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"Reconcile land system changes
with planetary health"

Simulating maize responses to different fertilisers of two crop models in multi-locations in West Africa

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Abstract

Maize is an important crop in West Africa (WA). Land degradation and climate change further constraints its productivity and environmental sustainability thus promoting sustainable intensification practices (SIs) is strongly relevant in this context. Comprehensive field trials could provide understanding of the performance of SIs across locations, nevertheless they are often lacking in WA. Moreover, successful upscaling of SIs practices from specific locations to regional scales requires further investigating the suitability of SIs, especially under high spatial and temporal heterogeneity of soil and climatic conditions. Dynamic crop models representing the impact of SIs e.g. manure and/or inorganic fertilisers and their rates theoretically could offer capabilities to investigate the effects of those SI practices on crop yield and soil nutrients. We employ two crop growth models [SIMPLACE<LINTUL5> (S-L5) and APSIM] along with the measured data from 20 maize fields in Northern Ghana to investigate the suitability of two models to simulate effect of SIs. Calibration work shows that both models are able to simulate seasonal aboveground dry biomass (AGB) and leaf area index (LAI). The simulated grain yield of S-L5 and APSIM are 4.33 ± 1.67 and 3.82 ± 0.67 ton ha^{-1}, respectively for the fertilised treatments which are close to the observed yield (3.11 ± 0.75 ton ha^{-1}). Compared to the observed yield in the control treatment (1.47 ton ha^{-1}), two models adequately simulate the low yield due to no fertiliser with 1.62 and 1.26 ton ha^{-1}, respectively. Two models capture well the decline of AGB, LAI, and grain yield caused by the reduced fertiliser rates and types although onset and magnitude of simulated nitrogen stress differ between the models. We also examined uncertainties in yield prediction due to use of different combinations of soil (SoilGrid and FAO HWSD2.0) and climate (AgriERA5 and NASAPOWER) input data to the models which depend on fertiliser types and applied rates. Our findings suggest a high potential of two crop models for their regional application for investigating the roles of SIs. However, caution must be paid to uncertain output variables which strongly depend on both model parameterisation and on soil and climate input data.

Keywords: APSIM, grain yield, mineral nitrogen, organic manure, SIMPLACE, simulation, uncertainty

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