



# International Lettuce and Leafy Greens Food Safety Research Conference



# Green Working Group

# Approach

- Sequentially considered
  - Production/Preharvest
  - Harvest/Cooling/Processing/Value-added
  - Distribution/Foodservice/Retail/End-user
- Separated Research needs from Best Practices/Compliance issues
- Avoided repeating existing research
- Higher priority to research needs that would lead to actionable results, risk reduction

# Production/Preharvest

## Soil Amendments

- Process/Compost type-specific validation protocols
- Lot-specific microbiological verification protocols and standards
- Protocols, standards to minimize risk of airborne contamination of fields from adjacent compost piles/operations
- Validated cleaning, sanitizing procedures and standards for compost handling equipment

# Production/Preharvest

## Irrigation water

- Agricultural water standards, based on transfer coefficients: if water contains pathogens, what levels and factors (amplification, die-off, type and age of leafy green, and other factors) result in a safe/unsafe condition
- Practical (sustainable, economical, legal) methods of irrigation water disinfection

# Production/Preharvest

## Production/harvest equipment

- Validation of cleaning procedures, including equipment sanitation standards based on transfer coefficients from field contaminants to equipment.
- Cleanability/sanitary design standards for produce contact equipment (production and harvest), including detection technology for equipment contamination

# Production/Preharvest

## Animals

- IPM for fields: practical, economical, sustainable, legal and effective deterrents (attractants, exclusion, redirection) for uncontrollable animals

## Other

- If contamination of field may have occurred, what factors influence persistence and what standards can be used to decide on field usability

# Post-harvest handling/processing

- Potential for internalization throughout the process from harvest to packaging (harvest time of day, cooling procedures, when and how cut, in-process shredding, washing, drying, and time to packaging) and practices to minimize internalization.
- Potential for pathogen (E. coli O157:H7) amplification between harvest and cooling under operational conditions
- Validation of methodologies for cleaning, sanitizing procedures for produce contact surfaces (bins, totes, hands, equipment, utensils)

# Distribution/Retail/Foodservice/ End-user handling

- Education, outreach, publication of existing data
- No high priority research needs

# BLUE WORKING GROUP

- All of the 15 Priority Issues identified were Pre Harvest, Field Preparation, Production and Harvest Areas except the 3 areas designated as Post Harvest.
- All research areas are critical to be conducted in pilot scale and in field operations scale instead of laboratory only operations.

# Priority Research Areas

## Post Harvest:

- 1. Need for new technologies on a kill step, sanitizing procedure that can tolerate organic load. (Consensus Area)

## PreHarvest

- 2. No science currently exists to support buffer distances imposed. Determine the validity of buffer distances from potential contamination sources such as intensive animal operations, sources of wildlife and determine if other intervention strategies are available. Do natural barriers reduce or increase risk? What are airborne risks?



# Priorities Cont'd

- **3. Develop water standards that are directly applicable and science based for lettuce and leafy greens production. Do the current recreational water standards have applicability for the field? Research is needed for environmental factors that contribute to transport and transfer of pathogens.**
- **4. Research is needed to determine what the particular ecological niche is for E. coli O157:H7:H7. Determine how E. coli moves through soils comparing vegetated versus cultivated operations, various soil types, etc. What is an E. coli O157:H7 surrogate that can be used? Examine use of modeling on distribution of contamination source.**

# Priorities Cont'd

## Post Harvest:

- 5. Additional interventions beyond the wash step- vacuum, antimicrobial film, chlorine dioxide, MAP, probiotics, etc (based on field contamination events).

## PreHarvest:

- 6. Need for Food Safe Compost Standards. Whatever method of composting is used, develop performance standards and point of sampling, time/temperature, etc. Is compost a deterrent to survivability of Salmonella and E. coli in amended soils?

# Priorities Cont'd

- 7. Examine whether we need seasonal and geographical intervention strategies due to seasonal changes in animal populations, temperatures, etc.
- 8. Does processing in the field contribute to contamination? Field coring, sanitization of equipment, time/temperature at the time of harvest, crop residue left in the field, chlorine levels, water temperature internalization, moisture levels at time of harvest.

# Priorities Cont'd

## Post Harvest:

- 9. Factors affecting survivability and growth of E. coli post harvest (entire production supply chain) from cut to cool – most numbers are quality not safety.
- 10. Need for new technology regarding the wash step? Research is inadequate at this point.

