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"Can agroecological farming feed the world? Farmers' and academia's views"

Synthesis of field experiments for the assessment of yield response to different management options in diverse agro-ecological zones in Kenya using the CERES-Maize model

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Abstract

Maize production important in sustaining the livelihoods of approximately 98 % of smallholder farmers in Kenya. The production, however, has been declining as a result of periodic climate shocks, pests, diseases, declining soil fertility, and poor agronomic practices. Aligning maize production to feasible management strategies is important for low production regions of Sub-Saharan Africa.

In this study, therefore, we synthesized field experiments conducted in the 2014 and 2021 growing seasons in the Endebess region in Kenya and three other well-calibrated and evaluated experiments conducted in Embu, Juja, and Naivasha during different maize growing seasons. Subsequently, we determined yield responses to strategies that include three fertilisation rates ($N = 50\,\text{kg ha}^{-1}$, $N = 75\,\text{kg ha}^{-1}$, and $N = 100\,\text{kg ha}^{-1}$), two irrigation management (rainfed and supplementary irrigation of 80 mm), and three sowing dates (15^{th} March, 1^{st} April, and 15^{th} April) using the DSSAT model (CERES-Maize). In total, we simulated 18 treatment combinations using long-term (1984–2021) weather data and computed the average yield.

Results show a varied response of the different strategies to maize production based on the agro-ecological zone. Under rainfed production and the recommended fertilisation rate of $75\,\text{kg N ha}^{-1}$, CERES-Maize simulated yields of $5835\,\text{kg ha}^{-1}$ and $4389\,\text{kg ha}^{-1}$ for Endebess and Embu, respectively. However, simulated yields in Juja and Naivasha were $3105\,\text{kg ha}^{-1}$ and $2899\,\text{kg ha}^{-1}$, respectively. The yields, however, increased by 27 % and 36 %, under supplementary irrigation and the recommended fertilisation rate. The relatively humid regions of Endebess and Embu showed little effect on supplementary irrigation (+5 % and +4 % yield increase), while a high fertilisation level of $100\,\text{kg N ha}^{-1}$ improved yields by 15 % and 19 %, respectively. This shows that in the upper midland agro-ecological zones in Kenya, nitrogen is the limiting factor for maize production, whereas moisture stress is attributed to low production in the lowland regions. Evaluation of the sowing dates shows that early planting (15^{th} March) combined with supplementary irrigation is beneficial only to the lowland regions. The results imply that accounting for site-specific conditions is necessary for improving maize yield in Kenya.

Keywords: CERES-Maize model, management strategies

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