University Research in Food Safety and Food Defense

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Government-University-Industry Research Roundtable

Food Safety Working Group

The National Academy of Sciences

29 - September - 2009

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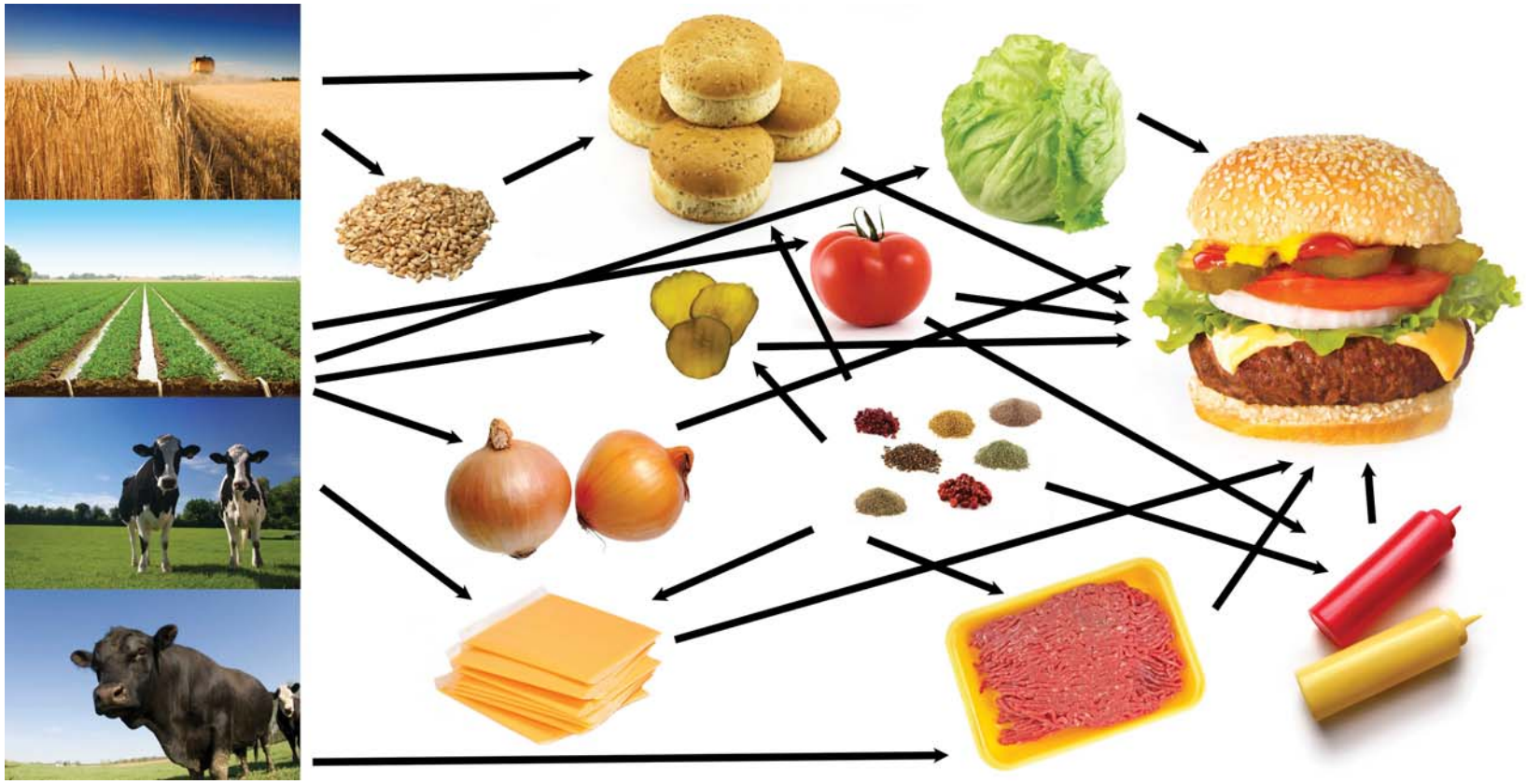
Security / Safety / Defense

- Food **Security**: Supply *sufficiency* – access to nutritionally adequate and safe food
- Food **Safety**: System *reliability* – reducing exposure to natural hazards/errors/failures
- Food **Defense**: System *resiliency* – reducing the impact of system attacks
- Food **Protection:** Global food supply system Safety/Defense "umbrella"

