N_2O and CH_4 emissions from cattle manure heaps in Kenya

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EGU online, BG3.3 Gas exchange between soil, plants and atmosphere, 08 May 2020

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ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

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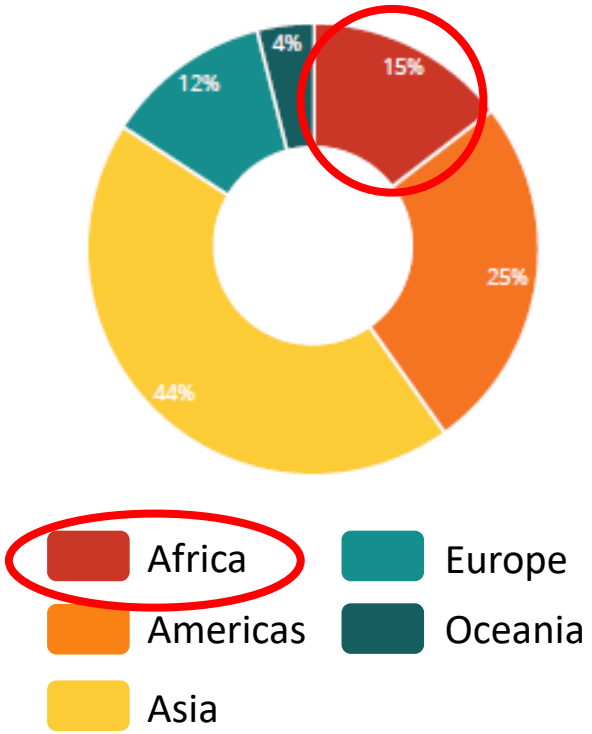
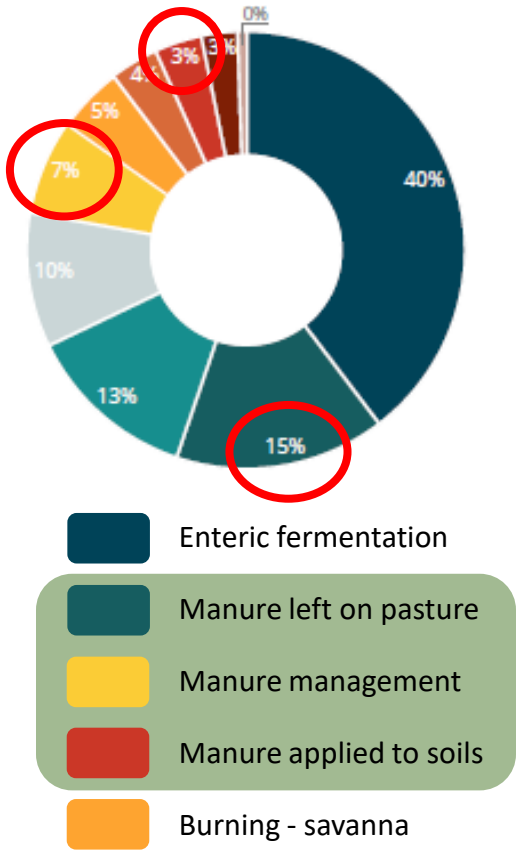
KIT Karlsruhe Institute of Technology

