USDA

United States Department of Agriculture

National Institute of Food and Agriculture

USDA NIFA

NATIONAL INSTITUTE OF FOOD AND AGRICULTURE

INVESTING IN SCIENCE | SECURING OUR FUTURE | WWW.NIFA.USDA.GOV

USDA/NIFA Programs & Resources to Support Nano-biosensor R&D

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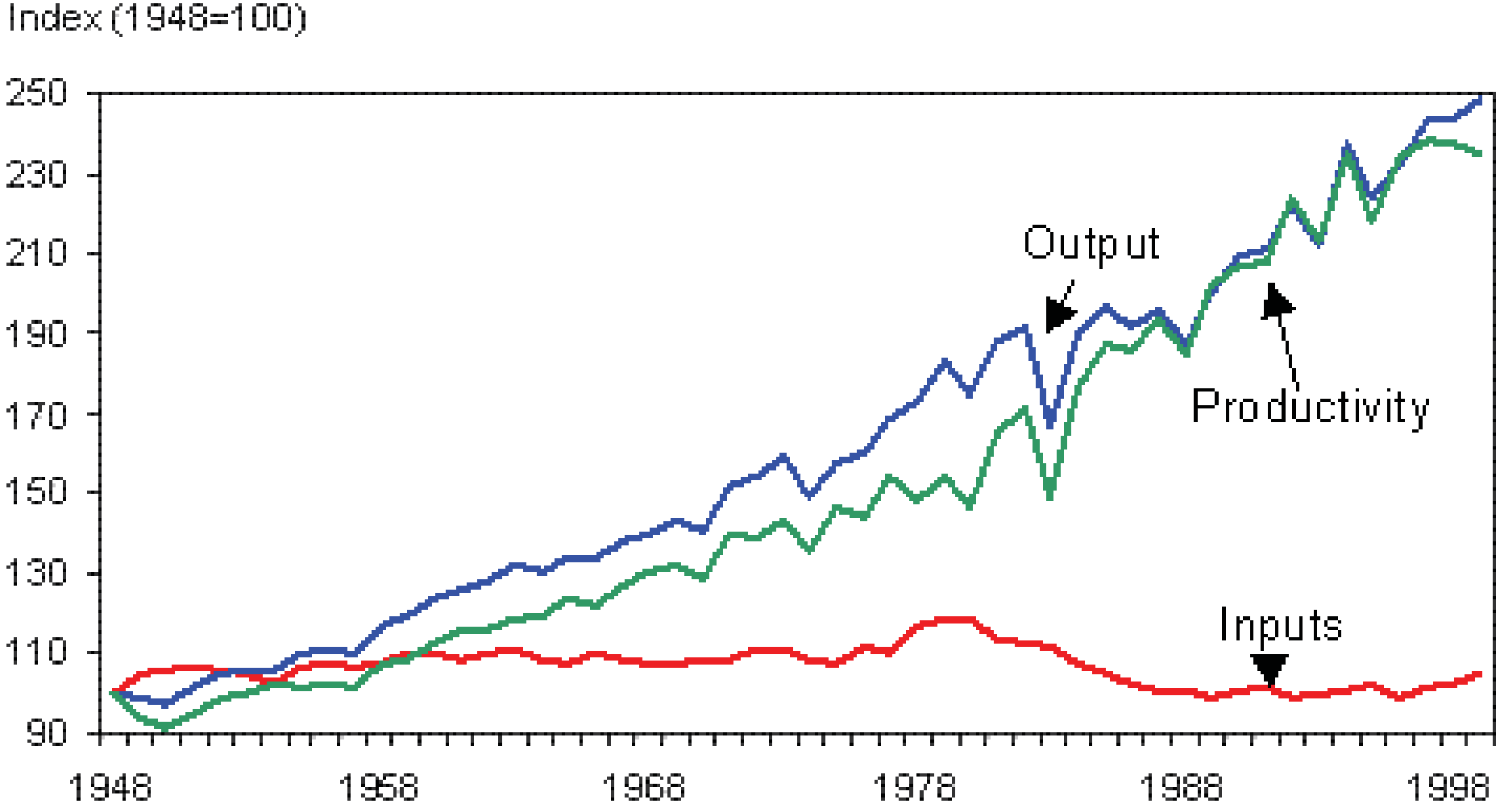
National Program Leader, USDA-NIFA

