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Long-term effects of different organic resource rates, quality and nitrogen fertilizer on SOC development and conversion efficiency across Kenya.

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Maize monoculture with low external inputs, as frequently practiced in sub-Saharan Africa, usually leads to the long-term loss of soil fertility. This threatens the already poor yields in the region. Practices that add organic and mineral resources to the soil therefore promise to counteract soil fertility loss by providing the potential feed-stock for microbes to build new soil organic matter. We studied the effect of organic and mineral resource addition from five organic amendment types of different quality (relative N, lignin and polyphenol contents) and quantity and from chemical nitrogen fertilizer, on soil organic carbon (SOC) and soil nitrogen in the 15 cm topsoil of four long-term trials in contrasted sites in Kenya. They had different climate and soil texture and lasted between 16 and 19 years. Treatments were identical among sites, the organic resources were *Tithonia diversifolia* (high quality and fast turnover) and *Calliandra calothyrsus* (high quality and slow turnover), stover of *Zea mays* (low quality and fast turnover), sawdust from *Grevillea robusta* trees (low quality and slow turnover) and locally available farmyard manure (undefined quality and slow turnover). The organic resources were added in the quantities of 1.2 and 4 t C ha^{-1} yr^{-1} and the experiments included a split-plot treatment of ±N addition (120 kg ha^{-1} in each of the two growing seasons per year).

Despite site-specific differences, the general trend across sites indicated that SOC is usually lost with all treatments. Typical losses ranged from 1.9% to 0.6% loss of initial SOC yr^{-1} for the control and the farmyard manure (at 4t C ha^{-1} $year^{-1}$) respectively. Adding *Calliandra* or *Tithonia* at 4t C ha^{-1} yr^{-1} also enable to slow the loss (about 1.1% of initial SOC yr^{-1} lost). Nevertheless, the addition of 4t C ha^{-1} yr^{-1} farmyard manure and *Calliandra calothyrsus*, together with mineral N addition, achieved a gain in SOC over time only in the site which had lowest initial SOC contents (about 6 g C kg^{-1}), a sand of 31% content and a climate that was suitable for maize growth. In contrast, another site with low initial SOC content, high sand content, but a less suitable climate, with frequent

failures of the maize crop, lost SOC in all treatments. In the site with initially 25 g C kg^{-1}, the farmyard manure treatment at 4t C ha^{-1} yr^{-1} with N addition was the only treatment that could maintain SOC, while in the site with initially highest SOC (about 30 g C kg^{-1}), all treatments lost SOC. The mineral N addition, with the exception of two treatments in the lowest fertility site, had no significant effect on the response of SOC to the different organic resource treatments. Our results indicate that farmyard manure may be the most suitable resource to reduce losses of SOC, but increases may only be possible in sites with initially low SOC contents, e.g. where, because of sufficiently long cultivation activities, a new steady state with low SOC contents has already been attained.