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Antibiotic resistance in agroecosystems

Agricultural antibiotic use is considered to foster the development and spread of resistant pathogens threatening human health and thus it is suggested that the use of antibiotics in production animals should be limited. Unlike in many big countries in the world, Finnish animal production uses antibiotics predominantly for treating bacterial infections. Nonetheless, the circulation of antibiotic resistance genes through intersecting ecosystems, such as production animal farms, might have a considerable role in transferring resistance genes from environmental bacteria to human or animal associated bacteria. Agroecosystems are unique settings where bacteria originating from animals and the environment are constantly mixed due to land application of manure and ingestion of harvested forage by production animals.

In this work it was clarified if genes related to antibiotic resistance and transfer disseminate from farms to the environment due to manure fertilization, if the abundance of these genes is affected by winter storage of manure and if resistance gene abundances are elevated in soils at crop harvesting time, and thus potentially cycled into the animal gut via forage. A field-compatible protocol for detecting antibiotic concentrations sensed by bacteria in different samples was also established.

Manure had the highest abundance of genes related to antibiotic resistance and transfer, and the abundance increased during storage. The genes abundant in manure disseminated to soil when manure was applied; however, at the harvesting time the soil resistome resembled the resistome of unfertilized soil. Antibiotic resistance genes were also detected in ditch water but most of them were undetected in manure, suggesting that genes in manure were not spreading to receiving waters. The results propose that manure fertilization does not inevitably generate a risk of disseminating antibiotic resistance and that agricultural practices largely determine whether or not the use of antibiotics in production animals contaminates the agricultural environment with resistance determinants. The presented field-use suitable assay can be used for samples with minor matrix-effects, e.g. surface waters. With further method development, the protocol could help in progressing from detection of antibiotics to the evaluation of their ecological effects in the studied environment.