Enteric bacteria build-up in effluent irrigated plantations

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Australia uses more than 70% of re-used effluent as irrigation in playgrounds, parks, golf courses and race courses [1]. This land irrigation is preferred over other methods (wetlands, tertiary treatment and aquifer storage) for being the economical, practical and vastly applicable option [2, 3]. Bacteria (*Escherichia coli*, and *Salmonella* spp.), protozoa (*Giardia* spp. and *Cryptosporidium* spp.), viruses (Poliovirus, Coxsackie virus and Norwalk virus) and helminths (tapeworms and hookworms) are the major pathogens present in municipal effluent. These enteric pathogens have the potential to enter the food chain and cause health risks. Although enteric pathogens start dying once in contact with aerobic environment, bacterial build-up as well as decay rate should be probed periodically.

The Centre for Plant and Water Sciences at CQU studied bacterial build-ups down to 1m depth under seven municipal effluent-irrigated agroforestry systems thrice at Yeppoon, Capricorn coast QLD. These plantations had either mono or mixed crops of Ma bamboo (B), pangola grass (P) and flooded gum (E), and were irrigated at the rate of 1.42ML ha^{-1} yr^{-1} via two irrigations per week (a small irrigation as compared to cotton/wheat irrigation). The primary objective of this study was to determine if agroforestry systems would have an attenuation effect on enteric microbes.

Periodic enumerations, made over 2 years, revealed that MPN of enteric bacteria increased significantly in comparison to the initial status, irrespective of season and soil depth. The MPN of total bacteria, across times and soil layers, ranged from 33-69x10^3 cfu g^{-1} dry soil under different agroforestry systems (Figure 1). Generally city councils irrigate public sites with effluents, and often the irrigation rates are higher than the one selected for this study. Thus, the effluent irrigated sites could have enteric pathogens present all the time. The mere presence of a pathogen does not cause a health hazard because the health risks are associated with quality of 'exposure to pathogens' as well [2]. However, councils should periodically monitor microbial populations and modify access to those sites to minimise exposure to the pathogens.

Enteric bacterial populations persisted in the soil, irrespective of the season, due to frequent effluent irrigation (every third day). Groundflora, provided with frequent effluent irrigations, was sufficient to foster microbial populations by promoting congenial growth conditions (shade, temperature and humidity). The compositions of tall plants did not affect microbial populations. The *E. coli* populations are known to persist in a subtropical riverbed environments characterised by warm and moist conditions with cyclic periods of wetter and drier weather, all of which are conducive to *E. coli* growth outside the mammalian gut [4]. The microbiota have been reported to persist from 15 days to several weeks after effluent irrigation [5]. Also, spatial and temporal variations in microbial populations are common [6] and

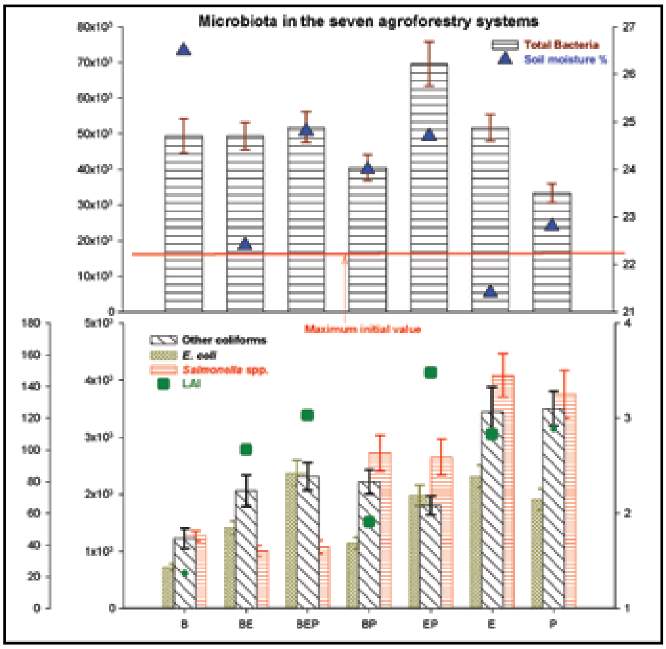

Figure 1. Average MPN of microbial populations in seven agroforestry systems. The data are an average of soil layers and seasons. Leaf area index and soil moisture content of the AF systems are also presented. Maximum initial value is marked by a horizontal line in the A graph (upper).

may require periodic monitoring to assess if different microbial populations prevail. Farmers growing pastures, root crops and bamboo shoots with effluent irrigation should determine the safe frequency of irrigation to avoid enteric microbes as well as minimise their associated health hazards.

The process of predicting the health hazard associated with effluent irrigation is complex but is based on the presence of *E. coli* alone. At times, the MPN of typhoid-causing *Salmonella* spp. was observed, increasing in deeper soil depths where *E. coli* was found declining. The agroforestry systems that had more shade (indicated by leaf area index – LAI), particularly the flooded gum and Pangola plantations, sustained higher *Salmonella* spp. (Figure 1B). Thus, enteric bacteria, other than *E. coli,* may also be included in the process of declaring effluent disposal site 'safe' for grazing or public access. Regional studies in the natural die-off rate of microbes may provide further insight into survival of microbiota under different environmental conditions, and increase the effectiveness of the practices followed in effluent irrigated plantations.

Acknowledgement

Efforts and inputs from Prof David Midmore and Ms Charmain Elder (both from CQU), and Mr Daniel Toon, Mr Bill Van Wees, and Mr Robert Effeny (all from Livingston Shire Council, Yeppoon) are kindly acknowledged.

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