Mineral fertiliser is a key option to improve maize yield in communal areas – but it comes at the cost of greater inter-annual yield variability

Highlights:

- Agroecological practices (crop residue mulching and intercropping with a legume) only marginally increase the impact of mineral fertilizer on maize
- Soil type drives the agronomic efficiency of mineral fertilizer, more than mulching and intercropping with a legume
- Intensifying maize production with mineral fertilizer comes at the cost of more sensitivity of yields to climate interannual variations, meaning higher risk of low return to inputs for farmers.

Details of the question / issue

Greater food availability, through an increase in crop production, is a necessary step towards better food security for a growing population. Nutrient availability is the prevailing constraint to crop growth, before water, in most of communal areas of sub-humid to semi-arid Zimbabwe where highly weathered sandy soils predominate, and under the current low-input farming. Using organic sources of nutrients (e.g. animal manure) is a relevant option to bring more nutrients to crop – yet their availability is severely constrained in the smallholder setting given the scarcity in grazing areas and the low number of animal head owned by farmers, a situation that was worsened by the sanitary crisis that impacted negatively and severely the cattle herd of the region in the past decade. Mineral fertilisers are a key option to restore fertility as needed to increase photosynthesis and thus carbon dioxide fixation by crops and finally biomass and grain production. However, the profitability of fertilisers is directly linked to the efficiency of their use by crops. Poor fertiliser use efficiency leads to low profitability. Agroecological options like intercropping and mulching are expected to increase fertiliser use efficiency. As the literature is not consensual on this benefit which appears varying across climate and soil conditions, it has to be tested in farmers' fields.

Findings:

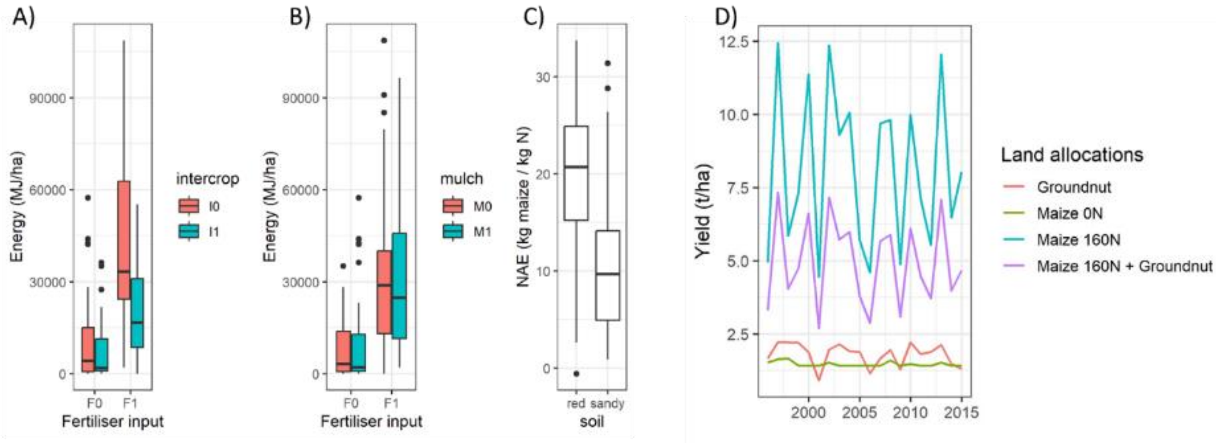

Figure 1: A) Comparative impact of intercropping and mineral fertilizer on maize-based system productivity in terms of energy in 11 trials in Murewa; B) comparative impact of mulch and mineral fertilizer on maize-based system productivity in terms of energy in 11 on-farm trials in Murewa; C) Impact of soil type on agronomic N efficiency (NAE) in 11 on-farm trials in Murewa and D) simulated inter-annual variability in sole maize with and without fertilizer

Increasing N input on maize leads to greater improvement in energy production than intercropping maize with cowpea or mulching (Figure 1A, 1B). Intercropping maize with cowpea leads to a slight decrease in maize grain yield, and the extra grain obtained from the intercropped cowpea is small also and does not compensate for this loss (Figure 1A). Maize response to fertiliser was much greater on red soils than on sandy soils (Figure 1C). Inter-annual maize variability was much stronger when maize was fertilised than when maize was not fertilised (Figure 1D).

Discussion / limitations/ perspective:

Agroecological practices such as intercropping and mulch, though providing several benefits (e.g. fodder production, weed suppression, erosion control) do not seem to help reduce the inter-annual variability of maize response to fertiliser. Yet, diversifying crop production with e.g. the integration of legume, can help lower risk of low food/fodder production at the farm level, because cereals and legumes have different sensitivity to climate variability. The small response of maize to fertiliser on the sandy soils of Murewa is worrying and this deserve more investigation to be fully understood (i.e. meso and micronutrient deficiency, and possibly water stress and/or leaching in the experimental years).

Methodological details

On-farm trials were established on farmers home and outfields on sandy soils and clay soils in Murewa (Agroecological Region II, sub-humid climate) to assess the impact of mulch, intercropping, and mineral fertiliser on maize production. The STICS soil-crop model was calibrated against this on-farm data to simulate the variations in maize yield with and without fertiliser for the historical (2000-2020) climate in Murewa.

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