Eliminate ***Fecal Coliforms*** From Your Vegetable and Fruit Safety Vocabulary

What a difference a name makes! Whether talking about Good Agricultural Practices or TMDL's (Total Maximum Daily Loads) in ag-runoff water, developing fruit and vegetable microbial standards, food safety management and certification plans, or setting regional water policy, basing decisions on total numbers of 'Coliform' bacteria or 'Fecal Coliforms' is not supported by current science. These days, there is a lot of talking and a lot of confusion. It may be helpful to look at Figure 1 and realize that all 'Fecal Coliforms' are also 'Coliforms' and some Fecal Coliforms are non-pathogenic *E. coli* and some are pathogenic and toxigenic *E. coli*. Some pathogens, such as *Salmonella* are 'Coliforms' but don't give a positive result in tests for "Fecal Coliforms'.

Who cares?
You should care because current methods and terminologies of establishing actions based on indicator bacteria are affecting your farming operations and activities, may impact your ability to market your crop, and are likely to impact your bottom-line.

These general terms for a large and diverse class of bacteria are useful and remain relevant in specific food, wastewater management, and water quality applications. However, they have limited or no useful meaning in describing quality or safety attributes of edible horticultural commodities and value-added produce. For the sake of being brief, let's focus on the bigger hot-button, 'Fecal Coliforms'.

'Fecal Coliforms' are a group of indicator bacteria related to common plant shoot and root colonizers, such as *Enterobacter*, *Pantoea* and many others, plant pathogens such as *Erwinia*, *Pectobacterium*, and plant pathogenic types of *Pantoea*, human pathogens including *E. coli* O157:H7, *Salmonella*, and *Shigella,* and a diverse group of soil and plant residents with equally obscure names. As the group name implies, microbiologists that developed the original techniques intended to indicate 'quality' or 'safety' of such things as dairy products, drinking water, composted manure, and treated sewage effluent. They developed the positive association of groups of bacteria, with common traits in rapid and uniform lab tests, to fecal contamination and residence in the gastrointestinal tracts of humans and animals.

Traits of a Recommended Fecal Pathogen Indicator
The problem is that this association just doesn't seem to hold up when evaluating irrigation water, run-off water, or typical product safety. To be a useful indicator of hygienic standards and water management decisions, the following assumptions must be true for 'Fecal Coliforms' in each setting where samples are collected and analyzed:

1) The only source of these bacteria is feces, manure, septic run-off, or sewage
2) There is no significant source in the environment unrelated to these primary sources
3) The indicator bacteria do not multiply in soil, water, and especially do not multiply significantly on the surface of crops, surrounding vegetation or rangeland plants

Research over many years has shown that the current, general grouping called 'Fecal Coliforms' most often fails in each of these assumptions when talking about horticultural commodities and water under the influence of run-off from production locations. The predominant numbers of bacteria that test positive in assays for 'Fecal Coliform', from horticultural production and postharvest handling operations are benign or non-pathogenic soil and leaf colonizers. Like true 'Fecal Coliforms', these soil and plant associated bacteria can grow well at 112F (44.5C), the temperature used in detection procedures, and we use the term 'Thermotolerant Coliforms' to get away from the presumed connection to fecal contamination. The numbers of 'Thermotolerant Coliforms' is highly variable and readily influenced by climate, weather, and crop management practices.

What are the consequences?

1) Uninformed individuals see high numbers of "fecal" bacteria from produce or water samples and assumes the grower's fruit or vegetable is not marketable
2) Some GAP and food safety planners and auditors erect impractical and unnecessary standards for microbial content
3) Some service providers use the data to sell unnecessary and potentially ineffective sanitation systems that provide no assurance of freedom from true pathogen contamination
4) Ag-water use and management policies may be developed without the benefit of a sound risk assessment

What indicator is best?

