

Sources of Pollution / Fate and Transport (Focus on Pharmaceuticals)

Group 1 Subtopic: Animal Production Agriculture and Veterinary Pharmaceuticals

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Environmental and policy issues targeting by-products of animal production agriculture has focused on animal waste treatment and management strategies relative to the discharge and emissions of manure constituents to environmental media. Nutrients (N and P), metals (Cu and Zn), pathogenic bacteria, volatile organic compounds, ammonia, hydrogen sulfide, particulates, and odor have to date been the primary environmental parameters of concern. A review of the scientific literature shows that while there remains debate and some uncertainty regarding the fate and transport of these pollutants under varying management and technology mitigation methods, the state of knowledge has been significantly advanced over the past few decades in this subject area. A relatively new and emerging environmental issue impacting animal production agriculture in the United States and elsewhere is the use of and environmental occurrence of veterinary pharmaceuticals. Comparatively, there is very limited scientific data regarding the fate, transport and environmental impact of these compounds.

In the United States veterinary pharmaceuticals are used in the production of many food animal commodities for treatment of disease (therapeutic doses) and also for disease prevention and to enhance feed efficiency and growth promotion (sub-therapeutic doses). The quantity of veterinary pharmaceuticals used as antimicrobial agents, reproductive aids, growth promoters, anthelmintics and antiparasitocides in the United States is arguable – published estimates vary significantly and range from approximately one-third to over one-half of the total annual market production of antibiotics (including ionophores and arsenicals). These estimated quantities may be better understood when considered relative to the magnitude of the food animal production agriculture industry in the United States; an annual inventory of over 100 million cattle, nearly 100 million swine, approximately 8 billion chickens and 300 million turkeys with an economic impact estimated to exceed \$900 billion annually on a national basis. In North Carolina, a leading meat production state, livestock and poultry production accounts for over half of the state's agricultural income. Thus, when considering not only the therapeutic use of veterinary pharmaceuticals for animal disease treatment but also the sub-therapeutic use for well documented economic benefits relative to disease prophylaxis, growth promotion and increased feed efficiency, it is not surprising that appreciable quantities of these compounds are utilized by this industry.

Veterinary pharmaceuticals are regulated and approved by the US Food and Drug Administration, Center for Veterinary Medicine. Nonetheless, there is considerable pressure from some stakeholder groups and organizations to reduce or cease the use of veterinary pharmaceuticals, especially for purposes of increased growth promotion and feed efficiency. Societal and / or regulatory trends in certain areas of the world have resulted in banning the use of targeted pharmaceuticals in animal feed. Recently, some U.S. companies have voluntarily greatly reduced or taken most of the antibiotics out of feed fed to healthy animals.

While there is limited data available in the subject area of veterinary pharmaceuticals impact on the environment, important information has been published¹. One fact is well documented – the

¹ See *Pharmaceuticals in the Environment: Sources, Fate, Effects, and Risks*. 2004 (Second Edition, Klalus Kummerer, Editor, Published by Springer Berlin Heidelberg New York, ISBN 3-540-21342-2); specifically Chapter 12 "Use of Veterinary Pharmaceuticals in the United States" by R.A. Bloom; Chapter 13 "Use and

amount of excreta generated by the food animal inventory referenced above exceeds 1 billion tons annually and the majority of this waste is treated by agricultural management practices involving land application proximate to the source of the animal production facilities. There is also little doubt that a portion of the veterinary pharmaceuticals (and their metabolites) administered to these animals will be contained in their excreta and thus land applied with the manure. Key questions involve the concentrations, subsequent abiotic and biotic degradation, and transport of these compounds once they are land applied. Most published work involves antibiotics and has largely been conducted over the past decade. Macrolide, sulfonamide, and tetracycline classes of antibiotics have been detected in swine manure storage and treatment facilities (lagoons) at low ppb to low ppm concentrations. Chlorotetracycline, sulfamethazine, tylosin, and roxarsone have been measured in poultry litter, again in low ppb to low ppm concentrations. Degradation studies have shown that the half life of tylosin and oxytetracycline is 8 and 30 days, respectively in the excreta; oxytetracycline was still detected 5 months after land application, but at much lower concentrations. Limited studies involving agricultural watersheds have been conducted; these studies show that concentrations of selected veterinary pharmaceuticals range from parts per trillion (ppt) to low ppb in surface and groundwater near animal feeding operations. However, the occurrence, transport, and degradation of these compounds are not well understood.

A separate, but related, topic includes the fate and environmental effects, especially as endocrine disruptors, of hormones resulting from concentrated animal feeding operations. Exogenous hormones are not approved for use in the poultry industry, and in the swine industry exogenous hormones are approved only for applications to induce estrus. However, the potential risks to aquatic environments resulting from naturally occurring estrogens excreted in animal waste are a concern and also poorly understood.

Collectively, this information illustrates the need to systematically, and objectively address questions regarding human health risks resulting from exposure to veterinary pharmaceuticals, naturally occurring estrogens, and the impact of antibiotic resistant bacteria (that may result from the use of antimicrobial pharmaceuticals). Equally important is the need to determine the impact of current animal waste management practices and new mitigation technology applications on veterinary pharmaceuticals and estrogens and their metabolites once these compounds are excreted and contained in animal manure. As noted previously, there is improved knowledge on the fate of certain animal manure constituents when managed and / or processed by a menu of biological and chemical-physical treatment applications including, anaerobic digestion, gasification, combustion, nitrification – denitrification, solids separation (mechanical and chemical), composting, and other technologies. There is limited or no information on the occurrence and fate of veterinary compounds, hormones and antibiotic resistant bacteria under these same treatment conditions. Such information would be beneficial to all impacted stakeholders relative to policy considerations regarding the use of veterinary pharmaceuticals in the United States.