Research Project: Forage Characteristics that Alter Feed Utilization, Manure Characteristics and Environmental Impacts of Dairy Production
Title: Greenhouse gas fluxes from experimental dairy barnyards

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Submitted to: International Conference on Greenhouse Gasses and Animal Agriculture
Publication Type: Proceedings
Publication Acceptance Date: March 4, 2013
Publication Date: June 23, 2013
Citation: Powell, J.M., Duval, B.D., Vadas, P.A. 2013. Greenhouse gas fluxes from experimental dairy barnyards. International Conference on Greenhouse Gasses and Animal Agriculture. 7(2):264.

Technical Abstract: Dairy production systems are well-established sources of greenhouse gas (GHG) emissions. Dairy cows emit methane (CH_4) directly, and contribute to carbon dioxide (CO_2), nitrous oxide (N_2O), and ammonia (NH_3) emissions via manure. The substrate on which manure is deposited is likely a control on GHG flux to the atmosphere, because substrate quality (e.g., carbon (C) and nitrogen (N) content, porosity, water holding capacity) controls microbial activity and microbial communities responsible for GHG production from manure decomposition. To examine potential GHG mitigation strategies in components of dairy production systems, we constructed experimental barnyards with different surface substrates and measured GHG fluxes from those barnyards over a two-year period. We constructed replicated (n = 3) barnyard plots (6.1 m x 6.1 m corrals) with surface (0 to 50 cm) substrates comprised of silt loam soil, sand and shredded bark at the research farm of the US Dairy Forage Research Center in Prairie du Sac, Wisconsin, USA. Holstein heifers were put on the plots, three to four per plot, for approximately 28 days per year (approximately seven days each during spring, summer, fall and winter). Measurements of CO_2, CH_4, N_2O and NH_3 were made using a portable FTIR multi-component gas analyzer (Gasmet, Model DX-4030). Gas measurements were made the day before putting the heifers on the plots and during the days just after the heifers were moved off the plots. Before starting the gas measurements, all plots were mechanically pumped to remove drained leachate (the barnyards were lined with rubber membrane to capture all leachate). There were no GHG emission differences among the different surface substrates just prior to introducing cows. However, after cows were in the barnyards for seven consecutive days, we observed significant increases in CO_2 and a trend for increased N_2O efflux from the soil plots. The presence of heifers increased CO_2 emissions from sand. We measured significantly higher emissions of CO_2 and CH_4, and trends for higher emissions of N_2O and NH_3 from the barnyards that had shredded bark as a surface substrate. These results highlight that differences in barnyard surface substrate are a significant control on GHG emissions. Coupling these emissions data with estimates of run-off losses of C and N, leached nitrate, and microbial community activity will be useful in understanding GHG flux from barnyards and in developing mitigation practices. Furthermore, these data can serve as baseline values for whole-farm GHG estimates, and will be relevant to simulation modeling and life-cycle analysis of cost-effective GHG mitigation strategies for dairy production systems.