Global Supply Chain Complexity



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Global Supply Chain Complexity

bleached wheat flour
malted barley flour
thiamine
riboflavin
Niacin
folic acid
reduced iron
Water
corn syrup
sesame seeds
soybean oil
Yeast
Salt
calcium sulfate
calcium carbonate
calcium silicate
soy flour

baking soda
wheat gluten
calcium propionate
enzymes
mono- and diglycerides
diacetyl tartaric acid esters
ethanol
sorbitol
polysorbate 20
potassium propionate
sodium stearoyl lactylate
corn starch
ammonium chloride
ammonium sulfate
calcium peroxide
ascorbic acid
azodicarbonamide

Milk
Water
sodium citrate
sodium phosphate
artificial color
acetic acid
Enzymes
milkfat
cream
salt
sorbic acid
cheese culture
soy lecithin
starch

USDA inspected beef

<u>Special Sauce</u>
Soybean oil
distilled vinegar
egg yolks
sugar
corn syrup
spice extractives
xanthan gum
prop. glycol alginate
potassium sorbate
garlic powder
caramel color
Turmeric
EDTA
pickles
water
HF corn syrup
onion powder
spice
salt
mustard flour
sodium benzoate
mustard bran
hydrolyzed proteins
paprika
calcium disodium

Cucumbers
water
Vinegar
Salt
calcium chloride
Alum
natural flavorings
polysorbate 80
turmeric

lettuce

dehydrated onions

<u>Grill Seasoning</u>
Salt
Pepper
cottonseed oil
soybean oil

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Globalizing the Cheeseburger

Vinegar

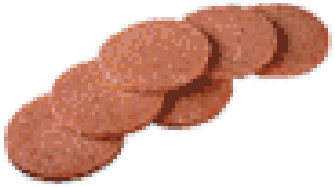
Argentina
Austria
Brazil
China
Colombia
Dom. Rep
Germany
Hong Kong
Italy
S. Korea
Peru
Portugal
Philippines
S. Africa
Spain
Turkey
U.K.
Australia
Belgium
Canada
Chile
Denmark
France
Greece
Israel
Japan
Lebanon
Poland
Serbia
Russia
Singapore
Sweden
Taiwan

Garlic Powder

Brazil
Canada
China
Germany
India
Israel
Japan
S. Korea
Mexico

Tomatoes

Belgium
Canada
Colombia
Costa Rica
Dom. Rep.
Guatemala
Israel
Morocco
Mexico
Netherlands
New Zealand
Poland
Spain



Beef

Australia
Canada
Chile
Costa Rica
Honduras
Japan
Mexico
Nicaragua
New Zealand
Uruguay

Wheat Gluten

Australia
Belgium
Canada
China
Czech Rep.
France
Germany
Kazakhstan
Lithuania
Netherlands
Poland
Russia
Switzerland
Thailand
U.K.

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University Research

- Investigator initiated in response to sponsor areas of interest
- Traditional model of lone investigators giving way often to teams of investigators
- Borders only relevant when the sponsor imposes restrictions
- Breadth of disciplines needed much broader than “food safety specialists

Disciplines Participating in NCFPD Research - P1

- Agri-Business
- Animal Science
- Applied Economics
- Bio-Engineering
- Biomedical Engineering
- Business Administration
- Chemical & Biological Engineering
- Communications
- Computer Sciences
- Disposal/ Decontamination
- Economics
- Education
- Electrical Engineering
- Electrical & Computer Engineering
- Engineering Risk Analysis
- Engineering

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Disciplines Participating in NCFPD Research - P2

- Environmental Health
- Food Safety
- Food Science
- Health Communication
- Industrial & Systems Engineering
- Logistics
- Mechanical Engineering
- Microbiology
- Pathobiology
- Poultry Science
- Public Health
- Rhetoric
- Risk Communication
- Toxicology
- Veterinary Population Medicine

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University Research

- No ready database to capture all food safety & defense research
  - One is coming through collaborative funding to NCFPD
- Total federal funding for university research in FY2010:
  - USDA-NRI $257 million (M), Hatch $139 M, Integrated $5 M, Special $3M (not all safety/defense)
  - DHS-University Programs $44M, Chem/Bio Division $200M (very little food safety/defense)
- Private sector and states also fund food safety & defense research

