Estimation of enteric methane emission factors and intensities in smallholder cattle systems in Western Kenya

Alice Onyango[a,b,c], Uta Dickhoefer[a], Klaus Butterbach-Bahl[b,d], John Goopy[b]

[a]University of Hohenheim, Animal Nutrition and Rangeland Management in the Tropics, Stuttgart, Germany; [b]Mazingira Centre, International Livestock Research Institute, Nairobi, Kenya; [c]Maseno Univesrity, Maseno, Kenya, [d]Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research, Atmospheric Environmental Research, Garmisch-Partenkirchen, Germany

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Introduction

Enteric methane (CH_4) emissions are a loss of feed energy and cause climate change. Quantitative estimates of CH_4 emissions are needed for mitigation and intervention planning, but there is paucity of data from smallholder cattle systems in East Africa. Estimates of CH_4 using area-specific feed and cattle data would improve accuracy and lower uncertainties.

Objectives

To estimate enteric CH_4 emission factors (**EF**), intensities (**EI**) for meat and milk production by Intergovernmental Panel on Climate Change (**IPCCT2**) and Goopy et al. (2018) (**GT2**) Tier 2 (**T2**) methods, and uncertainties of EF in cattle systems of Western Kenya

Materials and methods

60 farms visited: quarterly, 20 villages, 3 geographic zones, August 2014 to May 2015

Feeds (n=14) fed, frequency, land area, use, yields

Cattle (n=388): age, condition, weight, milk, hours worked, sales, physiology

Feed nutrient digestibility (proximate nutrients, *in vitro* gas production)

Diet ingredient composition based on biomass availability

Energy requirements and energy intake based on T2 - IPCCT2 and GT2

EF (IPCC2 - Dong et al. 2006; GT2 - Goopy et al. 2018); Uncertainty of EF (Kelliher et al. 2007); EI = (Σ Emissions)/annual production

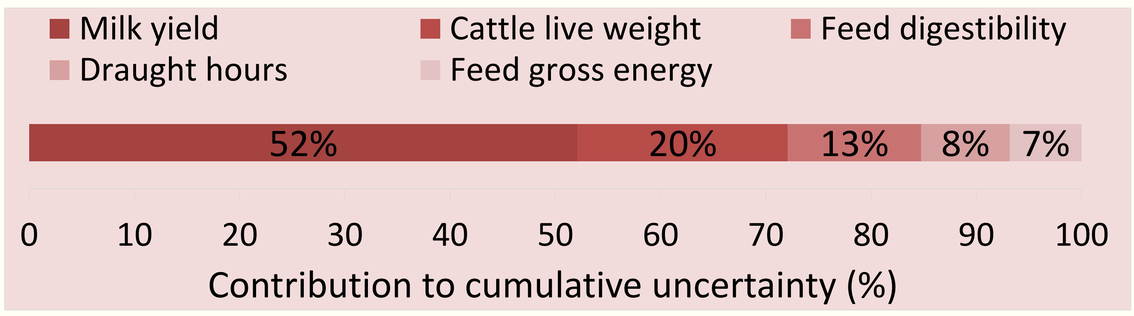
Results

Table 1. Dry matter intake, performance, and emission factors (range) of cattle in Western Kenya, August 2014 to May 2015

intake, performance, EF	Young	Adult male	Adult female
IPCC dry matter intake, kg/day	0 - 11	4 - 13	1 - 19
GT2 dry matter intake , kg/day	0 - 7	2 - 7	1 - 11
Live weight, kg	37 - 294	161 - 296	157 - 314
Draught, hours/day	na	1.0 - 2.1	na
Milk yield, l/day	na	na	0.2 - 12.4
IPCCT2 EF	13 - 35	28 - 50	20 - 75
GT2 EF	14 - 35	34 - 37	27 - 34
Default EF	16	49	41

Young (<2 years); adult (>2 years); IPCCT2 diet digestibility was 46 - 60% organic matter; GT2 diet digestibility was 56 – 64% dry matter; EF = emission factors, kg CH_4/head/year; na = not applicable

Figure 1. Contribution of cattle performance and feed quality to overall uncertainty of emission factors of cattle in Western Kenya, August 2014 to May 2015



- Overall uncertainty (95% confidence) was ±43% of mean EF.
- Milk and meat EI (kg CO_2 eq. per kg product) were: 4 - 31 and 56 - 100 (IPCCT2); 1 - 9 and 15 - 29 (GT2), compared to default 6 - 31 and 76 - 96 respectively.

Discussion

- Higher cattle performance than IPCC assumptions may explain IPCCT2 EF being higher than default.
- GT2 EF was lower than default possibly due to lower feed intake of higher digestibility than *ad libitum intake* in IPCC.
- High EI is typical of systems with scarce, low-quality feeds, and low cattle productive potential (Herrero et al. 2013).

Conclusions

- Accurate measurements of feed intake, diet quality, and performance data would improve accuracy of emission estimates while reducing uncertainties of EF.
- Nevertheless, actual EI may be lower than all these three scenarios considering the cattle serve multiple functions.

Dong et al., 2006: IPCC Volume 4 Chapter 10; Goopy et al., 2018, doi: 10.1016/j.agsy.2017.12.004; Herrero et al., 2013. doi:10.1073/pnas.1308149110; Kelliher et al., 2007. doi:10.1016/j.agrformet.2006.11.010

Correspondence to:
aninutrop@uni-hohenheim.de;
a.onyango@cgiar.org

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