Sensor Fabrication, Integration, and Commercialization Workshop

Room 375, Stafford I, National Science Foundation

September 11 & 12, 2014

Productivity continues to be the engine of growth in agriculture



Final data year is 2002.

Source: Economic Research Service, USDA

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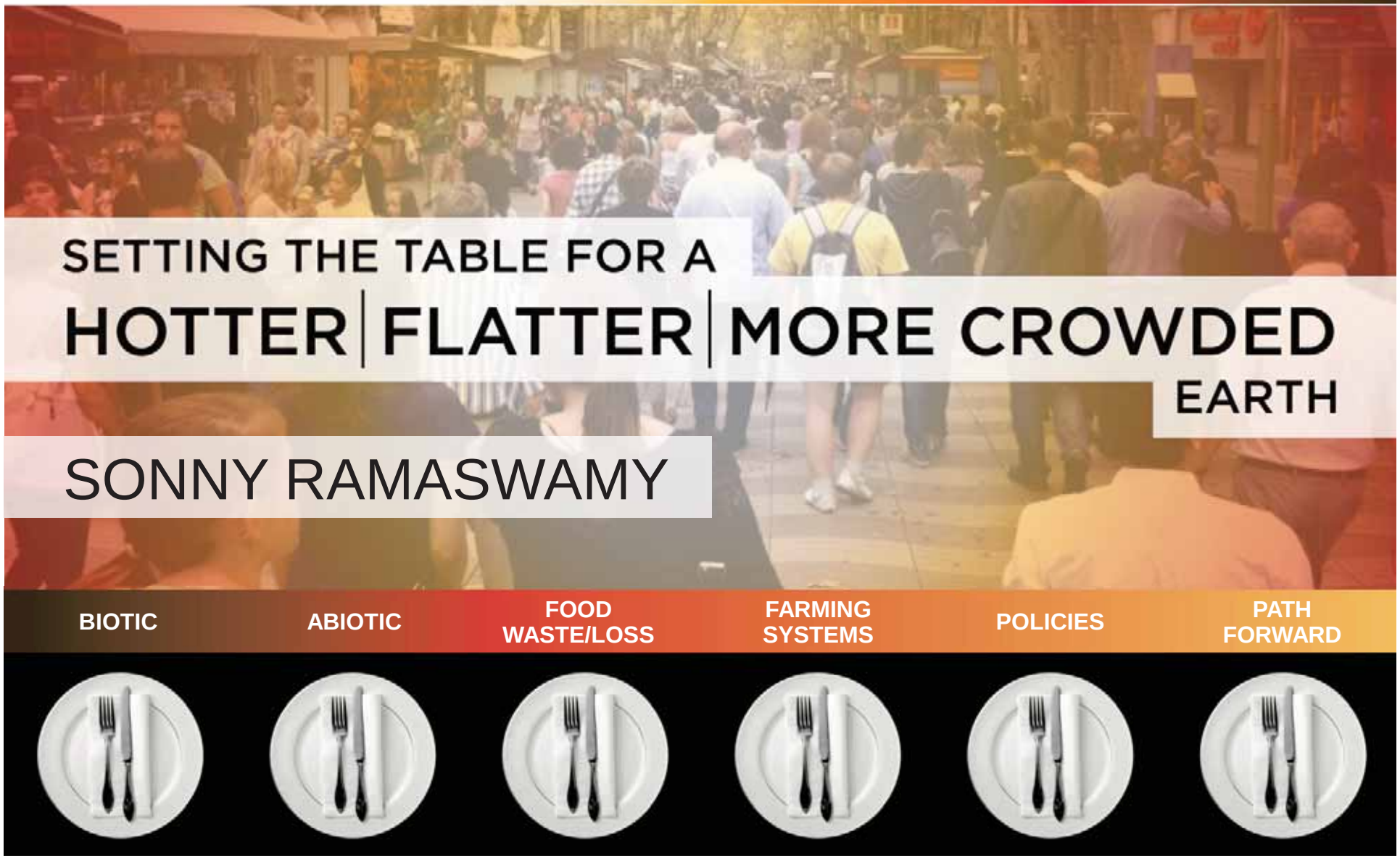
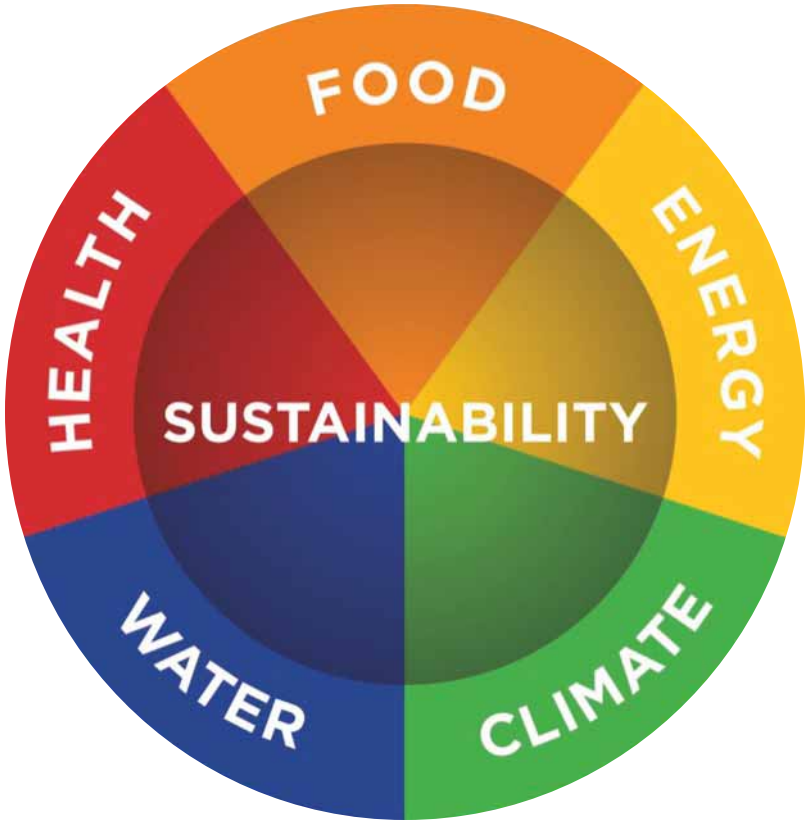