University Centers

- Common mechanism to coordinate within/across campuses for access to faculty and funding/fund raising
  - Private sector fee-based
  - State funded
  - Grant funded (federal agencies, foundations)
  - Agency contracts
  - University supported
- Logical touch-point for the National Laboratories

University Centers - Examples

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NCFPD Mission

- Reduce the likelihood of an attack
- Improve the nation's ability to respond effectively
- Reduce the consequences of an attack

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NCFPD Goals

Reduce the potential for catastrophic food system events by:

- Rendering targets unattractive
- Rapidly and accurately detecting attacks
- Responding effectively to minimize consequences
- Rapidly delivering effective recovery efforts
- Training/educating new scientists and professionals
- Partnering and collaborating to ensure success

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Broad Academic Collaboration

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Diverse Industry and Association Collaboration

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Collaborating Across Agencies

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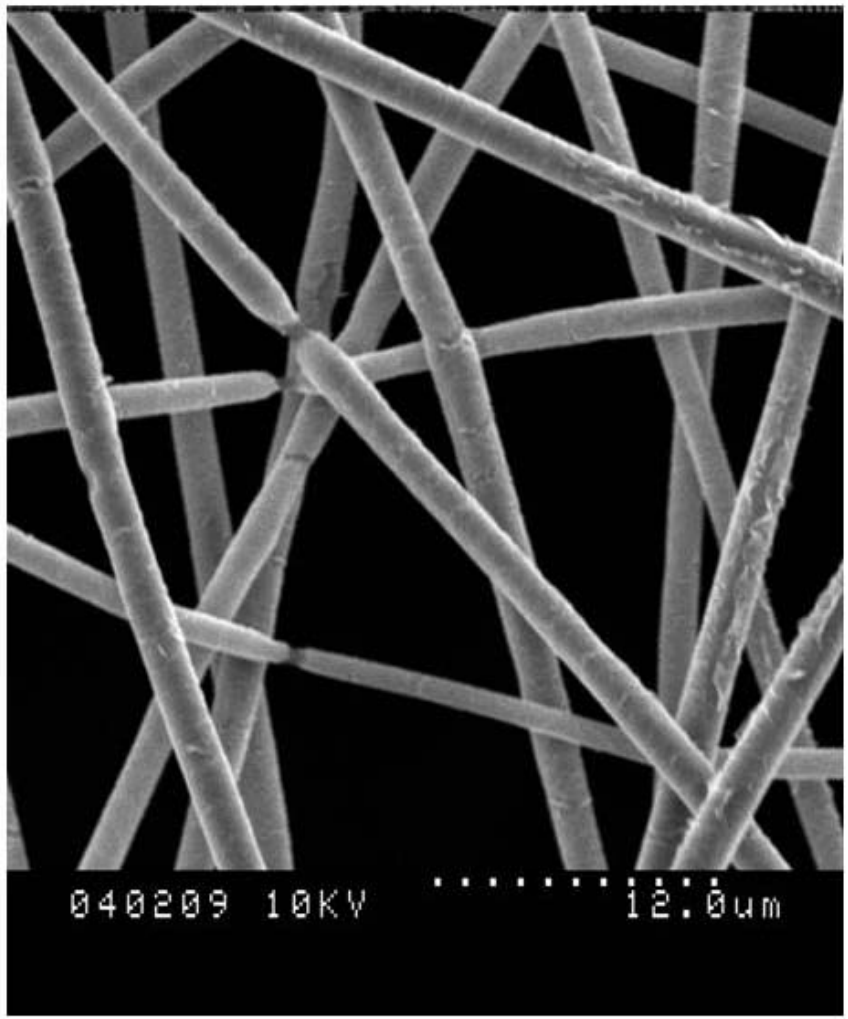
NCFPD Agent Research Goals

- Fundamental understanding of the chemical, physical and biological attributes of “agents” that may be intentionally introduced into the food supply.
- Specialized biosensors that can expediently extract, concentrate, and detect such agents in foods and beverages.
- Agent-specific strategies to prevent or recover from an intentional incident involving the food supply chain.