Background – Agricultural GHG emissions & productivity in the global context

%-contribution of continents to total AFOLU GHG emissions



AFOLU GHG-emissions by sector

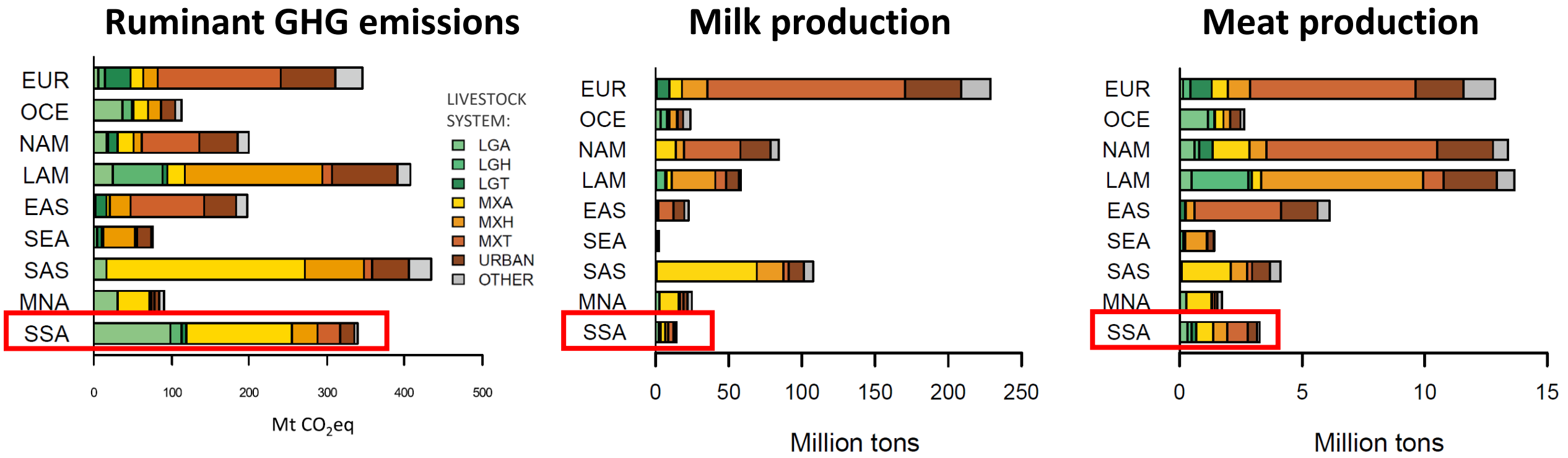


15% of agriculture GHG emissions come from Africa

25% of emissions related to manure

FAO, Tubiello et al. 2014

Background – Agricultural GHG emissions & productivity in the global context



- **Low productivity, high GHG emissions of livestock in sub-Saharan Africa (SSA) → high yield-scaled GHG emissions**
- **Productivity increase urgently needed to ensure food security & meet demand of growing population**
- **Sustainable intensification, climate change adaptation & mitigation (co-benefit)**

Herrero et al., PNAS, 2013 (Numbers are from 2010)

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Background – “Typical African smallholder farm”

Smallholder mixed crop-livestock farms:

- 50% of agricultural workforce employed in livestock production
- Average farm size 0.5-2 ha
- Crops (e.g. maize, wheat, barley, tomatoes, onions, sunflower, …)
- Few animals per farm (e.g. 2-5 cattle, some goats, sheep, chicken, pigs, …)
- Cattle: Local and “improved” breeds (e.g. Boran x Friesian)
- Manure management common, manure as fertilizer

FAOSTAT, World Bank, ILRI

Research questions & hypotheses

What is the magnitude of CH_4 and N_2O emissions from manure heaps in Kenyan smallholder farming systems?

1. Due to feed scarcity (e.g. dry season) and poor quality of feeds, manure-borne CH_4 and N_2O emissions are lower in Kenya than in developed countries.
2. Manure from hungry cows emits less N_2O compared to well-fed cows because of higher N retention under sub-maintenance energy feeding.
3. Manure from cattle fed with tropical forage grasses has low N concentration and lower N_2O emission factors (% manure-N emitted as N_2O-N) compared to IPCC Tier 1 default EF_{N2O} for solid manure storage.

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1. Experiment: Sub-maintenance energy feeding trial

Setup:

- Location: Mazingira Centre, Nairobi, Kenya
- Animal feeding trial with Boran steers
- Diet at 3 levels of metabolic energy requirement (MER):
  - 120% MER (yummy)
  - 100% MER (ok)
  - 60% MER (hangry!)
- Manure incubation in uncovered heaps (n = 3 á 100 kg FM) for 5 months
- Daily to 3x/week gas sampling

