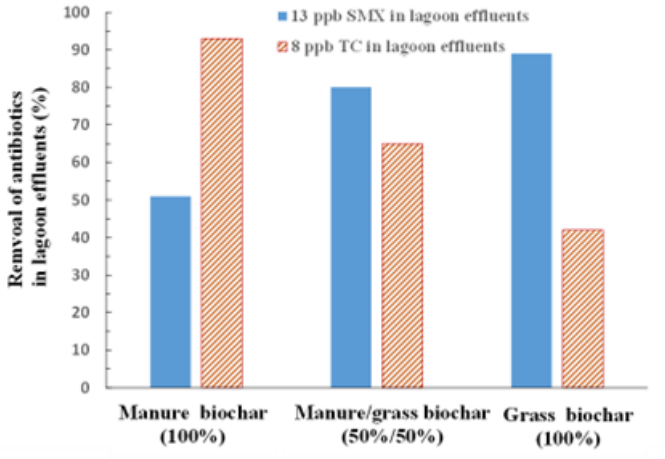
Assessment of Soil & Water Quality Impacts of Manure Application Practices

Efficacy of Management Practices in Various Soils/Crops/Climate Regimes

Background

Land application of dairy manure is a common agricultural practice. Manure serves as an excellent source of plant nutrients like phosphorus (P) and nitrogen (N); however, manure can also contain bacterial pathogens and antibiotic residues, and the nutrients in manure can exceed plant requirements. Where manure is applied too heavily, antibiotics, pathogens and excess nutrients may be released into the environment, contaminating soil, waterways and groundwater and causing weed and algal growth and an increase of antibiotic-resistant bacteria.

Crop species, crop productivity, and soil type all influence the rate at which a crop will uptake and neutralize different nutrients, antibiotics and pathogens (a process known as "phytoremediation"). Certain agricultural practices like cropping systems and conservation tillage can boost rates of phytoremediation and mitigate the adverse health and environmental effects of manure application. Similarly, soil amendments like biochar—a charcoal-like material made by thermally processing organic waste at high temperatures with little oxygen—can help absorb excess nutrients and antibiotics from manure and control microbial pathogens, including antibiotic- resistant bacteria. The remedial effects of biochar vary depending on the contaminant, as well as the biochar's composition and the heating time, temperature, and thermal reactor type used in its processing.



Results of preliminary studies by Texas A&M AgriLife scientists on the adsorption of antibiotics in dairy lagoon biochars (20 g/L biochar).

Gaps in Knowledge

While the effects of manure contaminants and mitigating agricultural practices have been studied in controlled environments, they have not been evaluated and quantified at field-scale. Moreover, intelligent decision-support platforms and tools specifically designed for analyses of agricultural, environmental, economic, and human health impacts of manure application are needed to assist policy makers in establishing guidelines for the safe use of manure as fertilizer in cropland and pastures.

The Agricultural Policy Environmental eXtender (APEX) is a simulation model developed to predict management and land use impacts on soil and water quality for whole farms and agricultural watersheds. While the model is validated on various environmental processes as the main model for the NRCS Conservation Effects Assessment Project – Croplands, its accuracy with respect to nutrient leaching and yields on manure fertilized fields (with and without conservation practices) is uncertain. Similarly, APEX has never been validated on the dynamics of pathogens or antibiotics under such conditions.

Objectives

This project integrates long-term field-scale experiments, laboratory analyses, and field-scale modeling using the APEX model to improve our understanding of fundamental processes of soil management and plant phytoremediation on dairy waste P, N, pathogenic bacteria and antibiotics, and to promote the adoption of consistent priority management practices across US croplands and pastures. Specifically, it will:

Sample maps of field experiments in Temple and Stephenville experiment stations.

Soil composite sample sub-sampled for shipping to individual labs for analysis.

1. Characterize the fate, transport and transformation processes of the above-listed dairy waste contaminants in runoff water and soil.
2. Evaluate and demonstrate through field experiments the effectiveness of agricultural management practices (biochar amendment, conservation tillage, and crop species selection) on controlling these contaminants.
3. Develop characteristic parameters and mathematical models using data from field experiments for quantitative assessment in APEX.
4. Scale up with these characteristic parameters and coefficients using a machine learning technique to US croplands and pastures.
5. Develop an Optimization Framework for decision aid on land management units of manure applied fields that considers soil, water, and socio-economic value.

Impact

The primary outcome will be the ability to quantitatively assess soil and water quality impacts of manure application practices and efficacy of management practices in various soils, crops, and climate regimes. These will ultimately provide guidelines for safe and sustainable manure application which will be highly beneficial to NRCS's conservation program.

Texas A&M AgriLife

Jaehak Jeong
Texas A&M AgriLife Research
Blackland Research & Extension Center
jjeong@brc.tamu.edu
254.774.6118

NRCS
United States Department of Agriculture
Natural Resources Conservation Service