RESEARCH ABSTRACT

ENVIRONMENT

Title: Meta-Analysis of Greenhouse Gas Emissions from Swine Operations – **NPB #10-104**

Investigator: Zifei Liu

Co-investigators: Wendy Powers, Huawei Liu

Institution: Michigan State University

Date Submitted: May 31st, 2011

Scientific Abstract:

The objective of the project was to provide a systematic review of the literature on GHG emissions from swine operations, which includes both a qualitative review and statistical analysis (meta-analysis) that integrates results of various independent studies. Based on results of the literature review and meta-analysis, variation of the measured CH_4 and N_2O emission rates has not been adequately captured by the Intergovernmental Panel on Climate Change (IPCC) approaches. For CH_4 emissions, the differences between the IPCC estimated emission rates and measured values were significantly influenced by type of emission source, geographic region and measurement methods. Larger differences between estimated and measured CH_4 emission rates were observed in North American studies than in European studies. In North American studies, the results of meta-analysis indicated an overestimation by the IPCC approaches for CH_4 emissions from lagoons (pooled relative difference: -33.9%; 95% CI: -66.8% to -0.01%), and the discrepancy between the IPCC estimated emissions and the measured values mainly occurred at lower temperatures. In European studies, the results indicated an overestimation of the IPCC approaches in swine buildings with pit systems. For N_2O emissions from swine operations, an overall underestimation of the IPCC approaches was observed in European studies but not in North American studies. In European studies, the pooled N_2O emission factors for swine buildings with pit systems was 1.6% (95% CI, 0.6% to 2.7%), while the IPCC default emission factor for pit systems is 0.2%. Lager uncertainties were observed for measured N_2O emissions from bedding systems and from straw flow systems. For N_2O emissions from swine manure applications, the IPCC default emission factor (1%) is within the 95%CI in both North American studies (0.7% to 2.2%) and European studies (-0.3% to 3.5%). The measured GHG emissions from swine operations were significantly different for different emission sources (swine buildings or manure storage facilities), different swine categories (stage of production), and different geographic regions. Swine buildings generated much higher CO_2 emissions than manure storage facilities while CH_4 and N_2O emissions were not significantly different. Farrowing swine emitted more CH_4 and CO_2 emissions as compared with other swine categories, while gestating swine had greater N_2O emissions. North American studies reported significantly higher CH_4 emissions from swine operations than European and Asian studies. In swine buildings, Straw flow systems generated the lowest CH_4 and N_2O emissions of systems compared, while pit systems generated the highest CH_4 emissions and bedding system generated the highest N_2O emissions (no statistical differences). Lagoons generated significantly higher N_2O emissions than slurry storage basin/tanks, while CH_4 and CO_2 emissions are not different. Swine buildings with straw-based bedding resulted in numerically higher CH_4 but lower N_2O emissions as comparing to saw dust based bedding (no statistical differences). An increasing trend was observed for CH_4 emissions as manure removal frequency decreased. Relatively high GHG emissions were observed from deep pits or from pits flushed using lagoon effluent. The CH_4 emissions from slurry storage facilities without covers were significantly higher than from

that with covers. Results also showed that the effects of temperature on CH_4 emissions were significant for lagoons or slurry storage facilities (regression slopes were 1.22 and 1.72 kg yr^{-1} hd^{-1} per ^oC respectively). Diet CP was found not a significant factor on GHG emissions from swine operations. The CO_2 emissions from swine operations were positively correlated with CH_4 emissions, especially for emissions from lagoons and slurry storage facilities (R^2= 0.98). Factors that can affect the GHG emissions from manure land applications include: temperature, precipitation, soil properties, manure application methods, manure application time, and composition of manure, etc. Results of meta-analysis showed that the measured cumulative CH_4 emissions increased with increasing average temperature but had a deceasing trend with increasing annual precipitation.