George Wanyama & Daniel Korir

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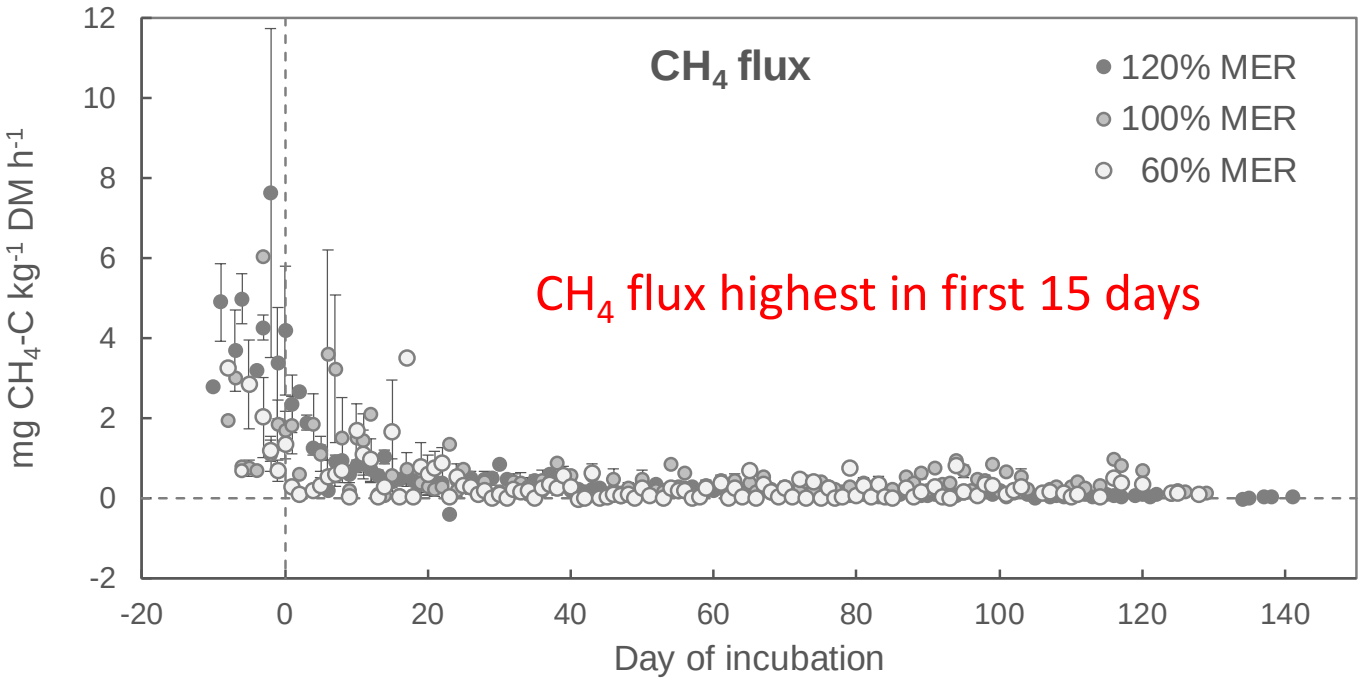
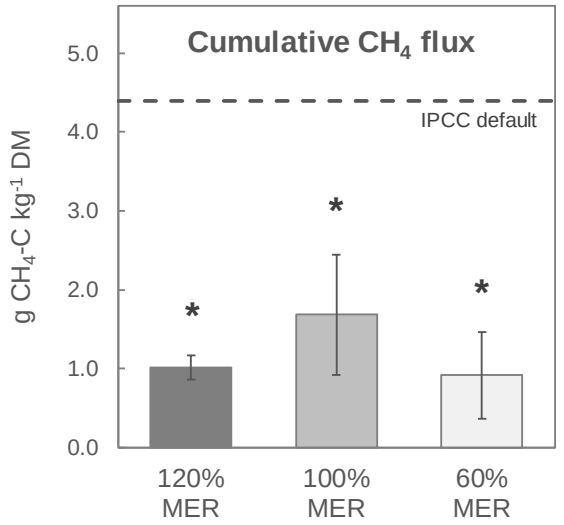
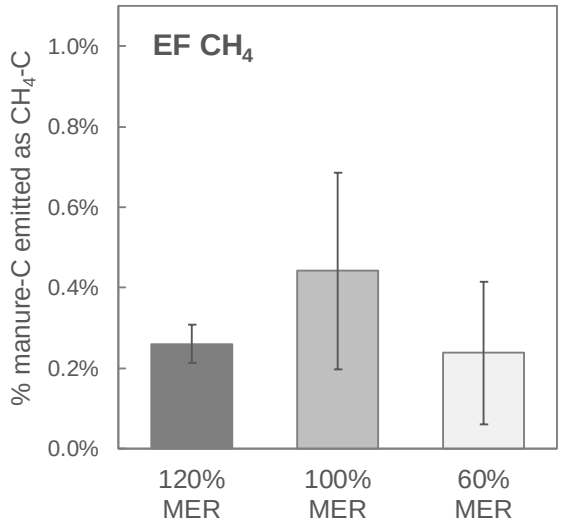
1. Experiment : Sub-maintenance energy feeding trial





