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"Solidarity in a competing world — fair use of resources"

Liebig's Law – Increase and Stabilise Tanzanian Maize Yields by Combining Different Crop Modelling Approaches

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Abstract

For Tanzania food security is an important challenge, which will increase for the next decades. In Tanzania, maize (*Zea mays* L.) is the most planted food crop. Due to limited extendable arable land, maize yields (per hectare) must increase to achieve a sufficient food production. Besides the average yield level, yield stability is also crucial for food security. Despite a low average actual maize yield of 1.3 t ha^{-1}, yield variability is relatively high (standard deviation: ±0.8 t ha^{-1}). For increasing and stabilising maize yields, crop models can contribute to optimising agronomic management practices. In our study, we analyse the yield impact of actual and optimal fertilisation and separate the weather-related yield variability for micro-insurance purposes. With the process-based model SWIM (Soil and Water Integrated Model), we compute impacts on crop yields of actual and optimal fertilisation. The statistical model IRMA (Interregional Regression Model for Agriculture) captures variability of weather, agronomic management, and socio-economic influences on farm maize yields. The model allows decomposing these effects. The use of those two crop models improves the robustness of both model outputs and enables yield assessments on different production levels. For entire Tanzania, we find a yield gap of 6.2 t ha^{-1} between actual and optimally-fertilised yields. Thus, actual yields are only 17 % of optimally-fertilised yields (7.5 t ha^{-1}). Such higher yields are more sensitive to weather impacts, because nutrient supply is no longer yield limiting (which is the major constraint of actual yields). To enhance the implementation of sufficient fertiliser supply in Tanzania, micro crop insurances can contribute indemnifying smallholder farmers for the increased yield variability. Since SWIM is only partly able to assess the inter-annual yield variability, we utilise IRMA to capture the remaining yield variability. By separating weather-related yield variability, IRMA provides insights of socio-economic impacts on maize yields. These IRMA results are directly useable to calculate micro-insurance claims, which might contribute to stabilise smallholder farmers' income.

Keywords: Food security, maize, process based and statistical crop models, risk assessment, Tanzania

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