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Traditional livestock enclosures are greenhouse gas hotspots in the African savanna landscape: The case of a rangeland in Kenya

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There is hot debate about whether grassland-based livestock production can be climate-smart or not. Greenhouse gas (GHG) emissions from livestock (primarily from enteric methane [CH_4] and manure CH_4 and nitrous oxide [N_2O]) stand vis-à-vis vegetation CO_2 uptake and soil carbon sequestration. In sub-Saharan Africa (SSA), livestock are a precious good that ensures the livelihoods of millions of people, which often belong to marginalized groups such as pastoralists. To protect their animals from predation and theft, livestock are secured in overnight enclosures ("bomas" in Kiswahili), which form the center of many pastoral settlements. However, in these enclosures manure accumulates for months or even years, making them a potential hotspot for GHG emissions. Here, we present the first year-long measurements of GHG emissions from active and inactive (abandoned) bomas from an African rangeland at the ILRI Kapiti Research Station in Kenya.

We found that active bomas were continuous sources for CO_2, CH_4 and N_2O emissions, with flux peaks of up to 1940 mg CO_2-C m^{-2} h^{-1}, 1600 µg N_2O-N m^{-2} h^{-1} , and 6690 µg CH_4-C m^{-2} h^{-1}. Even after their abandonment, fluxes from bomas continued to be elevated compared to savanna soil background emissions for all GHGs. When calculated over a full year and put in context with manure deposition rates into the bomas (GHG emission factors), we found that 12.6 ± 5.3 % manure-C was emitted as CO_2, 2.4 ± 0.4 % manure-N was emitted as N_2O, and 0.5 ± 0.1 % manure-C was emitted as CH_4. GHG emissions from active bomas were not affected by rainfall seasonality or temperature, presumably because the moisture content of the fresh manure was always high due to urine input, and because temperature did not vary much during the year. In abandoned bomas, GHG emissions were driven by rainfall events that triggered emission pulses, leading to higher emissions during the wet season.

The high N_2O and CH_4 emissions we found have implications for global GHG inventories, which

currently do not have a category for overnight livestock enclosures and therefore do not account for these emissions. Furthermore, hotspots for GHG emissions such as these livestock enclosures need to be included to assess the full GHG budget of pastoral livestock systems and to develop management interventions for low-emission livestock production in developing countries.