CH_4 emissions lower than IPCC Tier 1 default value



No difference in CH_4 emissions between MER treatments

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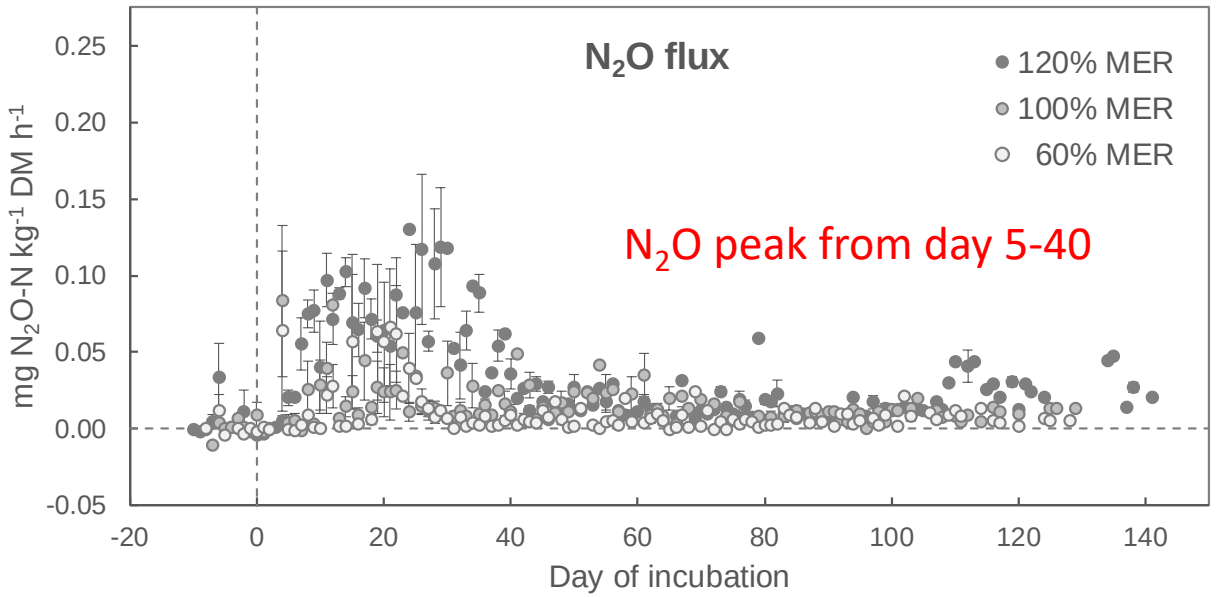
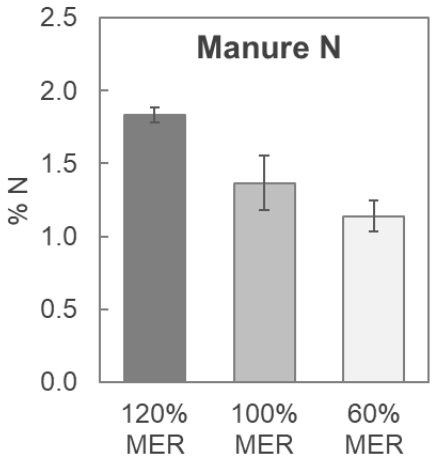
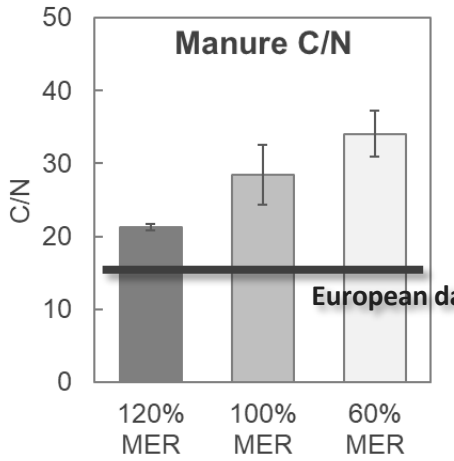
1. Experiment : Sub-maintenance energy feeding trial

