Prioritizing, quantifying and managing water quality impacts of veterinary antibiotic use in agricultural watersheds

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Problem Statement

Watersheds provide an important physical link between agricultural and urban settings, and can impact human health in many ways. Surface water has been identified as an important vehicle by which agricultural contaminants, such as antibiotic resistant bacteria and their genes, can reach human populations via direct recreational contact, drinking, or use as irrigation for food. Use of veterinary pharmaceuticals in food production systems is critical for insuring animal health and provides substantial economic benefits to consumers and producers. However, there are serious concerns regarding the risks associated with the biological effects of veterinary pharmaceuticals in the environment and potential for release resistant bacteria and genes beyond animal production facilities. Of particular concern are issues associated with the potential for low levels of antibiotics and bioactive antibiotic breakdown products in surface waters to select for resistance, promote horizontal gene transfer among environmental bacteria, and impact ecosystem functions such as nutrient cycling and water quality. These issues highlight a critical lack of understanding of the fundamental ecology of antibiotic resistance in mixed-use watersheds, the first theme addressed by this proposal.

In addition to the absence of data on the biological effects of food animal antibiotic use on watershed biology, information on the relationship between the antibiotic drugs, the resistant bacteria and the resistance genes is also unavailable. This knowledge gap challenges efforts to reach a consensus on how to quantify benefits or risks associated with the use of veterinary pharmaceuticals, including issues such as distinguishing anthropogenic effects from naturally occurring baseline levels of resistance. Because application of livestock manure and wastewater in agricultural watersheds is the primary route for the delivery of pharmaceuticals, resistant bacteria, and resistance genes into surface waters, a second theme of the proposed project will be to quantitatively evaluate existing and novel manure management strategies (storage, handling, and application) for their ability to reduce the transport of antibiotic drugs, resistant bacteria and resistance genes from terrestrial animal production sites. . The final element of the proposed project focused on the human-dimensions of farm management. (some of this text will depend on outreach goals). One novel element of this proposal is that we plan to involve farmers and producers in the hypothesis generating and testing phases of the project, so that their knowledge and expertise can be closely integrated with the scientific data, resulting in the development of solutions that are not only scientifically sound, but that have a real possibility for implementation in existing systems.

Research Objectives

1) Determine selected biological impacts of veterinary pharmaceuticals on bacterial communities and resistance genes in agriculturally relevant manure, wastewater, and surface water sample matrices on a laboratory, field, and watershed scale. 1.5) Develop and validate methods to track pharmaceuticals, resistant bacteria, and resistant genes in ag-impacted samples (manure,

soil, water), along with a set of quality control criteria for tracking antibiotic resistance in environmental samples.

2) Evaluate which management strategies can have the greatest influence in minimizing potential impacts by evaluating previous studies and conducting additional field and laboratory studies to provide the required information.

3) Integrate information on applied biological impacts of veterinary pharmaceuticals with field and watershed-level results to identify specific watershed control points that are most relevant for the transfer of resistance from agroecosystems to urban and suburban populations.

Research, Extension and Education Outcomes and Outputs

1) Scientists, agricultural producers, and consumers will have improved knowledge of linkages between agricultural contaminants and human health.

2) Scientists and agricultural producers will have improved knowledge of singular and combined manure management practices to positively impact human health.

3) Agricultural producers will implement livestock and manure management strategies that minimize adverse human health effects.

An open access manual of validated methods for tracking pharmaceuticals, resistant bacteria, and resistance genes in ag-impacted samples will be created and disseminated in print and online.

A communication network to connect scientists and non-scientist stakeholders will be developed to 1) provide a framework for active engagement of farmers and producers in deciding which applied control strategies to evaluate, and 2) establish long-term working relationships to facilitate successful applied implementation and troubleshooting of the selected management strategies.

A public service announcement campaign will be created and distributed through print, television, radio, and social media to educate stakeholders about management strategies that can minimize adverse impacts on humans from livestock and crop production.