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An agent-based model to simulate field-specific nitrogen fertilizer applications in grasslands

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Fertilization plays an important role in grassland management and decisions are usually made at farm level. Data on fertilizer application rates are crucial for an accurate assessment of the effects of grassland management on ecosystem services. However, these are generally not available on farm/field scale. To close this gap, we present an agent-based model for Fertilization In Grasslands (FertIG). Based on animal, landuse, and cutting data, the model estimates grassland yields and calculates field-specific amounts of applied organic and mineral nitrogen on grassland (and partly cropland). Furthermore, the model considers different legal requirements (including fertilization ordinances) and nutrient trade among farms. FertIG was applied to a grassland-dominated region in Bavaria, Germany comparing the effects of changes in the fertilization ordinance as well as nutrient trade. The results show that the consideration of nutrient trade improves organic fertilizer distribution and leads to slightly lower mineral N applications. On a regional scale, recent legal changes (fertilization ordinance) had limited impacts. Limiting the maximum applicable amount of organic N to 170 kg N/ha fertilized area instead of farm area as of 2020 hardly changed fertilizer application rates. No longer considering application losses in the calculation of fertilizer requirements had the strongest effects, leading to lower supplementary mineral N applications. The model can be applied to other regions in Germany and, with respective adjustments, in Europe. Generally, it allows comparing the effects of policy changes on fertilization management at regional, farm and field scale.

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