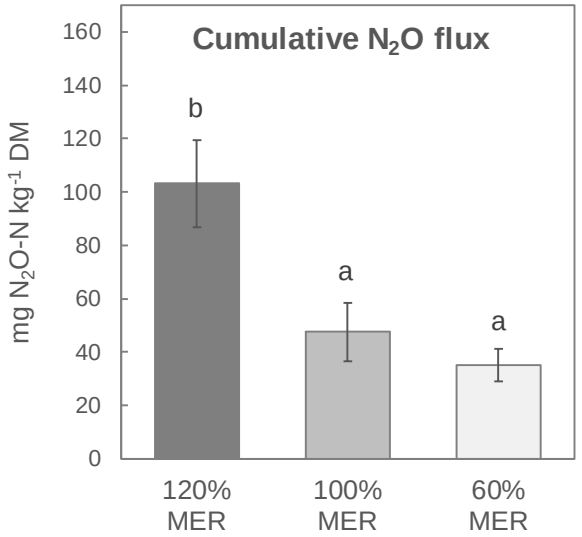


N_2O peak from day 5-40

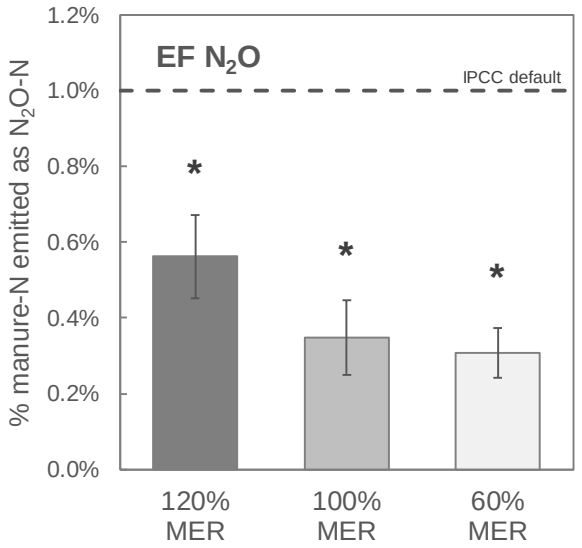




Manure N lower & C/N higher in hungry cows



Manure from hungry cows emits less N_2O



Emission factor 50% lower than IPCC Tier 1 default value

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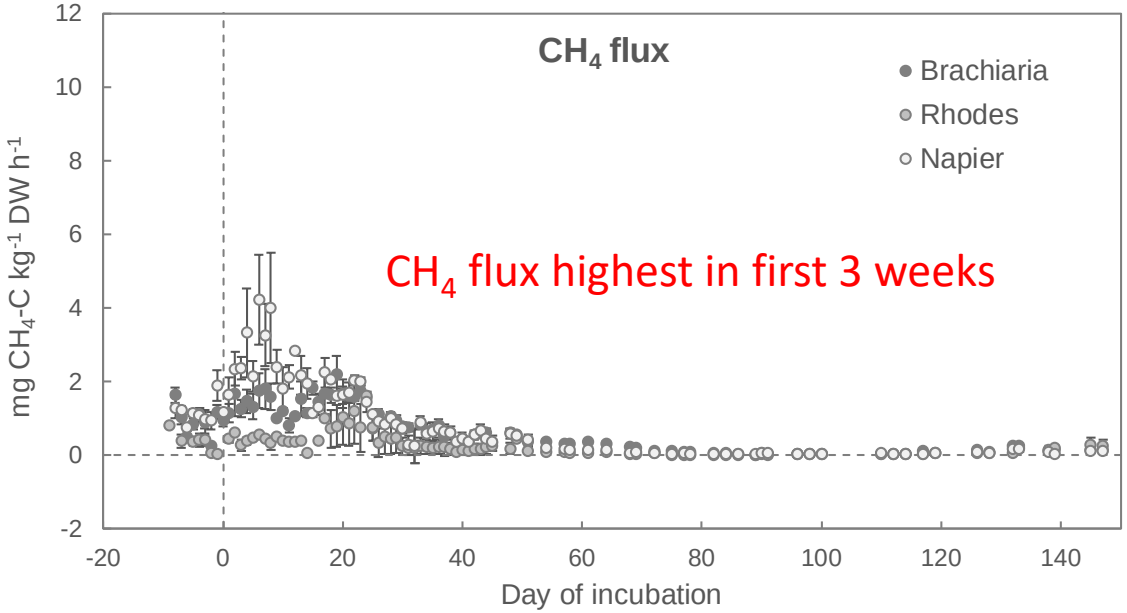
2. Experiment : Tropical forage grass feeding trial

Setup:

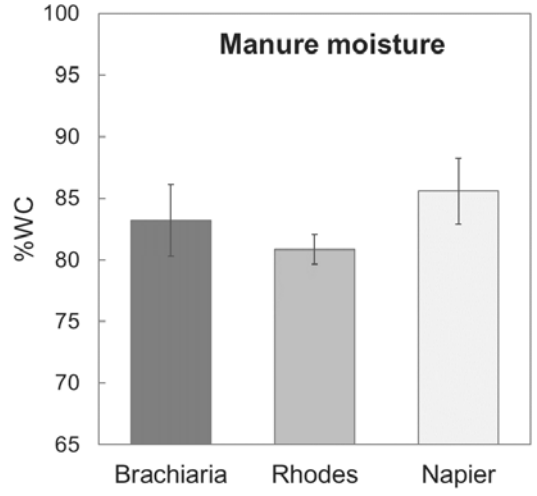
