

Ammonia Modeling of U.S. Dairy Farming

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Abstract: Dairy production systems are hot spots for ammonia (NH₃) emissions, which can lead to different environmental issues. There is a high demand for the quantification and mitigation of NH₃ emissions from dairy farming systems. However, because of the large variability of NH₃ emissions, the quantification and mitigation are difficult to perform. In this study, a process-based biogeochemical model, Manure-DNDC, was tested against measurements of NH₃ emissions from five dairy barns and two lagoons in the United States to verify its applicability for quantifying NH₃ emissions from dairy production systems over a range of environmental conditions and management practices. The model was then applied to assess impacts of alternative management practices on NH₃ emissions from whole dairy farm. The results from the model validation indicate that the predictions of annual total NH₃ emissions by Manure-DNDC were consistent with the corresponding measurements. In addition, the model can generally capture the seasonal dynamics of NH₃ emissions. The modeled impacts of alternative farming management practices can be summarized as follows: (a) all the selected alternative management strategies can mitigate the NH₃ emissions from the tested dairy farm, although their efficiencies were different, (b) intervening management practices in one component may simultaneously regulate NH₃ emissions from several components; (c) up to 50% reduction of NH₃ emissions could be achieved by combining the improvements in feeding, method of manure removal, manure storage, and manure application. The results from this modeling study may provide useful information for mitigating NH₃ emissions from dairy production systems and emphasize the necessity of whole-farm perspectives on the assessment of potential technical options. This study also demonstrates the potential of utilizing process-based models, such as Manure-DNDC, to quantify and mitigate NH₃ emissions from dairy farms.

Keywords: Manure-DNDC, NH₃ emissions, dairy, management practices.