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Soil greenhouse gas (GHG) emissions from smallholder crop-livestock systems in Central Kenya

Daniel Ortiz Gonzalo (1), Philippe Vaast (2), Andreas de Neergaard (1), Myles Oelofse (1), Alain Albrecht (3), and Todd S. Rosenstock (4)

(1) PLEN (Department of Plant and Environmental Sciences), Faculty of Science, University of Copenhagen, Denmark (gonzalo@plen.ku.dk), (2) CIRAD (Centre de coopération International en Recherche Agronomique pour le Développement), UMR Eco&Sols, Montpellier, France , (3) IRD (Institut de Recherche pour le Développement), UMR Eco&Sols, Montpellier, France, (4) ICRAF (World Agroforestry Centre), Nairoby, Kenya

Few studies measured empirically greenhouse gas (GHG) emissions in sub-Saharan Africa. More specifically, there is no experimental data on GHG emissions from coffee systems in East Africa and estimations with GHG calculators have shown some limitations. The objectives of our study are to: 1) Quantify soil GHG fluxes in smallholder coffee-dairy farms in Central Kenya and; 2) Compare results with the GHG emissions estimated with GHG calculators. The study area is situated in Murang'a County at 1700 m.a.s.l. on the Eastern slopes of the Aberdares Range, where coffee (Coffee arabica) is cultivated within integrated crop-livestock-agroforestry systems. We carried out GHG measurements along two cropping seasons using non-flow through non-steady static chambers. Sixty rectangular frames (0.355m x 0.255m) were installed at two representative farms, including the three main cropping systems found in the area: 1) Coffee (Coffee arabica); 2) Napier grass (Pennisetum purpureum); 3) Maize intercropped with beans (Zea mays and Phaseolus vulgaris). We used the gas pooling technique to overcome spatial variability and obtain a composite sample from the two treatment chambers: fertilized and non-fertilized. The sampling was performed twice per week during the rainy season and once per week during the dry season. Fertilizer and manure applications were followed by daily measurements during seven days after application. Annual fluxes (cumulative) in coffee plots ranged from 0.8 to 2.1 kg N2O-N ha-1, 6.3 to 8.2 Mg CO_2-C ha-1 and -1.3 to -0.8 kg CH4-C ha-1, with higher fluxes during the rainy seasons. Emissions of N2O and CO_2 from coffee plots were 20 to 80% higher than those in maize and napier grass. We found significant higher emissions in fertilized hot-spots (45 -190 % higher around coffee bushes perimeter, within maize rows and in napier holes) than in non-fertilized locations (between trees, between rows and between holes). Though this aspect is crucial for upscaling the emissions to farm scale, it is not always accounted in empirical models. GHG calculators overestimated both background and induced soil N2O emissions from fertilizer and manure applications in the three cropping systems. Our study contributes to the generation of underlying data and emission factors (EFs) for quantifying GHG emissions in tropical farming systems.