- Location: Mazingira Centre, Nairobi, Kenya
- Animal feeding trial with Boran steers
- Three tropical forage grasses (fed *ad libitum*)
  - Napier grass
  - Rhodes grass
  - Brachiaria grass
- Manure incubation in uncovered heaps (n = 3 á 100 kg FM) for 5 months
- Daily to 3x/week gas sampling

Daniel Korir & Dónal Ring

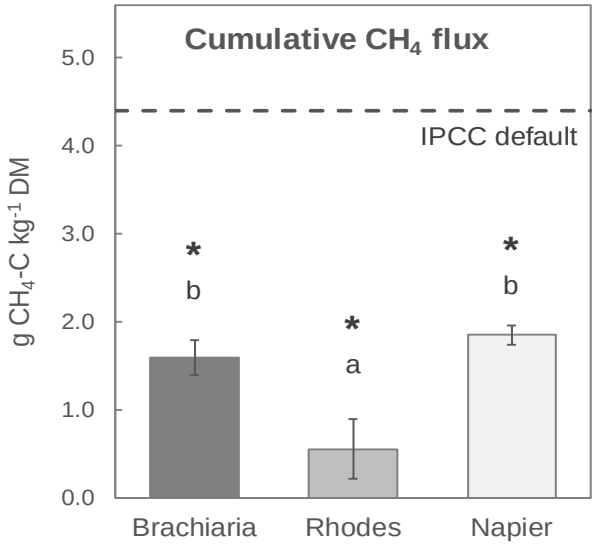
2. Experiment : Tropical forage grass feeding trial