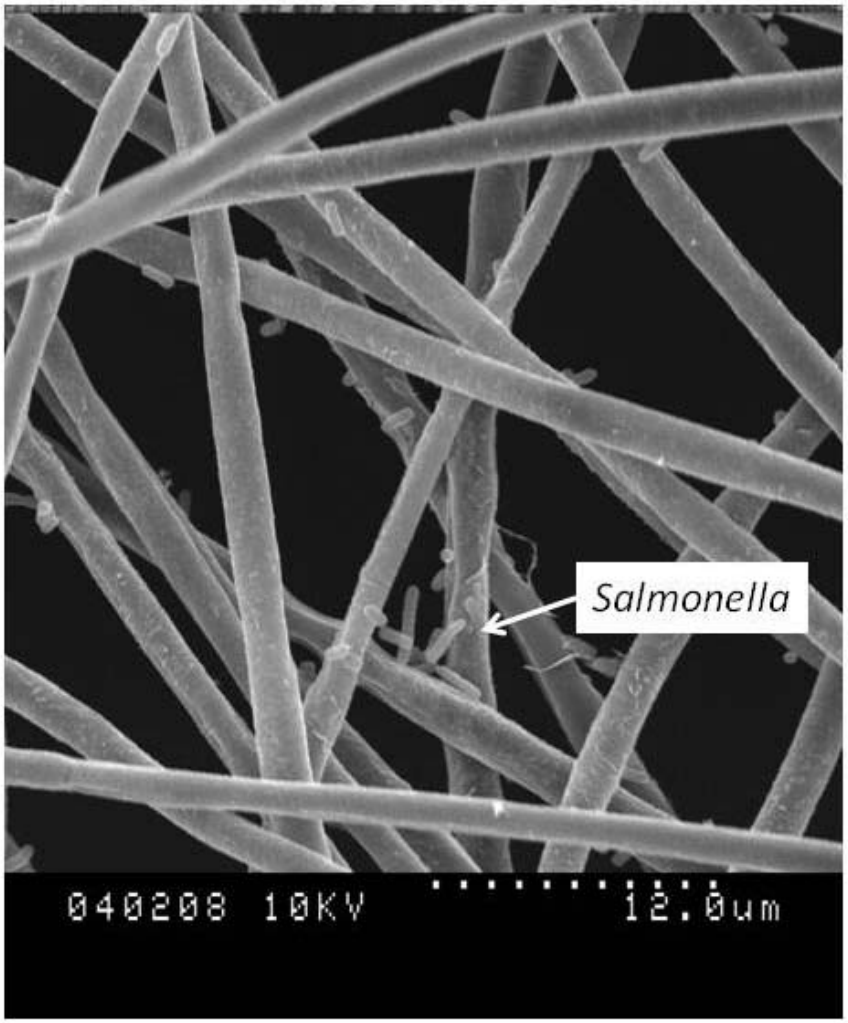
Chemical Agent Project Example

Extraction and concentration of chemical (tetramethylenedisulfotetramine) and biological (ricin) toxins

- The use of molecularly-imprinted electrospun fibers to selectively extract and concentrate select agents
- Selective and rapid detection of select agents using conducting polymers
- Techniques to immobilize and imprint molecules onto high surface-area fibers



Control



Antibody Modified

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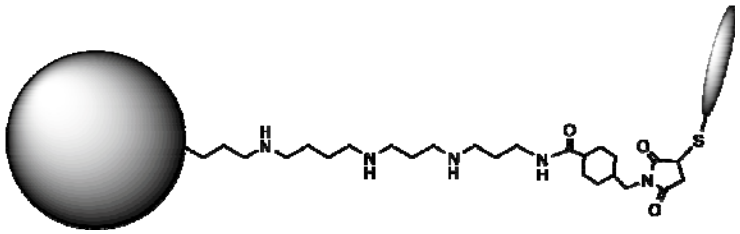
Biological Agent Project Example

