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Challenges in measuring greenhouse gas emissions from a horse paddock

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The number of horses is increasing in Europe and in Finland also, which is increasing the amount of manure they produce. Horse dung is collected from the barns to be used e.g. as fertilizer or as bioenergy but part of the dung is left in the paddocks and pastures. Because dung contains lot of nitrogen and organic matter, horse paddocks and pastures can be significant sources of greenhouse gases (GHG), such as nitrous oxide (N2O), carbon dioxide (CO_2) or methane (CH4). There are lot of publications about GHG emissions from e.g. cattle and sheep pastures, however, none of them are reporting emissions from horse paddocks or pastures. The emission rates and dynamics of horse dung can be different from dairy cows since horses are not ruminants and the manure properties are not similar. Also, the input of fresh horse dung and urine into the paddocks is constant throughout the year in contrast to e.g. dairy cows which are in the northern parts of Europe spending time outside only during the short grazing season. We measured N2O and CH4 emissions from one selected horse paddock nine times in period from June to October in 2018 to estimate the emission rates and dynamics. The study site was located in Kuopio, Eastern Finland. In the studied paddock (2500 m2, soil type silt/clay) a total of four horses is spending about 10 hours daily, throughout the year. There were five sampling points; three inside the paddock and two outside of the paddock. Gas flux measurements were made with manual chambers (three replicates on each plot). Round metal chambers (ø 30 cm) were twisted in the soil and gas samples were collected, injected into a pre-evacuated vials and analyzed with gas chromatograph. Soil samples were also collected for analysis soil properties. The growing season in 2018 was very dry and warm. Maximum soil (depth 5 cm) temperature was measured in July (25 oC) and the lowest in October (0.5 oC). Soil moisture content was very low (less than 10%) during the summer but started to increase in September. All plots were small net CH4 sinks during the study period. N2O emissions did not correlate with temperature and there was a high spatial and temporal variation. The highest emissions (up to 1300 μg N2O-N h-1 m-2) were detected inside the paddock in early June. As a conclusion, we can say that horse paddocks can be significant but local sources for N2O, and small sinks for CH4. However, calculation of seasonal/annual emission rates is very challenging due to highly heterogeneous and dynamic site, which is changing all the time. Dung and urine patches and compaction of the soil are highly affecting the gas fluxes. The very high temporal and spatial variation cannot be captured with manual samplings and therefore continuous eddy correlation method would be optimal. Also, the effect of soil type, dung management, horse density, and weather conditions should be studied further.