CH_4 flux highest in first 3 weeks

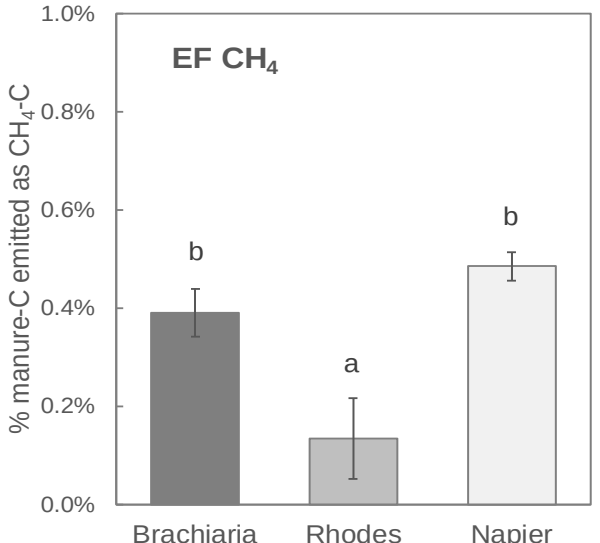


No difference in manure moisture content



Manure from Rhodes grass diet has lowest CH_4 emissions

Again, CH_4 emissions lower than IPCC default values



Carbon in Rhodes manure is less readily converted to CH_4

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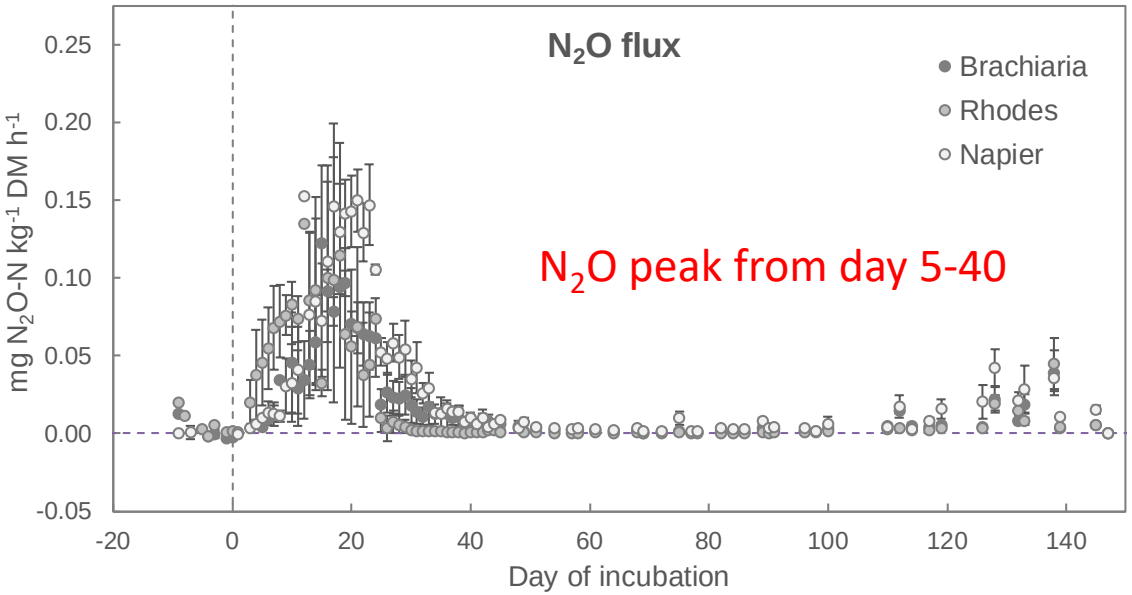

