Greenhouse Gas Emissions and Fertiliser Quality from Cattle Manure Heaps in Kenya

Better lives through livestock

Session “Climate change - Mitigation and adaptation”, Tropentag Virtual Conference 2020

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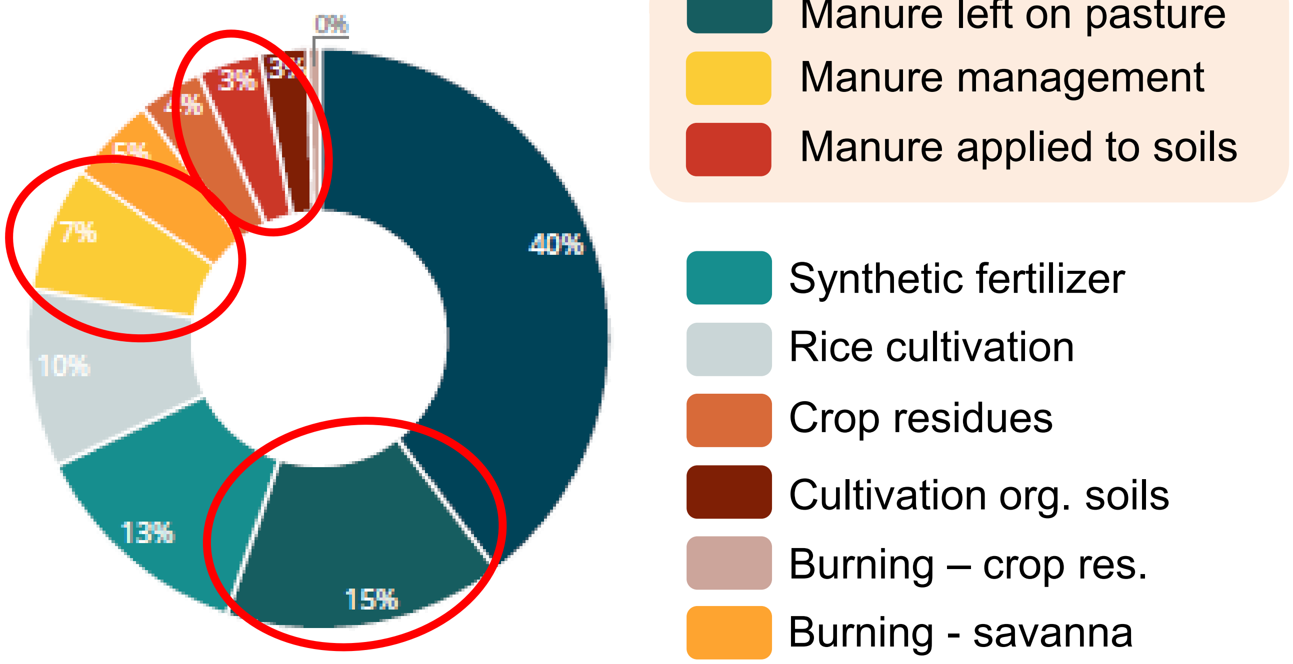
Background

AFOLU GHG emissions by source (globally)



FAO, Tubiello et al. 2014

- 25% of global AFOLU GHG emissions from livestock manure
- African countries rely on default IPCC emission factors for GHG reporting
- Few *in situ* data on manure GHG emissions from smallholder systems
- Low livestock productivity in SSA:
  - Low forage quality: tropical grasses with low protein and high fibre content
  - Low fertilizer use: soil nutrient mining

➢ Need for sustainable intensification and closed nutrient cycles

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Research questions & hypotheses

Q1: What is the magnitude of CH_4 and N_2O emissions from manure heaps in Kenyan smallholder farming systems?

Q2: How do animal diets affect manure CH_4 and N_2O emissions and manure fertilizer quality?

H1: Manure from hungry cows has lower N concentrations and emits less N_2O compared to well-fed cows because of higher N retention under sub-maintenance energy feeding.

H2: Poor quality tropical forage grasses result in manure with low N concentrations and low manure N_2O emissions.