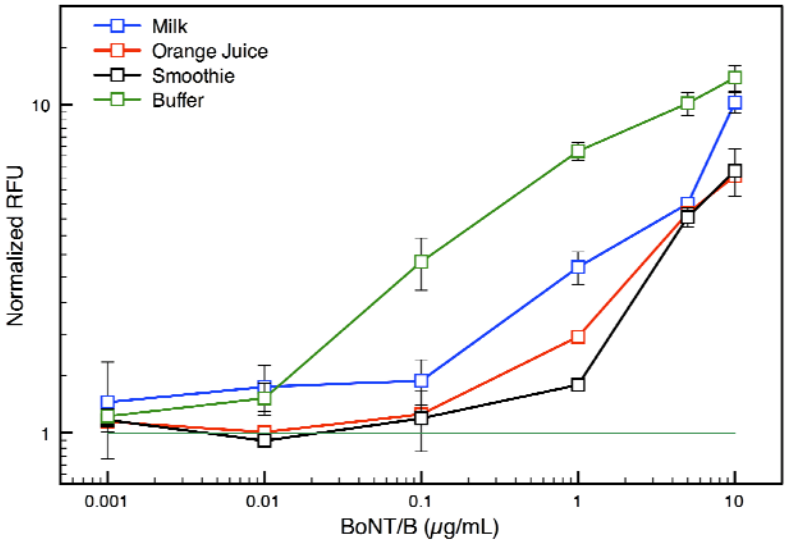
Botulinum neurotoxin sensing in food matrices

- Platforms:
  - Microfluidic channels
  - Affinity bead capture
  - BoNT receptor ligand
- Remote Sensing
- Food Matrices
- Comparison to mouse bioassay

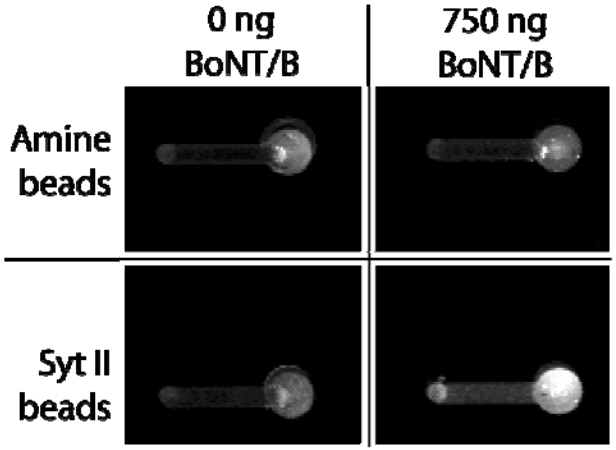
Magnetic Bead Capture of BoNT/B

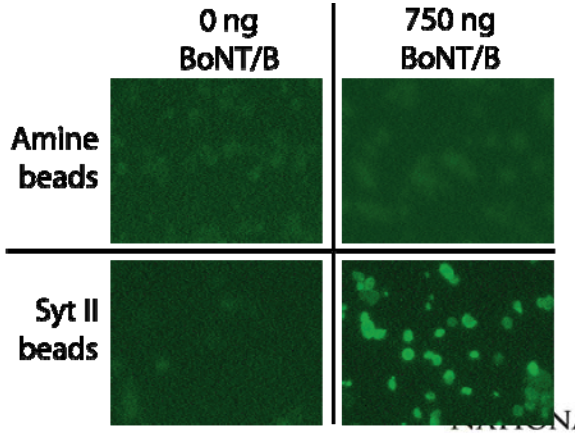


Amine-terminated paramagnetic bead conjugated to synthetic Syt II 22mer peptide



Approximate LOD for buffer is 200 pg, milk is 150 pg, juice is 350 pg, and juice concentrate (V8 consistency) is 3 ng.

