Improved Greenhouse Gas Emissions and Nutrient Losses Estimates from Manure of Kenyan Smallholder Dairy Farmers

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Introduction

1. African agriculture produces 15% of the global agricultural greenhouse gas (GHG) emissions, with 25% of these emissions associated to manure and manure management.
2. There are few available studies that aimed at characterizing manure management within smallholder dairy farming systems in Sub-Saharan Africa (SSA) as well as the factors leading to the chosen manure management system.
3. Why is it important to characterize manure management systems? Is it a first step towards developing mitigation strategies?
4. Increases in atmospheric greenhouse gas (GHG) concentrations, especially methane (CH_4), carbon dioxide (CO_2) and nitrous oxide (N_2O) from agricultural activities is a global concern as it leads to climate change. Human population growth and increased demand for livestock products, including milk, is expected to lead to intensification of the dairy sector in sub-Saharan Africa.

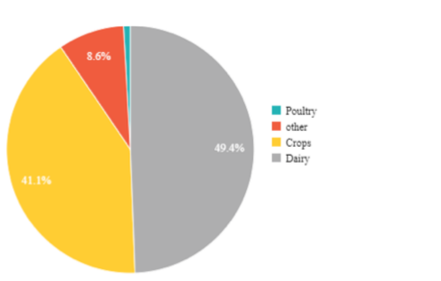
Methodology

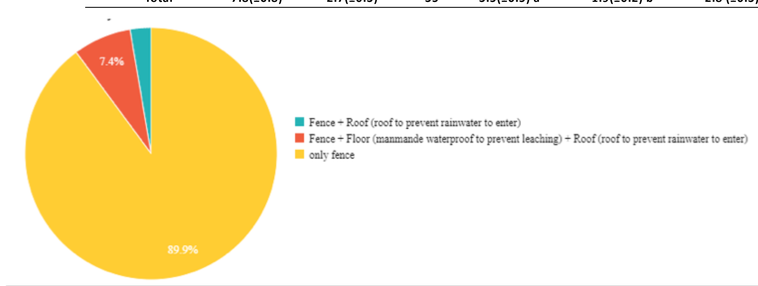
1. Activity data were collected from 336 farms to identify distinct animal confinement systems, main manure management systems and also categories of duration of storage of manure.
2. This study quantified GHG emissions and nitrogen leaching from uncovered dairy cattle manure heaps; a common manure management system in smallholder dairy farms in sub-Saharan Africa.
3. Fresh farm manure was collected from nine smallholder dairy farms in Western Kenya who used one of three animal confinement systems: 'Fence Only (F)' 'Fence and Roof (FR)' and 'Fence, Roof and Floor (FRF)'.
4. Approximately 100 kg of fresh manure from each farm was heaped and GHG emission measurements, using non-flow through, non-steady state chambers, were carried out daily from 30 January until 1 May 2017.
5. Leachate was collected daily via an inbuilt drainage tube with solid manure sampled from the heaps monthly.

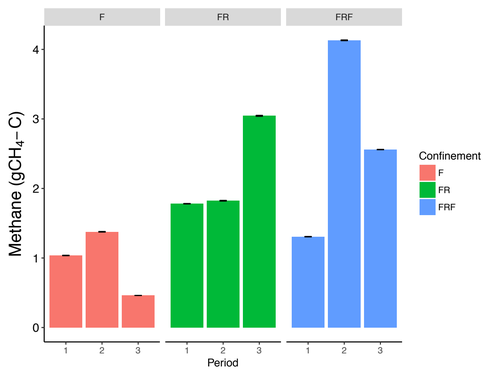
Results

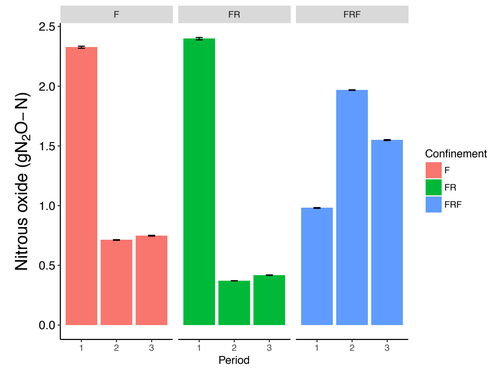
Table 1: Average farm size and mean grazing area for the three different agro-ecological zones (AEZs). Mean grazing area divided by main source of income (dairy vs. non-dairy). Mean grazing area for the three confinement systems in Nandi County. All values ± SE.