Escherichia coli or *E. coli* has been suggested as the preferred indicator of fecal contamination in fresh water sources and on produce. The Environmental Protection Agency (EPA) cites *E. coli* as the best indicator of microbial water quality in recreational freshwater systems. The EPA levels are not strictly applicable to developing irrigation water standards but serve as useful guidance for current research and practical approaches to on-farm food safety system development. Non-pathogenic *E. coli* have most of the traits of a "Recommended Indicator" (listed above) and the cost of monitoring is not prohibitive for most growers and shippers. Unfortunately, several years of research has shown that the predictive correlation between *E. coli* and the presence of human pathogens, including viruses and parasites, is highly inconsistent or entirely lacking in many applications for fruit and vegetable production and postharvest handling. In addition, recent reports have found that *E. coli* has the ability to multiply in tropical production environments, thereby mistakenly elevating the apparent risk and concern. However, it is the best we have for now. Monitoring for pathogens is impractical and too costly while other promising indicators, such as viruses of *E. coli*, persist much longer in the environment than many pathogens. Finding better indicators is an active area of research at many institutions.

How should *E. coli* data be used?

If you choose or are required to establish on-going microbial monitoring, the first essential step is to develop and implement a GAPs program and a broader food safety management system to minimize the likelihood of pathogen contamination and survival. Second, within the establishment of the GAPs program, develop a baseline of data, over time, to identify what should generally be expected for surface water and on harvested crops. The way tests are done, both 'Thermotolerant Coliforms' and *E. coli* population estimates are determined from the same sample unit and assay. *E. coli* in well (ground) water would not be expected and its presence should trigger further evaluation and treatment. The third step, and not necessarily the last, is to determine the locations and frequency of routine monitoring to test for significant variance from the baseline and tie these to a self-determined action plan. Currently, this is not necessarily a simple step to take and it would be worthwhile to seek qualified input to arrive at the best practical and economic approach.

Additional background information, resource contacts, and links to GAP development and on-farm self-audit resources may be found at http://ucgaps.ucdavis.edu and http://vric.ucdavis.edu.

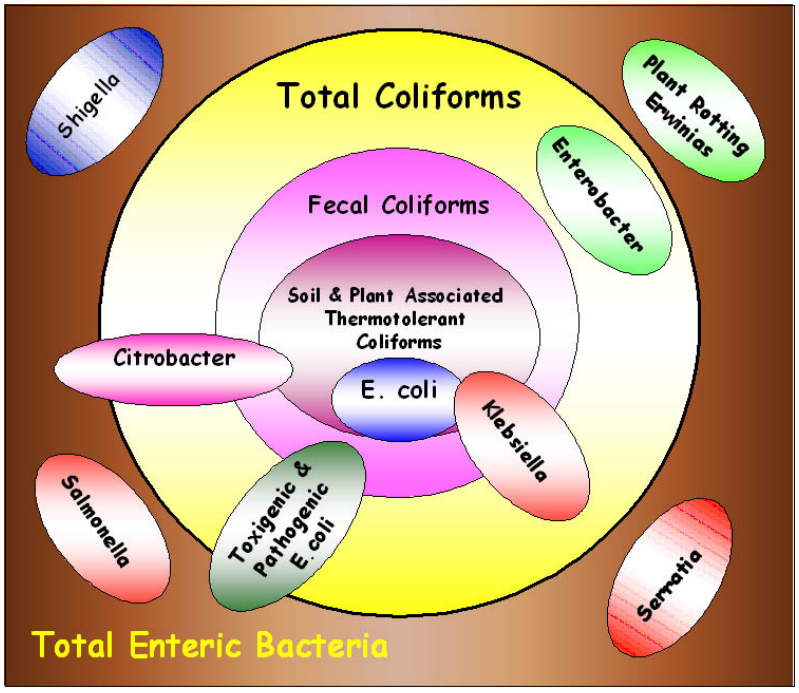

Fig. 1 – In standard microbiological testing from horticultural production and postharvest handling environments, counts of Total Coliform or Fecal Coliform bacteria are poor indicators of quality or safety. Presence/absence tests or counts of generic *E. coli* in water or on fresh produce are poor indicators of fecal contamination and worse predictors of pathogen presence, but it is the best we have for now.