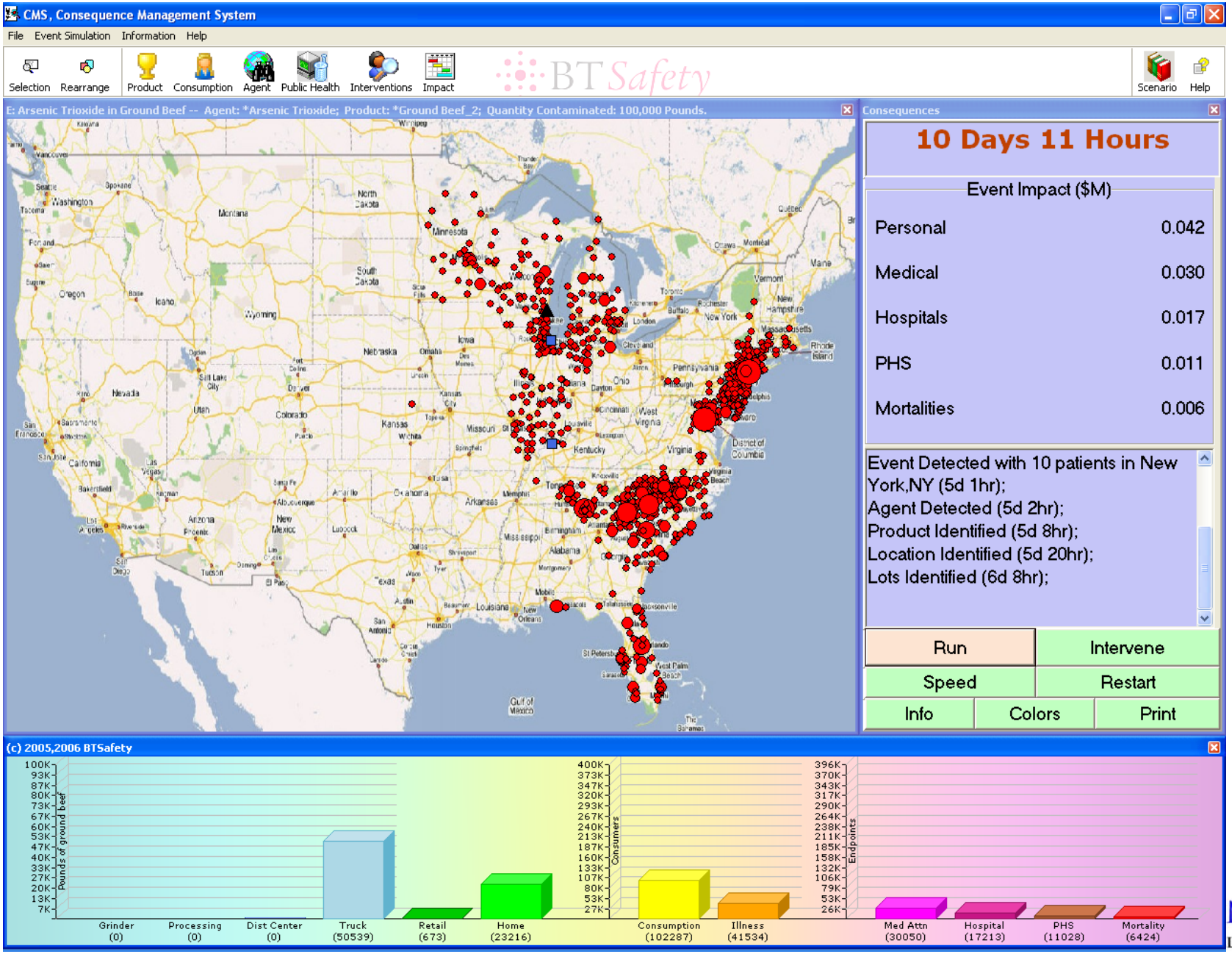




Versatile detection using both fluorescence microscopy (green false color) and IR scanning (whole channel image). Can also format for direct microchannel fluor quantification in plate reader (not shown).

NCFPD Event Modeling Research Goals

- Event models for consequence, risk and vulnerability assessment
  - To evaluate preparedness, response and recovery strategies
  - To aid in decision support
  - To insure that emerging event models can communicate with one another, if required



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Event Modeling Project Example

Vulnerability assessment and reduction of economic impact for the fruit and vegetable industry

- Food defense assessment survey for F&V shipper/growers, including threat point analysis to evaluate gaps
- Develop intelligent/ risk based sampling procedure
- Dynamic market equilibrium models to simulate potential economic estimates of terrorist attacks
- Develop training materials for the imported produce industry

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NCFPD System Strategies Research Goals

- Food supply chain designs that degrade gracefully and recover quickly when subjected to a major disruption (resiliency).
- Approaches to diagnose or predict the causes of a major supply chain disruptions that are closely linked to the design of resilient food supply chains.
- Continuous tracking and analyzing consumer confidence in the U.S. supply chain.
- Assess the economic impact of a catastrophic terrorist food system attack.

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Systems Strategies Project Example

Continuous tracking and analyzing consumer confidence in the U.S food supply chain

- Monitor consumer confidence in the food system, and conduct trend/event analysis related to food defense and supply chain safety/security events, including concern with food defense relative to other terrorist targets.
- Predict how communications drive consumer attitudes and purchase intentions for food.
- Construct a food system Consumer Confidence Index, estimate the effects of media coverage of these events on it.

