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A model-based decision support system for sustainable grassland management

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The Decision Support System (DSS) for grassland farming is a user-friendly online tool designed to assess the effects of current and alternative management practices and climate scenarios on key grassland parameters. These include yield, changes in soil carbon (C) stock, and environmentally relevant nitrogen (N) losses via leaching and gaseous emissions. The tool is based on the terrestrial ecosystem model LandscapeDNDC, which quantifies C and N turnover and exchange processes across the pedosphere, biosphere, hydrosphere and atmosphere from site, landscape up to national scales.

For site-scale simulations, users can access the DSS through a graphical web interface. As a first step, the location of the model application can be selected via an interactive map. By default, location-specific soil profiles (Bayerisches Landesamt für Umwelt) and current climate and projection data (ClimEx) from regional databases are used. Users can also choose between a quick and an expert mode. While the quick mode utilizes data from the regional database, the expert mode allows for further refinement of the climate and soil information.

As a final step, accurately defining grassland management actions is crucial for the quality of the simulations. Users can specify the frequency and timing of fertilization and cutting events per management season over a 10-year period. Additionally, fertilizer type (organic or mineral) and amount, fertilizer C and N content, cutting height, and mulching options can be manually adjusted. The total N applied per management season is automatically calculated to ensure compliance with the German Fertilizer Ordinance, which sets a maximum limit of 170 kg N of organic fertilizer per hectare per year.

Simulation results include yield, fodder quality, soil C balance, N use efficiency, N_2O and NH_3 emissions, and NO_3 leaching. These outputs are presented using a traffic-light system based on threshold values from the literature. The DSS allows users to compare different management scenarios and view projections of management and climate conditions up to 2050.

By bridging the gap between scientific research and agricultural practice, the DSS supports farmers and stakeholders to develop economically viable and environmentally sustainable grassland management strategies.

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