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Emerging Contaminants in Dairy Farming: Source Characterization and Shallow Groundwater Impacts

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Abstract Text:

Intense animal husbandry is of growing concern as a potential contamination source of a variety of emerging contaminants including pathogens, naturally occurring and synthetic steroid hormones, and various pharmaceuticals, particularly antibiotics. For example, more than twenty million pounds of antibiotics are sold for use in animal husbandry with 95% going towards therapeutic use. Intense animal husbandry is of growing concern as a potential contamination source of enteric pathogens as well as antibiotics. To assess the public health risk from emerging contaminants and to understand their hydrologic pathways, we hypothesize that the animal farm is not a homogeneous diffuse source, but that pathogen loading to the soil and, therefore, to groundwater varies significantly between the various management units of a farm. A dairy farm, for example, may include an area with calf hutches, corrals for heifers of various ages, freestalls and exercise yards for milking cows, separate freestalls for dry cows, a hospital barn, a yard for collection of solid manure, a liquid manure storage lagoon, and fields receiving various amounts of liquid and solid manure. Pathogen shedding and, hence, therapeutic and preventive pharmaceutical treatments vary between these management units. Here, we focus on the application and potential environmental occurrence of pharmaceuticals, disinfectants, and pathogens on dairies. Recommended drug applications are available from national databases. Statistical data on actual usage, however, are not available. We complement national data with interviews and dairy visits for further evaluation of drug and chemical usage (not including pesticides used on crops and fertilizer) and an overall assessment of the potential antibiotics output in dairy waste. We find that aminoglycosides, tetracyclines, and coccidiostats make up much of the total mass of antibiotics used. On dairies using the ionophoric antibiotic monensin as feed additive, monensin makes up a large fraction of the total antibiotics use (by mass). Other chemicals of potential concern include disinfectants used to prevent mastitis, detergents used in the milking parlor, footbath reagents to prevent and treat lameness, and insecticides used to control flies and mites. We are implementing a field reconnaissance program to determine the occurrence of three different pathogens (E. coli, Salmonella, Campylobacter) and one indicator organism (Enterococcus) at the ground-surface and in shallow groundwater of seven different management units on each of two farms, and in each of four seasons (spring/dry season, summer/irrigation season, fall/dry season, winter/rainy season). Initial results indicate that significant differences exist in the occurrence of emerging contaminants between management units and between contaminants. These differences are weakly reflected in their occurrence in groundwater, despite the similarity of the shallow geologic environment across these sites. Our results indicate the importance of differentiating sources within a dairy farm and the importance of understanding subsurface transport processes for the various emerging contaminants.

Impact Statement:

This project is a first step in understanding the occurrence of emerging contaminants in modern dairy farming. Our results indicate the importance of distinguishing various sources within a dairy and provide an initial overview of the potential impacts on shallow groundwater quality.