SETTING THE TABLE FOR A HOTTER | FLATTER | MORE CROWDED EARTH

SONNY RAMASWAMY

BIOTIC | ABIOTIC | FOOD WASTE/LOSS | FARMING SYSTEMS | POLICIES | PATH FORWARD

The Nexus



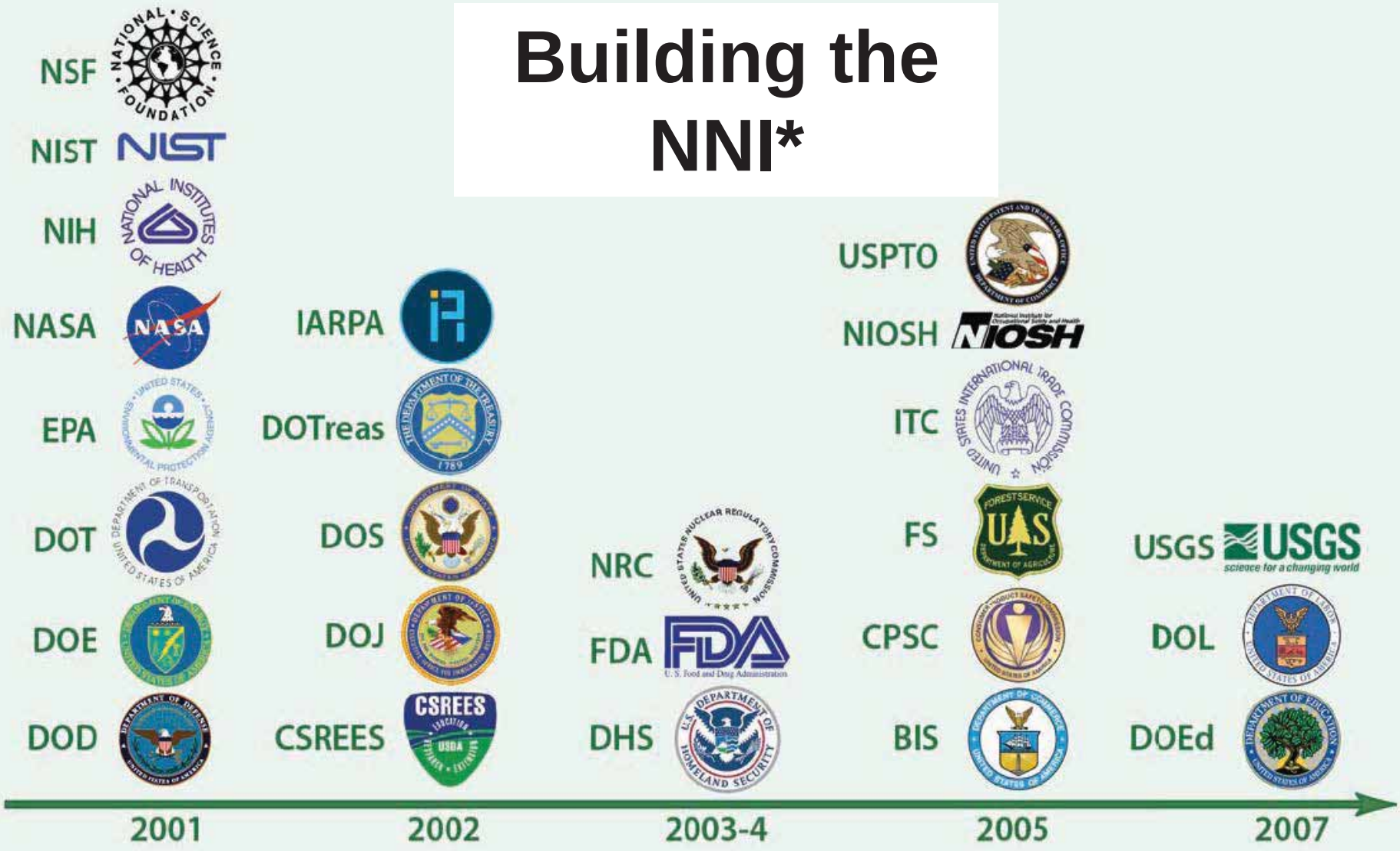
National Institute of Food and Agriculture (NIFA)

- **Mission**
  - Invest in and advance agricultural research, education and extension to solve societal challenges.
- **Vision**
  - Catalyze transformative discoveries, education, and engagement to address agricultural challenges.

NIFA Priority Science Areas

- Global Food Security and Hunger
  - To boost agricultural production, improve global capacity to meet the growing food demand, and foster innovation in fighting hunger.
- Climate Change
  - To adapt to changing environments and sustain economic vitality; and to take advantage of emerging mitigation technologies.
- Sustainable Energy and Bio-based Products
  - To develop biomass (forestry and crops) used for biofuels, bioenergy production, and value-added bio-based products.
- Nutrition and Childhood Obesity
  - To ensure nutritious foods affordable and available; and to provide guidance for health and well-being decision making.
- Food Safety
  - To reduce the incidence of food-borne illness, provide a safer food supply and develop food processing technologies to ensure food safety.