AEZ	Farm area (ha)	Grazing area		Grazing area				
				Main income source		Confinement type		
		(ha)	%	Dairy (ha)	Non-dairy (ha)	F (ha)	FR (ha)	FRF (ha)
Lower Highland 1	8.6(±1.0)	4.0(±0.6) a	47	4.2(±0.8)	3.5(±1.0)	3.7(±0.8)	3.0(±0.5)	2.9(±0.5)
Lower highland 2	5.4(±0.5)	1.7(±0.2) b	31	2.2(±0.5)	1.46(±0.2)	1.8(±0.5)	2.3(±0.4)	2.8(±0.3)
Upper midlands	12.6(±4.4)	2.3(±0.6) a,b	18	4.5(±1.9)	1.51(±0.4)	2.7(±2.1)	3.0(±0.0)	1.7(±0.7)
Total	7.8(±0.8)	2.7(±0.3)	35	3.5(±0.5) a	1.9(±0.2) b	2.8 (±0.3)	1.1± (0.3)	1.8(±0.4)









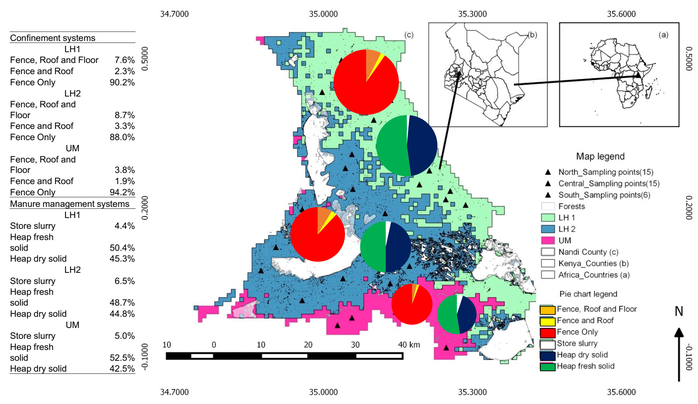


Figure 1: (a) The study location in showing Kenya in Africa, and (b) the location of Nandi County in Kenya. (c) Detailed map of Nandi County showing the three different Agro Ecological Zones (AEZs, indicated as Lower Highland 1 (LH 1, green), Lower Highland 2(LH 2, blue) and Upper Midlands (UM, pink). Forested areas (white) were marked out and sampling points from this study are highlighted with triangles. The pie charts show the proportion of animal confinement systems of smallholder dairy farmers in each of the AEZs (fence - F; fence and roof - FR; and fence, roof and floor- FRF) and major manure management practices (slurry storage; heap - fresh solid; heap - dry solid). The table shows the actual percentages of both confinement and manure management systems in the pie charts.

Conclusion

1. Smallholder dairy farmers have reduced land sizes available for grazing, and also most manage their manure unlike what is assumed. The Type of animal confinement is related to the manure management practices.
2. CH_4 and N_2O was most emitted from FRF systems after 90 days
3. Train farmers to collect as frequent as possible, as fresh as possible and put in the soil as fast as possible.
4. Ensure farmers always cover manure heaps,/pits
5. Ensure farmers use manure in Fodder as well as in Cash crops.

Jesse Owino [1,2,*], David E. Pelster[2], Klaus Butterbach-Bahl[2,5], Asaah Ndambi[3], Shem Wandiga[1], Daniel Olago[1], Mariana Rufino[4], Lutz Merbold[2]
[1]-Institute for Climate Change Adaptation (ICCA), University of Nairobi, College of Biological and Physical Sciences P.O. Box 30197-00100 Nairobi, Kenya
[2]-Mazingira Centre, International Livestock Research Institute (ILRI), P.O. Box 30709, 00100 Nairobi, Kenya
[3]-Wageningen Livestock Research, Wageningen University & Research P.O. Box 338, 6700 AB Wageningen, Netherlands
[4]-Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, United Kingdom
[5]-Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU) Karlsruhe Institute of Technology (KIT), Garmisch Partenkirchen, Germany.
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