H3: Forage grass with a low DM content will increase manure moisture content and lead to higher manure CH_4 emissions.

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Animal trial 1: Sub-maintenance feeding

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- **Setup**: Animal feeding trial with local *Boran* cattle (1.5 yr young steers) fed below their metabolic energy requirements (MER)
  - 100 % MER (ok)
  - 80 % MER (hungry)
  - 40 % MER (really hungry!)

- **100 kg FW manure incubated in heaps (n = 3)**
  - CH_4 and N_2O fluxes measured with manual static chambers for 5 months (daily to 3x/week gas sampling)
  - Manure chemistry (DM, C, N, ash)

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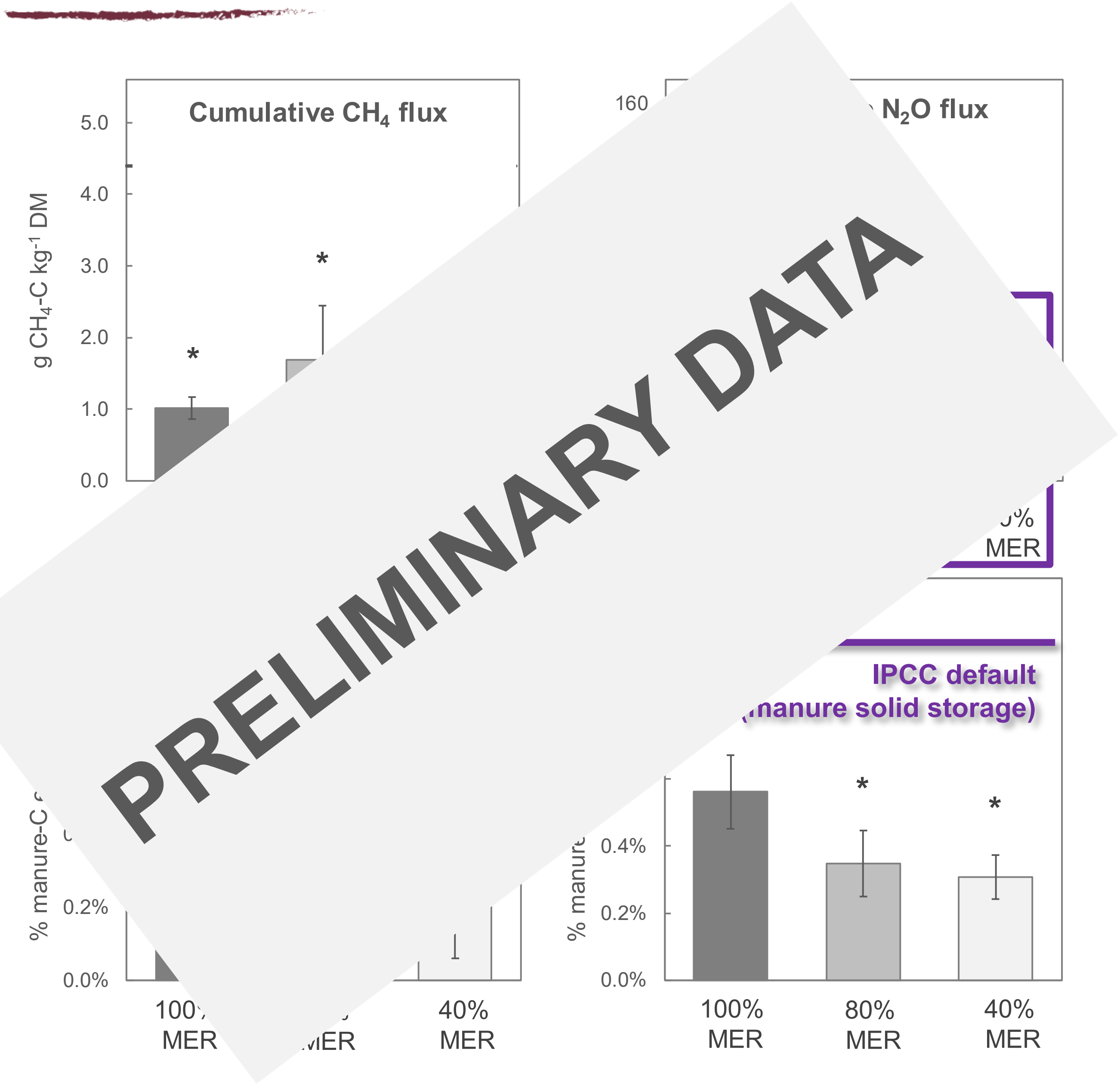
Animal trial 1: Sub-maintenance feeding