History - National Nanotechnology Initiative (NNI)



* Note that USDA/CSREES has now been renamed National Institute of Food and Agriculture (NIFA). Also, USDA/ARS joined the NNI in 2012, bringing the number of participating agencies to 26.

NIFA Nanotechnology Priorities

- Overarching principle: to advance nanoscale science, engineering, and technology R&D, education and outreach to address a broad range of grand societal challenges and opportunities facing agriculture and food systems
  - Discovery and characterization of nanoscale phenomena and processes important to agricultural production species;
  - Novel uses and high-value-added products of nano-biomaterials of agricultural origins for food and non-food applications (biobased products and bioenergy);
  - Improvement of the nutritional quality of food and feed;
  - *Early detection and effective intervention technologies for ensuring food safety and biosecurity;*
  - *Nanoscale-based sensing mechanisms and devices for reliable and rapid detection of diseases and monitoring of physiological biomarkers for optimal agricultural production;*
  - *Precision agriculture technologies, including ones to efficiently manage applications of agricultural chemicals and water resources, including water quality improvements;*
  - Better understanding of relevant environment, health, and safety (EHS) implications;
  - Education and extension.

The NNI Supplement to the President's FY 2014 Budget, NSTC

Some of NIFA Funding Sources

http://nifa.usda.gov/business/business.html

- Competitive Grants
  - Agriculture and Food Research Initiative (AFRI)
  - SBIR
  - High Education
- Formula Funds
  - Multistate research committee – NC1194

NC1194: Nanotechnology and Biosensors

Objectives:

1.Develop new technologies for characterizing fundamental nanoscale processes

2.Construct and characterize self-assembled nanostructures

3.Develop devices and systems incorporating microfabrication and nanotechnology

4.Develop a framework for economic, environmental and health risk assessment for nanotechnologies applied to food, agriculture and biological systems

5.Produce education and outreach materials on nanofabrication, sensing, systems integration and application risk assessment

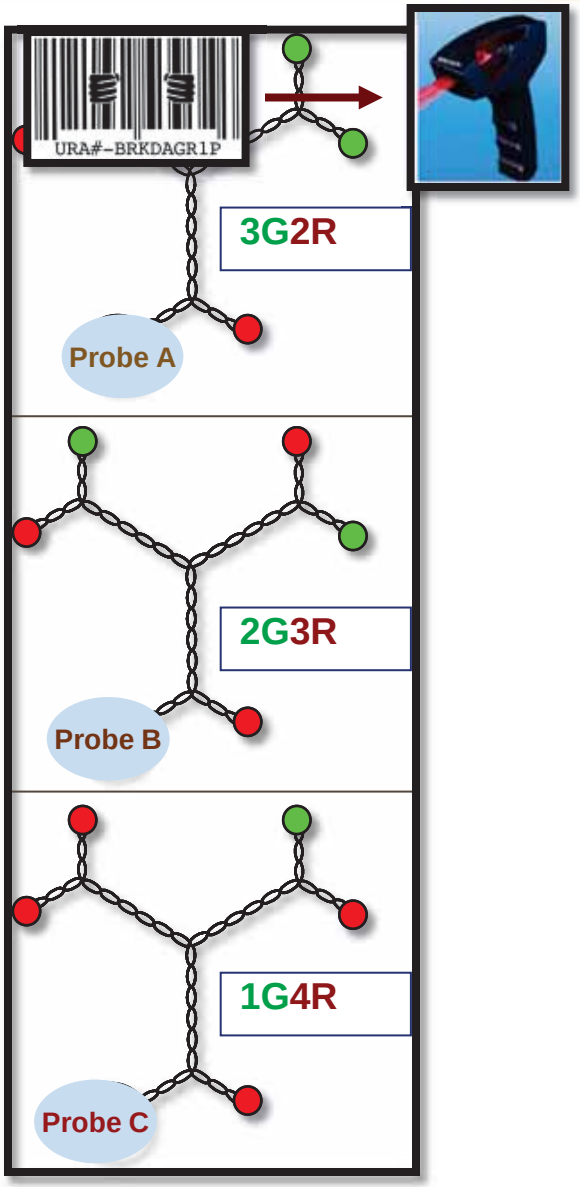
Participating States/Institutions:

