Escherichia coli O157 and Salmonella are food-borne pathogens of importance to the Australian beef and dairy industries. Cattle are a significant reservoir for both of these pathogens and beef has been the source of food-borne outbreaks of both E. coli O157 and Salmonella. The presence of pathogens in cattle can lead to contamination of carcasses during slaughter and products produced from these contaminated carcasses pose a risk to consumers.

However, the magnitude of the risk is not clear. Until recently, almost all of the information published on E. coli O157 and Salmonella in cattle has consisted of only qualitative information i.e. the prevalence of these organisms in cattle. In order to estimate risk, it is important to understand not only how many cattle shed E. coli O157 and Salmonella but also the number of pathogens shed.

For example, does a group of cattle with only one animal shedding high numbers of E. coli O157 or Salmonella pose a greater risk than a group where all animals are shedding low numbers? Risk assessments in this area have highlighted the importance of ‘high shedders’ in determining the final risk. Obtaining quantitative data on the numbers of these pathogens in cattle at the time of slaughter is therefore important.

The observed prevalence of E. coli O157 and Salmonella in groups of cattle can vary anywhere between 0 and 100%, with individual animals varying in their shedding patterns over time. Methods for enumerating E. coli O157 and Salmonella in cattle have relied on the Most Probable Number (MPN) technique as it allows detection of low numbers of bacteria in the presence of high numbers of competing background microflora. For example, the population of E. coli in cattle faeces is often $10^6$ CFU, whereas E. coli O157 and Salmonella numbers may be significantly lower. It is therefore difficult to enumerate low numbers of these pathogens (less than 100 CFU/g) by using plating techniques.

Enrichment using MPN methods can detect low numbers of pathogenic bacteria; however, MPN is a statistically based sampling method and is not as accurate as direct plating. The sensitivity of the MPN method can be increased by improving the detection of pathogens using molecular and immunological techniques.

Immunomagnetic separation (IMS) technology has been considered the ‘gold standard’ for detection of E. coli O157 and is becoming established for the detection and isolation of Salmonella. Advantages of IMS include not only the specificity and sensitivity of the method, but the target organism is isolated, and can be further characterised by serotyping and for virulence markers. Using molecular techniques such as PCR for confirmation of the presence of an organism in an MPN tube does not provide this information without subsequent isolation of the target organism.

The combination of MPN and IMS has been used by several studies for enumerating E. coli O157 in cattle samples. While still not as accurate as direct plating, the method provides valuable information that can be readily incorporated into risk assessments.

A recent study investigating the numbers of E. coli, Salmonella and E. coli O157 in Australian cattle found almost 100% of cattle contained E. coli in their faeces with most animals shedding between $10^6$ and $10^7$ CFU/g (Figure 1). E. coli O157, a subset of the E. coli population, was present in only 13% of the cattle, most of which shed less than 10 MPN/g of faeces. Salmonella were present in 7% of the cattle, with the majority of animals shedding less than 10 MPN/g in their faeces. It was concluded from this work that cattle generally shed low numbers of these pathogens, indicating that the risk of carcass contamination in most cases is low. But what happens in those situations where high numbers of pathogens are present in animals?

Some cattle shed high numbers of E. coli O157 in their faeces e.g. $10^6$ to $10^7$ per g of faeces. These animals have been referred to as ‘supershedders’ or ‘high-shedders’ and it is has been proposed that
that, if such animals are present in a group of cattle being slaughtered, the risk of carcass contamination is increased. When consecutively slaughtered cattle were sampled, high numbers of E. coli O157 in faeces and on hides were associated with carcass contamination [Fegan et al. manuscript in preparation] (Figure 2). Each animal was tested for the presence of E. coli O157 in its faeces and oral cavity and on its hide and carcass prior to chilling. While hardly conclusive, the data suggest that high numbers of pathogens in and on cattle at the time of slaughter are important risk factors for carcass contamination.

While qualitative data are still important, targeted quantitative studies can provide useful information that can allow risk assessors to better model the dynamics of human exposure to food-borne pathogens. Such quantitative assessments can then be used to better inform risk managers and allow them to make more appropriate decisions.

The studies presented here are the beginning of such work and highlight some of the dynamics that need to be considered. As methods continue to improve and become more sensitive, quantitative studies will contribute more to our understanding of the ecology of bacterial pathogens in food systems and hopefully lead to safer food.

References