Nitrous oxide and methane emissions from cattle manure heaps in Kenya

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Agricultural greenhouse gas (GHG) emissions in Africa contribute 15 % to the global total agricultural emissions, which is in the same range as agricultural emissions from Europe. The majority of these agricultural GHG emissions is attributed to livestock farming (up to 80 % at national scale), of which 10-25 % originate from livestock manure. At the same time, livestock production is essential for the livelihoods of millions of people in Sub-Saharan Africa (SSA), where 45-80 % of livestock production occurs in smallholder systems. With the growing population in SSA, the demand for livestock products is expected to increase, and – without low-emission manure management – a rise in manure-borne GHG emissions will occur. However, reliable in situ measurements from SSA are scarce, leading to substantial uncertainties in agricultural GHG budgets and making assessments of potential mitigation options difficult.

Here we present results from two cattle manure incubation experiments in Kenya, using manure from Boran (Bos indicus) cattle, a breed common in East Africa that were fed with typical feeds used in SSA smallholder farms. Manure was collected and piled in heaps (solid storage), the most common form of manure storage in Kenyan smallholder systems, and CH₄ and N₂O emissions were measured over 140 days. In the first trial, cattle were fed a diet that either met their maintenance-energy requirements (i.e. animals received enough food to support their metabolism), or a diet at sub-maintenance energy levels to simulate common conditions in smallholder farming systems, particularly during the dry seasons. Cumulative manure N₂O emissions from the sub-maintenance diet (i.e. the “hungry” cows) were lower than from cattle fed at maintenance energy levels. These lower N₂O emission likely resulted from lower N concentration and a wider C:N ratio in the manure than in the “better fed” animals. Furthermore, the urine-N:faecal-N ratio in the “hungry” cows decreased, indicating a shift from urine-N (mostly inorganic N) to faecal-N (mostly organic N), which further backs the lower observed N₂O emissions. Both N₂O as well as CH₄ emissions from manure were lower than the IPCC default emission factors for solid storage in tropical regions across all diets tested.

In the second trial, Boran cattle were fed with three different tropical forage grasses common in
Kenya: Napier (*Pennisetum purpureum*), Rhodes (*Gloris gayana*), and Brachiaria (*Brachiaria brizantha*). Manure from the Rhodes grass diet had the lowest N concentration and also the lowest cumulative CH$_4$ emissions, while N$_2$O emissions did not differ between diets. Similar to the sub-maintenance feeding trial, total CH$_4$ and N$_2$O emissions were lower than the IPCC default factors. Taken together, these results are an important step towards reducing the uncertainties in GHG emissions from agriculture in SSA. Furthermore, if African nations use IPCC default values for their national GHG reporting on livestock, emissions are likely to be overestimated, highlighting the importance and benefits of localized data from Africa.