



**Jerry Gillespie**  
Director,  
Western Institute  
for Food Safety  
and Security, UC Davis

## Lessons from the *E. coli* outbreak — understanding the complexity of foodborne disease

We are in the “recovery period” of the spinach-related, foodborne-disease outbreak of August 2006, caused by *Escherichia coli* O157:H7. This outbreak resulted in at least 204 illnesses in 26 states, three deaths and more than 100 hospitalizations; 29 had hemolytic uremic syndrome, and it is suspected that many more became ill. As of March 2007, reports from official investigations have not been released. Nevertheless, we have learned enough to draw some important conclusions.

Perhaps the most significant lesson is that foodborne disease outbreaks are complex and multidimensional; they require a multidisciplinary, multi-industry approach if preventative measures are to be found. In recent years, regulatory agencies have focused their epidemiological investigations on production units (farms) identified as sources of contaminated produce that caused previous foodborne disease outbreaks linked to fresh produce. For example, researchers examined water (irrigation, flood, runoff), soil and fertilizers, production practices, wildlife, labor, equipment, and other potential routes of introduction of foodborne pathogens (such as *E. coli* O157:H7) on the farm (Sargeant et al. 1999). Microbiologists with diverse backgrounds in genomics, diagnostics, pathogen biology, and bacterial culture and isolation technologies, to name a few, have been central to this research. Much of the initial research involved collecting large numbers of samples from the farm environment in search of *E. coli* O157:H7 (*California Agriculture* 61[5]).

These investigations suggest that *E. coli* O157:H7 might have been introduced to the spinach by water, wildlife fecal matter or other materials brought to the farm from off-site sources. To explore these sources, we must understand livestock management practices, environmental biology, waterway dynamics and farming practices. The fundamental question is: What is the ecology of *E. coli* O157:H7 in spinach production, processing, shipping and retail marketing?

We know that we can isolate this pathogen from fecal matter from animals (including humans), occasionally from waterways, and soil and plant surfaces. We do not know specifically how long *E. coli* O157:H7 can survive in each of these environments nor precisely how it moves from one to the next (such as from fecal matter to spinach leaves). Using current technology, *E. coli* O157:H7 is difficult to isolate, and its concentration in any environment varies from time to time. It is also known that as few as 10 *E. coli* O157:H7 organisms can cause disease in people. Those few organisms would be easy to miss because of how difficult it is to isolate this strain of *E. coli* from environmental or food samples.

Even with the causal associations made in the current investigations, there is no definitive epidemiological pathway identified for the spinach contamination. In fact, it is possible

there were several simultaneous routes of contamination, some not recognized in any investigation to date. For example, scientists have found the specific pathogenic strain of *E. coli* O157:H7 (EXHX01.0124) in samples from cattle manure near spinach fields, in wild pig manure from spinach fields, in recovered bags of spinach, and from stool samples from those affected, suggesting a path from cattle to pigs to spinach field to humans. However, investigators cannot rule out that it reached the spinach from fecal discharges by birds flying over, or contaminated workers’ shoes or tractor tires.

Each of these modes of introduction would require somewhat different preventative practices to forestall contamination of product. The investigations are not complete or comprehensive enough to provide producers with definitive actions to prevent future contamination. Many believe other segments of the spinach continuum need to be rigorously investigated. For example, are the trucks that carry the product contaminated? Are there sites within packaging plants that are adding pathogens to the product? Are there practices in the storage or cooling plants that are allowing the introduction of pathogens? Are retail outlets (grocery stores or restaurants) potential sites for contamination? Finally, we cannot rule out deliberate contamination by a disgruntled individual acting alone or as part of a terrorist cell.

Our task of enhancing food safety is made all the more daunting by the rapid globalization of the food supply and the rapid changes in the technologies used at each step in production, from farm to consumer (*California Agriculture* 54[5]). Investigators must keep track of changes in production and identify new potential risks. Our risk analysis must also look at intentional contamination; for example, how vulnerable are seaports to agroterrorism?

To seriously address leafy-green contamination, we need more comprehensive research, including more academic disciplines and more segments within the leafy-green continuum. We need research expertise on the livestock industry, wildlife biology and water. This is precisely why UC and its partners formed the Western Institute for Food Safety and Security (WIFSS) in 2002, to build needed expertise and foster partnerships between university scientists and industry.

To make the most out of WIFSS partnerships, the WIFSS laboratory must provide a consistent and focused long-term research program that persists between foodborne disease outbreaks and food-system disasters. Partnerships are important to expanding research capacity and, in particular, for filling research niches that cannot be covered by the WIFSS laboratory. These partnerships will involve scientists from a wide spectrum of disciplines and experts from every segment of the global food system.

Sargeant JM, Hafer DJ, Gillespie JR, et al. 1999. The prevalence of *Escherichia coli* O157:H7 in white-tailed deer sharing rangeland with cattle. *JAVMA* 215:792-4.