The re-use of water in agricultural settings

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Agriculture offers considerable opportunities for the safe and sustainable re-use of water, be that water sourced from humans or animals. A key point is understanding the differences in pathogen profiles between wastewater from humans as compared with that derived from animals. Agricultural re-use also offers the opportunity to appropriately match the treatment level of the used water with the planned end-use. There is no doubt that the re-use of water in agriculture will be an increasing focus as Australian agriculture adapts to the challenges of food security in a changing world.

Around the world, there is a recognition that water is a limited resource [1]. This recognition of the limited nature of water resources has resulted in an increasing interest in, and indeed use of, treated wastewater for agricultural applications [2]. Regardless of whether effluent comes from a sewage treatment plant or a piggery, a key issue is managing the pathogens potentially present in the water to be re-used. This means that there is a need to understand the type and level of pathogens present in the wastewater, to understand the efficacy of the treatment system used on the wastewater and to have an understanding of the type of re-use application.

Sampling pasture plots irrigated with piggery effluent.

'Oils ain't oils'

There is a difference between the range of pathogens present in wastewater arising from an animal production system as compared with human sewage. There are over 140 types of enteric viruses that can be present in human wastewater, including astrovirus, hepatitis A virus and norovirus [3]. In contrast, there are few, if any, viruses present in animal wastewater that could be regarded as realistic health risks. In the Australian context, there is no endemic presence of avian or swine influenza, two agents that are of considerable concern in other countries. There is some evidence that suggests that, possibly, rotaviruses (in pigs and cattle) [4] and caliciviruses (in pigs and cattle) [5] may be zoonotic agents. There is considerable evidence that pigs are a source of genotypes III and IV hepatitis E virus for humans [6]. However, with these few exceptions, wastewater from animal production systems does not contain viral agents of concern for human health.

There are pathogens of concern in animal wastewater. Based on the available literature, we have concluded that in both the pig and poultry industries, the only pathogens that pose a realistic public health concern in waste from these industries are *Salmonella* and *Campylobacter* [7, 8]. We have found that *Salmonella* was present in the final treatment ponds of four of 13 piggeries in South East Queensland, although at low levels (the highest level being 51 MPN per 100ml) [9]. In these same piggeries, the level of *Campylobacter* varied from none detectable (two of 13 piggeries) to a maximum of 930 MPN per 100ml [9]. We have performed similar studies on the levels of bacterial pathogens in effluent from Queensland coastal sewage treatment plants (STPs) [10]. In this study, *Salmonella* was detected in the final effluent of six of the 33 STPs, at levels that ranged from 0.7-110 MPN per 100ml [10]. The quantitative information gathered in our studies of STP effluents and pig effluent ponds is an essential basis that is required to develop methods and approaches that allow the safe re-use of these valuable resources.

Evaluating health risks

If water re-use schemes are to be widely adopted in agriculture, there is a need for a solid scientific basis that allows an informed public decision on the risks associated with these activities. We have looked at the survival of key pathogens in soil irrigated with piggery effluent [11]. We monitored the survival of *Arcobacter* and *Campylobacter* at different irrigation sites in South East Queensland over a summer and a winter. At the four sites, *Arcobacter* survival ranged from 7-14 days in summer and 7-42 days in winter. *Campylobacter* survival ranged from 0-4 days in summer and 0-7 days in winter. The rapid-die off of *Campylobacter* suggests that this organism is low risk in pathogen transfer scenarios involving the re-use of piggery effluent. However, *A. butzleri,* an emerging food-borne pathogen, was present in all piggery effluents and all irrigated soils, survived longer than *Campylobacter* and needs to be considered as a potential risk in piggery effluent re-use scenarios [11].

We have also used MS-2 phage (as a surrogate for human enteric viruses) to look at the risks associated with the use of chlorinated, stored effluent to irrigate commercial fruit trees and the potential for pathogen transfer to the environment and the fruit crop [12]. We spiked the holding ponds with MS-2 phage at high levels (1,000 times higher than the typical levels present in South East Queensland sewage effluent) in order to study phage die-off and phage movement in the environment. We found a 10-fold to 100-fold die-off in phage the spiked ponds (with no such die-off in control phage suspensions) within 72 hours. Additionally, we found only very low levels of phage in soil irrigated with the spiked effluent (around 100 phage per gm of soil). Overall, our use of MS-2 phage provided valuable new information on a operating re-use scheme that ensured appropriate guidelines were in place [12].

Sampling effluent pond.

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