## PreHarvest

- 11. Need for effective rapid microbiological methods for E. coli O157:H7:H7 and other pathogens. Examine whether bioterrorism field air monitoring is applicable.
- 12. Conduct intensive raw material sampling and analysis on representative farms and field that represent specific conditions to evaluate effectiveness of current metrics and standards.

- 13. Research environmental factors that contribute to the transport and transfer of pathogens.
- 14. Develop better strategies and uniform procedures to samples and assess fields. This is a key area for evaluation.
- 15. No ecology of *E. coli* postharvest. Varietals differences, maturity, internalization, etc particularly on injured and cut surfaces.

# Other Research Areas

- **Examine contamination potential from biodiverse versus “sterile” water bodies.**
- **What is the magnitude of use of treated recycled water, captured tail water, etc.? What are the microbial levels?**
- **What is appropriate level of time for equipment sanitization?**
- **Comparison of farms/firms frequently involved in recall versus those not involved.**
- **What is the role of hands and coring knife in contamination spread and also harvesting equipment.**
- **What are alternative indicators to generic E. coli in water and produce for harvest?**
- **Research to determine practices after flooding or contamination to eliminate E. coli in soils from, tilling practices, days in sunlight, etc.**
- **Research on soil amendments or competitive exclusion, microbial antagonism to reduce E. coli.**

# Other Research Cont'd

- Development of an indicator on or in the bag to indicate *E. coli* or better time temperature indicator which is economically feasible.
- Is the natural contamination in a biofilm or in a way that sanitizers can access?
- Do processing methods/conditions need to be changed for better sanitizing methods?
- Are current employee hygiene practices adequate?
- Ice in cooling? Is this a source of contamination?
- Ease of sanitizing? Is a more frequent, clean in place, continuous method better?
- What is the potential cross contamination in storage?
- What is the effect of temperature abuse and use of products in home, conditions after use and level of *E. coli*/surrogate?
- Research effective messaging to the distribution, retail, food service, consumer issues
- Develop effective cold chain guidance based on research.

**Thanks to a wide and diverse  
group of industry,  
government (state and  
federal), academia and trade  
associations**

# Orange Working Group report

# Overarching / Pre-requisite Research Issues

(How to model the real world)

- Develop a mechanism (means of collaboration) to access & harness industry data/research//learnings.  
Assure confidentiality
- Develop a means for rapid response research to address transient real world research questions (research ready SOPs).
- Interventions – define what needs to be achieved (FSO's)
- Develop a harmonized criteria to evaluate new & emerging intervention technologies.
- Development of protocols for surrogate use that can be agreed upon.

# Production & Harvest

- Microbial Ecology – Effects of temporal changes in water quality, soil and plant surfaces on plant pathogen growth and survival in the production environment.
- Transfer – Potential for pathogen transference as effected by adjacent land use practices (e.g. air dispersion from soil, air dispersion from water use, etc.)
- Microbial Ecology – Survival of pathogens under various production conditions and the effects background microflora, UV light, temp, RH, etc.
- Pathogen survival and growth on LLGs – as affected by commodity, leaf morphology, varieties, maturity, seasonality (i.e. spring, summer, fall, winter crops).
- Potential for internalization of pathogens into the leaf subsurface tissue and how it may be effected by commodity type, variety, season and maturity.

# Postharvest & Fresh-cut Produce Handling

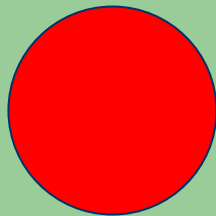
- Pathogen Transfer – Food contact surface transfer coefficients.
- Effect of time and temperature on pathogen survival and growth from farm to fork (Harvest, Cooling, Process Plant, In Bag, Distribution, Retail & Food Service)
- Pathogen internalization by vacuum cooling, hydrovac and washing.
- Optimizing water disinfectant efficacy and preventing disinfectant failure (i.e. loss of efficacy) due to factors such as pH, temp, time, concentration, product flow rate (product to water ratio), etc.

