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"Reconcile land system changes
with planetary health"

Effect of climate change on mixed crop-livestock systems in the Sudan savannah of west Africa

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Abstract

Climate change is projected to have significant impacts on food and feed production, especially in the Sudan savannah zone of West Africa where mixed crop livestock systems (MCLS) dominate. However, in contrast to specialised farming systems (crop or livestock), the estimation of climate impact on mixed systems using combinations of detailed crop and livestock models remains under-developed in this region. Here, we apply a modelling approach to estimate the impacts of climate change on crop (maize, millet, sorghum, and peanut) yields and livestock numbers using the Scientific Impact assessment and Modelling Platform for Advanced Crop and Ecosystem management (SIMPLACE) modelling framework and the Sudan savannah zone of West Africa as case studies. In applying the framework on selected locations in Ghana and Burkina Faso, we demonstrated that the model satisfactorily estimated grain yields and livestock numbers. Our results show that, maize and sorghum yields were slightly and moderately overestimated, respectively. Conversely, grain yields of millet and peanut were moderately underestimated. Overall the mean residual error (MR) for grain yield was between -12 % to 18 % which was judged satisfactorily. For livestock numbers, the model deviated from observed values by recording an MR of 27 %. Furthermore, the validated model was used to estimate grain yields and livestock numbers under projected future climate change using downscaled GFDL-ESM4 projections (2025–2050) under the SSP5–8.5 emissions scenario. The results demonstrated that in the future, the studied locations will likely experience a significant decline in maize (up to -34 %), millet (up to -57 %), sorghum (up to -53 %), peanut (up to -23 %), and a significant increase in livestock numbers (up to 181 %). We conclude that, given the interplay of resource use in MCLS, it is important to also consider climate impacts beyond yield and livestock numbers to be able to implement adaptation strategies that ensure climate mitigation and resilience while sustaining crop yields and livestock productivity.

Keywords: Climate change, grain yield, livestock numbers, mixed crop-livestock systems, SIMPLACE

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