

## **Integrated food safety and plant health approach to controlling microbial hazards in greenhouse tomatoes**

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Tomatoes have been linked to multiple outbreaks of foodborne disease. In the period of 1998-2008, 32 multistate outbreaks were associated with the consumption of fresh tomato in the US leading to 3456 illnesses and three deaths. Tomatoes can become contaminated with enteric pathogens at any stage of production. In addition, tomato diseases are ranked the highest risk to greenhouse tomato productivity and profitability due to their destructiveness, the high cost of managing and in some case the lack of effective management strategies. Systems approaches that integrate prevention and control of human pathogens along with plant pathogens may provide a comprehensive, successful strategy to minimize food safety risks in greenhouse tomato production, achieve adequate quality of the produce and ultimately secure economic growth of greenhouse tomato industry. To address this problem, a multidisciplinary research and outreach team including plant pathologists, food safety and IPM experts was established. Standardized comprehensive questionnaires were developed and on-site visits were used to assess production methods and practices including propagation, growing, harvesting, handling, packaging, storage and transportation. Greenhouse tomato production process flow diagrams were constructed for large medium and small growers to identify possible points of pathogen entry, dissemination and proliferation throughout the entire greenhouse tomato production cycle, from seed to retail. Risk ranking criteria were developed for assessment of microbial hazards including *Clavibacter michiganensis* subsp. *michiganensis*, Botrytis gray mold (*B. cinerea*), Pepino mosaic virus, tomato viroid complex, *Salmonella* spp., and other human pathogens. The risk assessment will be used to identify opportunities for improved control for each pathogen, and importantly to identify critical points in which both human and plant pathogens can be controlled simultaneously. Development of a system-wide framework in which the introduction and spread of plant and human pathogens in greenhouse tomatoes can be effectively managed will enhance public health and provide fundamental basis for growth of greenhouse industry.