- Manure N_2O emissions of hungry cattle lower than when fed at maintenance levels
- No difference in manure CH_4 emissions between diets
- ***CH_4 emissions and N_2O emission factors lower than IPCC Tier 1 default values for solid storage***

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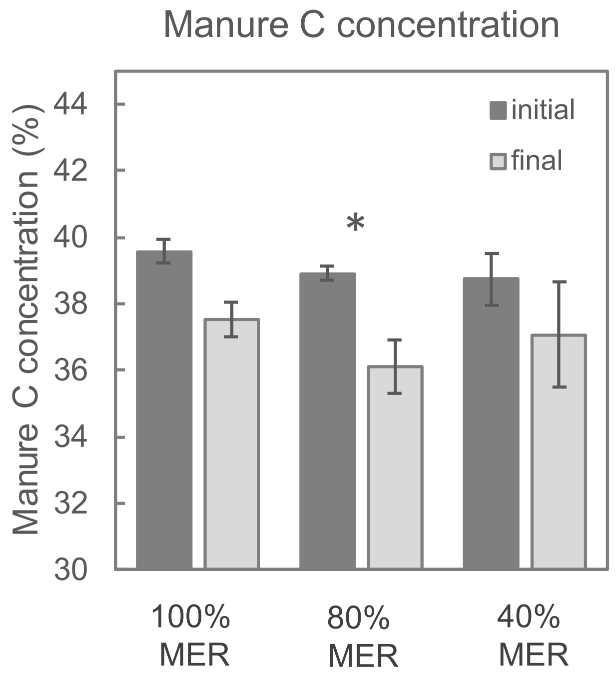
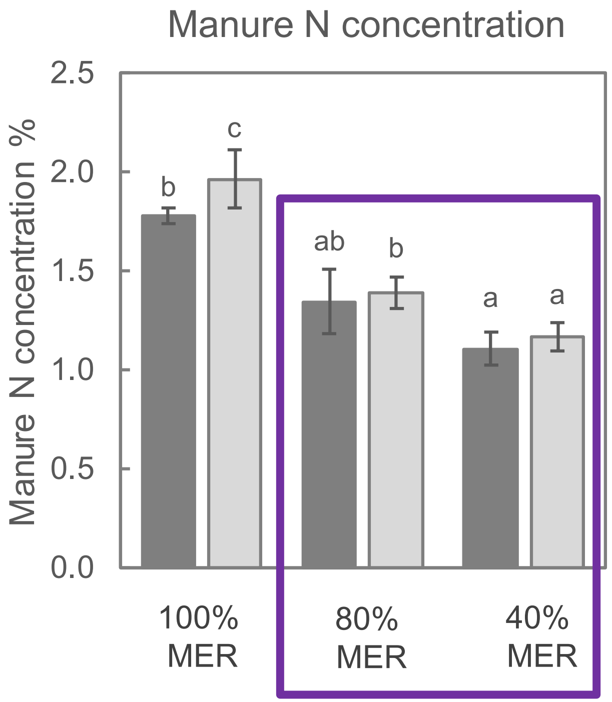
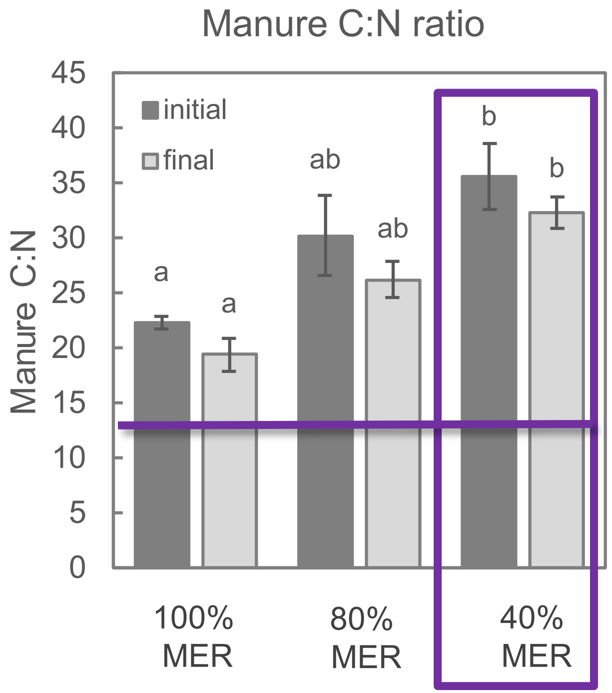
Animal trial 1: Sub-maintenance feeding