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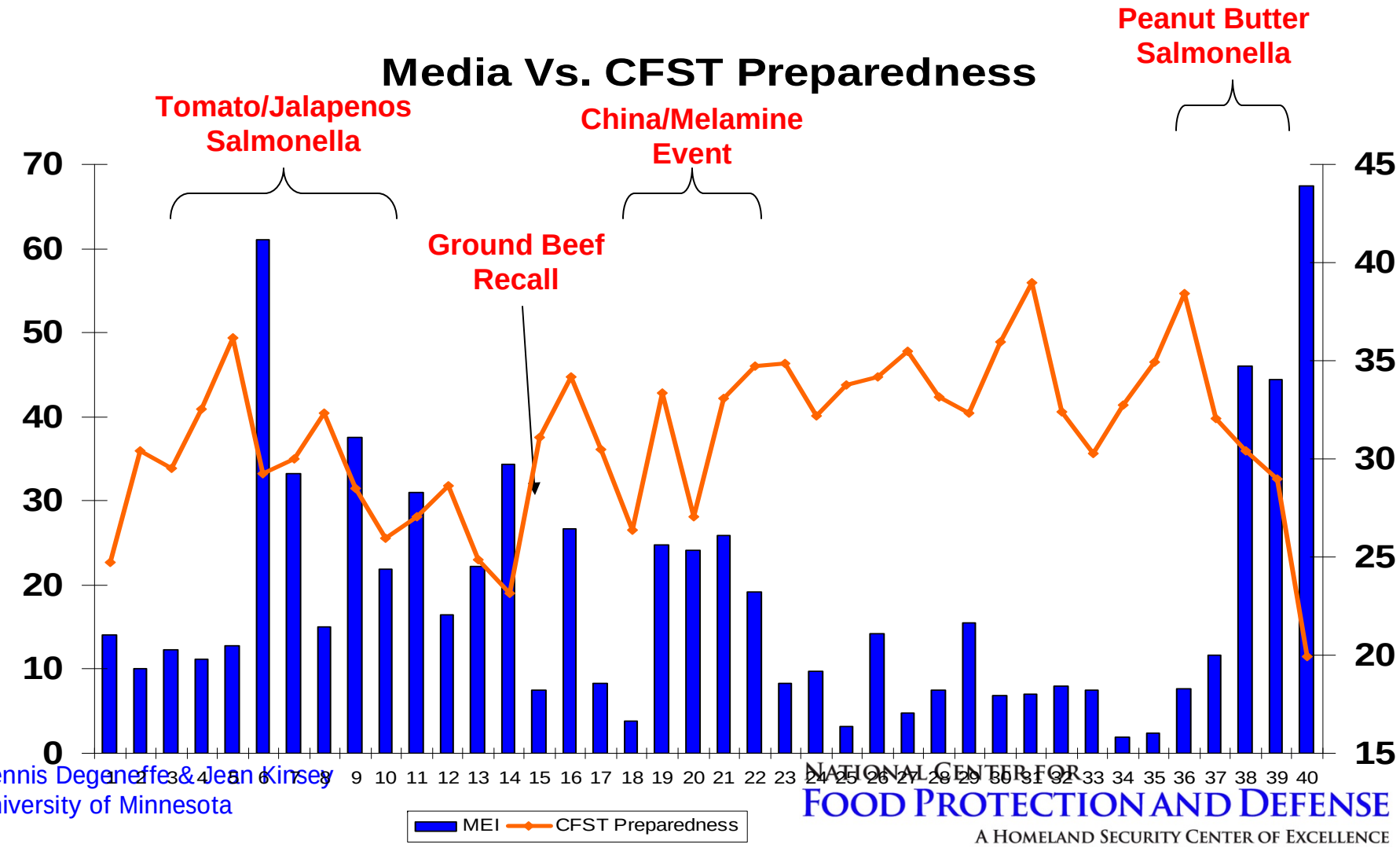
CFST Preparedness in Food System

May 2008 - February 2009



Dennis Degeneffe & Jean Kinsey
University of Minnesota

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NCFPD Risk Communication Research Goals

- Risk communication best practices for potentially catastrophic events.
- Approaches for engaging the media, across media types and audiences, as a resource for managing high risk and crisis events.

Risk Communication Project Example

Assessing message effectiveness with diverse cultural groups based on learning styles

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NCFPD Vision

Defending the **safety** of the **food system** through **research** and **education**

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