Beneficial management practices for reducing waterborne zoonotic pathogens attributable to animal agriculture

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Numerous zoonotic pathogens are present in animal agricultural systems which have the potential to be transmitted to humans through the waterborne route of exposure. In most if not all cases zoonoses that can function as foodborne hazard will likewise function as a waterborne hazard. An exact list of important zoonotic species present in U.S. animal agriculture is hard to precisely agree upon due to the lack of survey data in agriculture and credible evidence of animal-to-human transmission via water for many rare or unusual microorganisms. Nevertheless, the list of opportunistic or overtly pathogenic waterborne zoonoses would likely include some set of viruses, bacteria, protozoa, and helminths, with a primary emphasis on bacterial and protozoal species that are shed in fecal material, such as *Salmonella*, *Campylobacter*, serotypes of pathogenic *Escherichia coli*, and protozoal species such as *Cryptosporidium parvum* and *Giardia lamblia* (a.k.a. *G. duodenalis*, *G. intestinalis*). A waterborne route of transmission for BSE or other such entities is somewhat speculative at this time; the limited number of documented cases in livestock in the United States likely precludes any major role for this entity as a significant waterborne hazard to humans. Basic strategies for designing beneficial management practices (BMPs) that reduce the risk of an agricultural operation discharging unacceptable levels of one or more zoonotic species typically include one ore more of the following: (1) reduce the rate of environmental loading of the zoonosis by the animal host population, (2) reduce the transport potential of the zoonosis once shed by the animal host population, (3) reduce the survivability of zoonosis once shed by the animal host population.

Methods aimed at reducing the rate of environmental loading of the zoonosis by the animal host population typically focus on either reducing the incidence and/or intensity of fecal shedding of the zoonosis, or simply rely on reducing the stocking density on the watershed of concern during either the rainfall season or on a year-round basis. Reducing the incidence and/or intensity of fecal shedding of a zoonosis within a host population can rely on such strategies as vaccination and probiotics, or strive to reduce the environmental exposure of susceptible animals to the zoonosis through such efforts as improved feed and water quality, better hygiene for confined animals, improved waste management, and minimizing stress. These herd-health efforts are often hampered by our poor understanding of the medical ecology of the zoonosis, limited information on how exactly to interrupt transmission between the biological reservoir and susceptible animals, and the lack of cost-effective vaccines that target zoonoses and have been proven to be efficacious under commercial agricultural settings.

BMPs aimed at reducing the transport potential of the zoonosis once it is shed by the animal host are being developed for both intensive and extensive livestock systems. Methods typically rely on either maximizing the physical distance between accumulations of fecal material and the water body of concern, minimizing subsurface seepage for manure storage lagoons, or encouraging pasture or rangeland runoff to infiltrate into the soil profile before it reaches adjacent waterways. Transport BMPs for extensive livestock systems have a rich history of

development in such areas as range science and grazing management. One such strategy is to place vegetated buffer strips between an animal agricultural operation and vulnerable surface water supplies. Optimal design criteria for vegetated buffer strips are just beginning to be developed for waterborne microbial contaminants. Additional strategies for extensive operations include such practices as herding of livestock away from riparian areas, strategic fencing along waterways and variable source areas, and strategic placement of attractants (e.g., salt block) that manipulate the spatial distribution of livestock in order to reduce direct fecal deposition in riparian areas and directly in waterways. As our public lands are increasingly closed to livestock grazing, ranchers and livestock operators increasingly rely on irrigated pasture to remain economically viable. Hence, there is a growing need for research on improved irrigation management for these grazed pastures or rangeland so that tailwater flows are minimized to the best extent possible, thereby reducing pasture runoff containing high levels of fecal contaminants.

BMPs that attempt to reduce the survivability of zoonoses once shed by the animal host are under rapid develop for confined animal feeding operations (e.g., dairy, poultry, swine, feedlot) and in their infancy for extensive agricultural systems that deposit their pathogen loads in a non-point source manner. The majority, if not all microbial zoonoses shed by U.S. livestock and that function as credible waterborne hazards are susceptible to a large variety of environmental and biological stressors that accelerate the rate of inactivation or removal from the animal waste stream. A primary goal, therefore, is to design and operate waste management systems so that these processes of inactivation and removal are optimized, resulting in sufficient logs of removal prior to being discharged back out into the environment. Answering the question of how much inactivation is sufficient to safeguard water quality and human health remains a point of lively debate in the scientific and regulatory community given the numerous and often substantial uncertainties regarding the annualized waterborne risk to humans presented by animal agriculture as it is practiced today in the United States. Developing a well designed and properly focused research program under the auspices of the National Research Initiative Competitive Grants Program, U.S.D.A., would go a long way in providing the necessary funding to resolve these many uncertainties and would provide a rapid stimulus for applied and basic research in this area of waterborne zoonoses attributable to animal agriculture.