- ***Manure from hungry cattle contains less N and has higher C:N***
  → lower fertilizer value!







European dairy cow
Amon et al., 2001

Animal trial 2: Tropical forage grass diets

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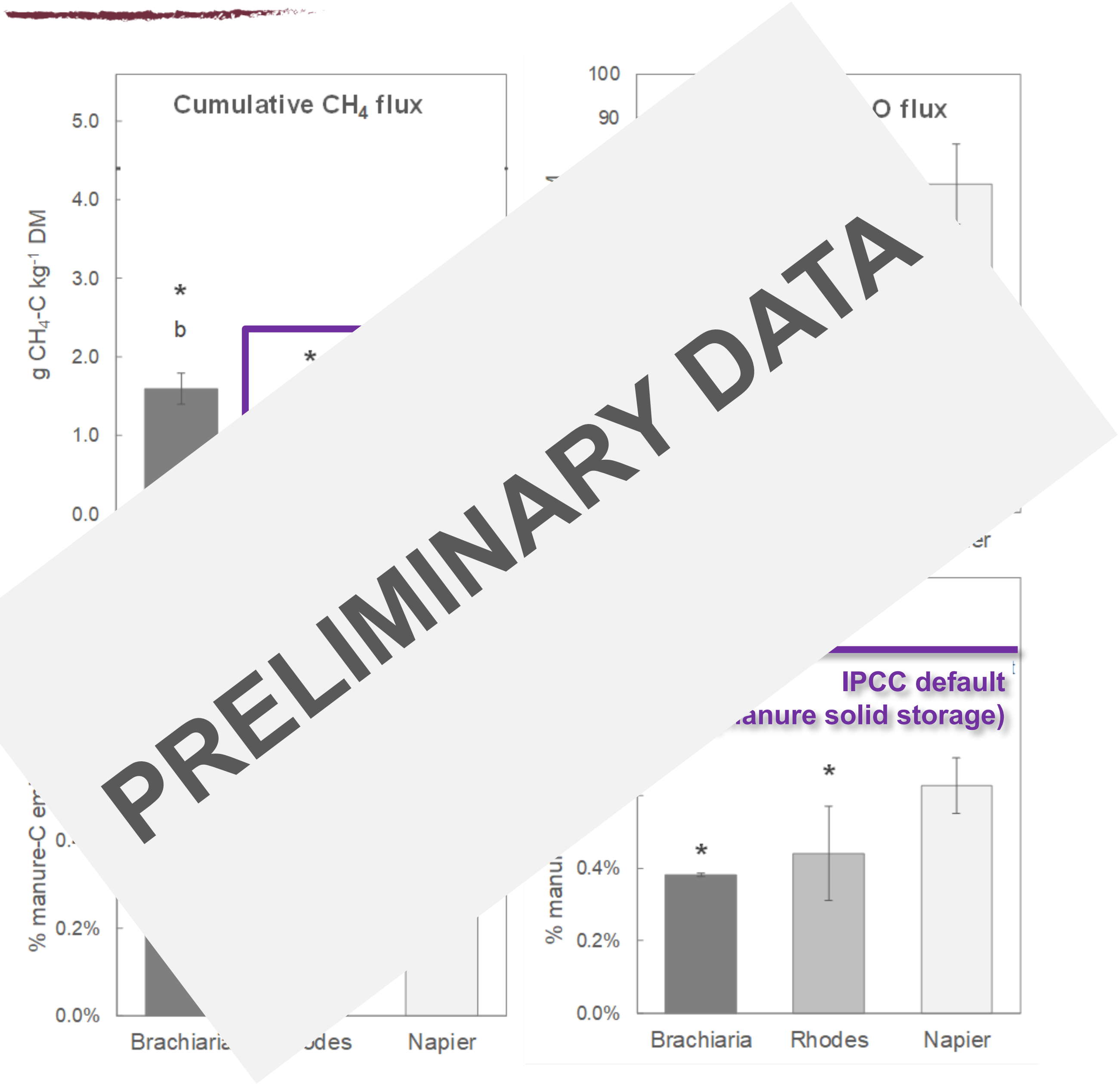
- **Setup**: Animal feeding trial with local *Boran* cattle (1.5 yr young steers) fed only with tropical forage grasses
  - Napier grass (*Pennisetum purpureum* var Kakamega 1)
  - Rhodes grass (*Chloris gayana* cv. Boma)
  - Brachiaria grass (*Brachiaria brizantha* var xaeres)