# Red Working Group Report

Lettuce & Leafy Greens  
Food Safety Research  
Conference

September 21, 2007

Hilton Washington Dulles Airport



# Field Preparation, Production & Harvest

- 30 research opportunities identified
- Top 3 ranked opportunities
  - ✘ Data mining existing (industry) data sets
  - ✘ Risk ranking for environmental factors
    - Persistence/growth/survival factors – other than in field
    - Treatments for irrigation water
    - Ecology of irrigation water sources

# Field Preparation, Production & Harvest

- Low ranked opportunities
  - Amplification versus dissemination of pathogens
  - Change in plant over time
  - Testing methodology
  - Sources of pathogens
  - Survival/growth in field - what's there
  - Sampling techniques in field (e.g. water, soil, etc.)
  - Geomorphology and other agr operations
  - Weather
  - Phage as an intervention in field
  - Small vertebrates as carriers/sources
  - Harvest equipment cleaning (belts, wheels) transfer
  - Why no outbreaks elsewhere - ID conditions that prevent
  - Prevalence of pathogen on seeds - effect of treatments aimed at plant pathogens
  - Debris as a holder for pathogens
  - Levels of pathogens in amendments
  - Water used at harvest
  - Growing practices, plant structure, temp, interactions
  - Sanitary practices of people - Social science/compliance - Compare elsewhere to CA
  - Effect of agr practices (e.g. bed density) and stress
  - Competitive exclusion in field
  - Distribution of organism in field
  - Harvest equipment & dissemination
  - Equipment design
  - Trucks etc as source of spread
  - Internalization - Does it happen? When? So what?

# Post Harvest Handling & Processing

- 18 research opportunities identified
- Top 5 opportunity
  - ✘ Lethal/kill step for pathogens
    - Why are pathogens on produce so resistant to treatments?
    - Rapid testing of water
    - Wash water treatment
    - Use of cumulative hurdles and interventions (practical)

# Post Harvest Handling & Processing

- Low ranked opportunities
  - Effect of organic load on efficacy
  - Gas treatments in vacuum cooler
  - Radiation and potential for *C. botulinum* growth w/o competition
  - Antimicrobial packaging
  - Very rapid tools for presence/absence of pathogens during process & in finished product
  - Continuous monitoring for antimicrobials
  - Equipment spreading contamination and treatments
  - Process validation at process scale
  - Consumer response to treatments
  - Is it possible to be too clean?
  - GMO to resist human pathogens or indicator method
  - Water used in cooling (hydrovac)
  - Treatment during transport (i.e. gas treatments)

# Distribution, Retail, Food Service & Consumer

- 11 research opportunities identified
- None had the same interest as “High Interest” opportunities for farm or processing
- Top 5 opportunity
  - ✿ Temperature effects on virulence
    - Retail practices and risk (misting, temperature, co-mingling, crisping)
    - Norovirus at retail and food service
    - Consumer acceptance of novel technology for food safety and effectiveness of education
    - Antimicrobial treatments for retail & food service

# Distribution, Retail, Food Service & Consumer

- Mid to low ranked opportunities
  - Temperature during supply chain - cold chain
  - Pallet and container washing - what to do and how important
  - Research on effective training methods
  - Data mining of existing temperature info
  - Home washing practice
  - Co-transport of meat and produce items

# **General Consensus of the Workgroups**

# General Consensus

1. “A kill step would make a lot of these research needs unnecessary”; but none likely short term
2. Data mining of industry data and research important for progress
3. Research should be done on a pilot-scale or field-operational basis; must get beyond laboratory studies

# General Consensus

4. No high priority research needs identified in Distribution/Foodservice/Retail/End-user, but not a lot of input from that sector
5. Optimizing wash water treatment
6. Factors affecting survivability and growth of EHEC from harvest throughout the supply chain

# Conclusions of the Working Groups

1. Ensure research is based on real-world conditions
2. Microbial ecology, including transfer coefficients
3. Collaboration and data sharing:
  - researcher-industry-government collaboration;
  - mining of operational data;
  - learn from outbreak data, epidemiology, seasonality
4. Real-time education outreach
5. Funding agencies must be engaged
6. Developing Kill Step, validated cleaning procedures, optimization/validation of produce washing procedures,
7. Production environmental controls, including developing food safe compost standards, wild animal controls, etc.

# Next Steps

- Conference report will be prepared by Organizing Committee
- Compilation of research needs, overall report, presentation slides and other conference outputs to be published (websites), widely distributed to researchers, funding agencies
- Conference attendees will be notified