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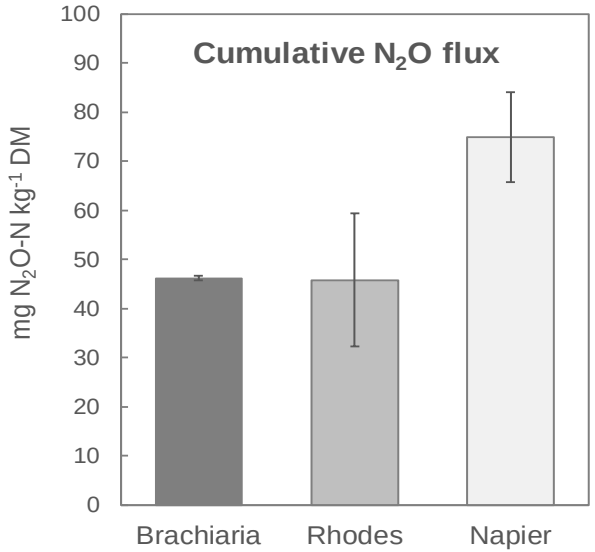
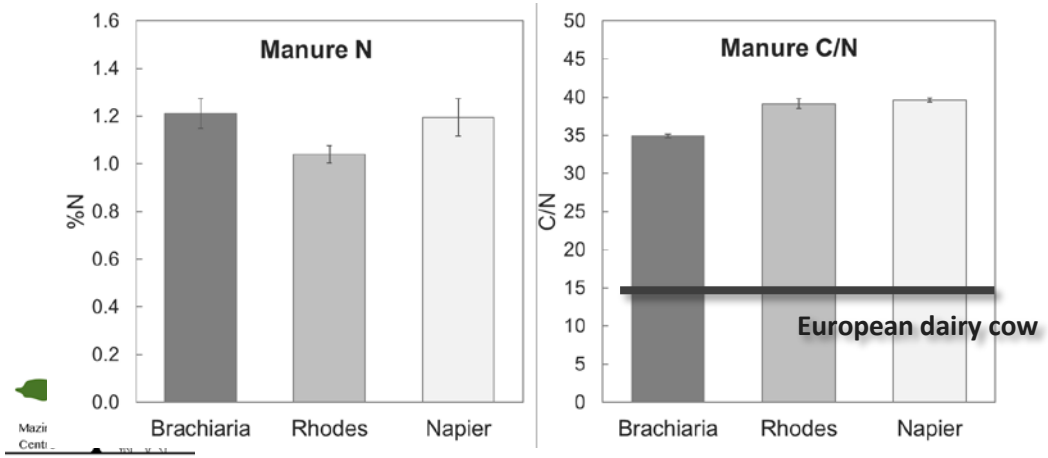
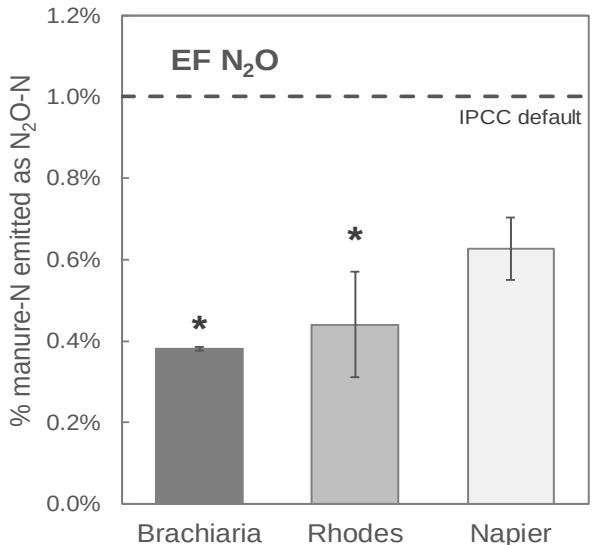


Cumulative N_2O similar for all grasses



Manure C/N of forage grass diet 2x higher than “European-style” diet



Again, N_2O emission factor below IPCC default value

Conclusions

- Manure N concentration from African smallholder farms lower than in developed countries
- Current IPCC default factors for manure N_2O and CH_4 are too high compared to *in situ* measurements.
- This potentially invalidates current mitigation practices in SSA because baselines are incorrect, also reporting under UNFCCC is biased.

What needs to be kept in mind:

- Spatial variability (characteristics & intensity of farming systems varies across Africa)
- With agricultural intensification total N_2O and CH_4 emissions in SSA likely to go up
- However, with improved management (closed nutrient cycles) productivity can go up faster than emissions → GHG emissions intensities could go down
- Also, more productive and diverse systems are often more resilient to stresses.

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Thank you for tuning in!

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