- **100 kg FW manure incubated in heaps (n = 3)**
  - CH_4 and N_2O fluxes measured with manual static chambers for 5 months (daily to 3x/week gas sampling)
  - Manure chemistry (DM, C, N, ash)

Animal trial 2: Tropical forage grass diets



- No difference in manure N_2O emissions between grass diets
- Manure CH_4 emissions of cattle fed on Rhodes grass lower than fed on Napier or Brachiaria
- ***CH_4 emissions and N_2O emission factors lower than IPCC Tier 1 default values for solid storage***

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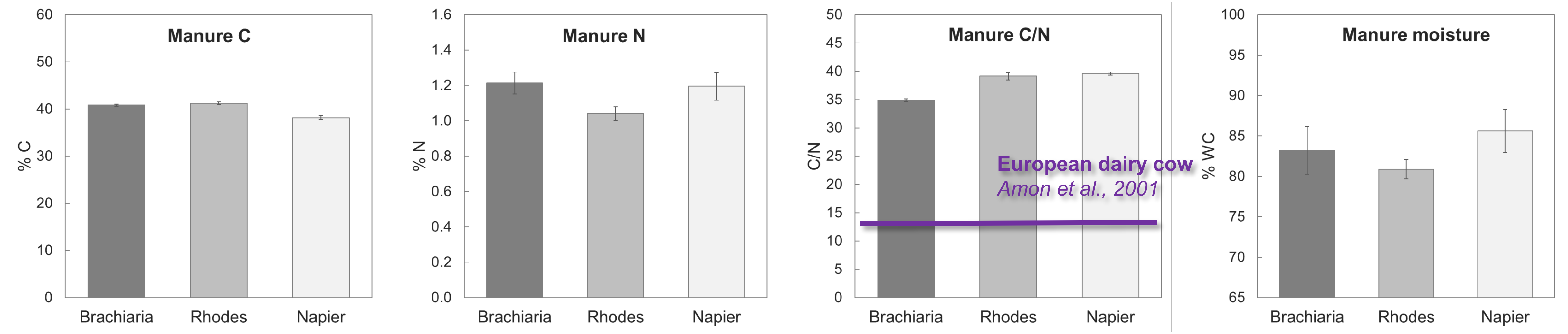
Animal trial 2: Tropical forage grass diets

- No difference in manure chemistry or moisture
- C:N ratio 3x higher compared to “European diet” → poor fertilizer value



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Conclusions

- Manure GHG emissions depend on cattle diet: feet scarcity and poor-quality forage grasses reduce N_2O emissions

- Smallholder farming systems in East Africa quite unique & diverse
  → Tier 1 assumptions and default values often not valid
  → over-estimation of manure GHG emissions with default values
  → need for localized measurements

- Future experiments must consider breeds (local vs. improved), feed quality & quantity, manure storage type & duration, climate

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… and all the donors for funding our research.

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