varied greatly depending on the land use of the grasslands.

A diverse mixture of more than 50 native grasses and herbs grew on the less intensively used meadows and pastures of the GCEF. However, on the intensively used grassland, the researchers had sown only the five grass varieties recommended to farmers by the Saxony-Anhalt State Institute for Agriculture and Horticulture for drier sites at the start of the experiment. These included varieties of meadow grass (Dactylis glomerata) and perennial ryegrass (Lolium perenne).

Because such grasses are bred for maximum yield and were also heavily fertilized—as is common in agricultural practice—the intensive meadows were initially much more productive than the more diverse grasslands. However, they were able to make use of this advantage only in favorable climatic conditions and were not able to withstand the drought as well as the plants in the low-intensity meadows and pastures. In times of drought, the grasses in the intensively used meadows increasingly died back and were replaced by other species such as chickweed (Stellaria media), shepherd's purse (Capsella bursa-pastoris), dandelion (Taraxacum officinale), and small-flowered cranesbill (Geranium pusillum).

"These are mostly short-lived species that survive as seeds," explains senior author Dr. Harald Auge, also a biologist at the UFZ and iDiv Member. When the more competitive plants succumb to drought, these species take the opportunity to invade their habitats: they either migrate from the low-intensity grassland or germinate from the seed stock in the

soil.

This shift in species composition is not particularly welcomed by farmers, especially because most of the new arrivals have a lower fodder quality than the grasses originally sown. The common ragwort (Senecio vulgaris), which was frequently represented among the immigrating species in the experiment, is in fact poisonous. All of this reduces the productivity of the land.

Farmers have long been aware of this kind of degradation of high-performance grassland by immigrating species. They therefore expect to have to plow up and reseed their land every few years.

"However, climate change may accelerate this need and lead to additional costs," says Korell. Perhaps everything will go well for a few years and it will rain enough. However, it is also possible that several dry summers will follow one another. Climate change is making conditions even more unpredictable.

Farmers who have only intensive grassland are therefore less able to plan in such times and thus bear a greater economic risk. On the other hand, low-intensity meadows and pastures not only make an important contribution to preserving biodiversity but also help to stabilize the productivity of grassland in times of climate change.

More information: Lotte Korell et al, Land use modulates resistance of grasslands against future climate and inter-annual climate variability in a large field experiment, *Global Change Biology* (2024). DOI: 10.1111/gcb.17418

Provided by German Centre for Integrative Biodiversity Research (iDiv)

Halle-Jena-Leipzig