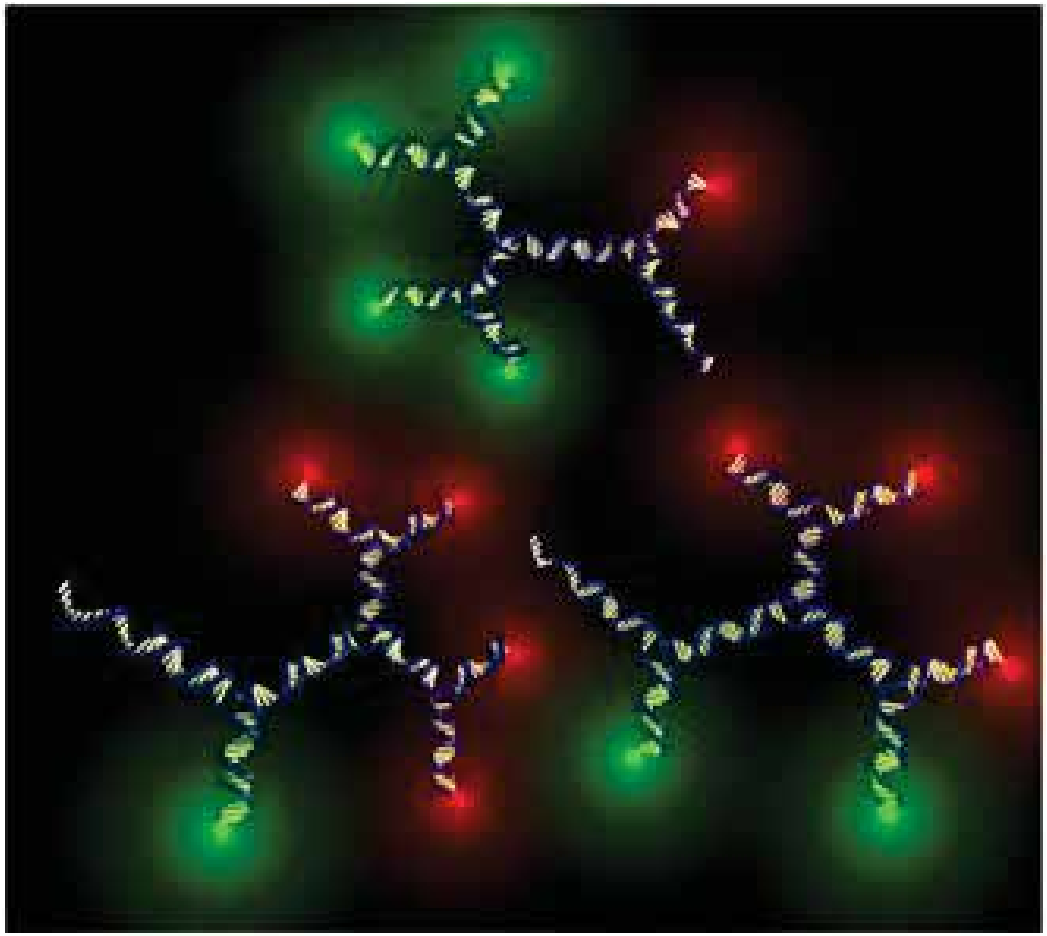
AL, AZ, FL, HI, IL, IN, IA, KY, LA, MD, MI, MN, MO, NJ, NC, ND, SC, TN

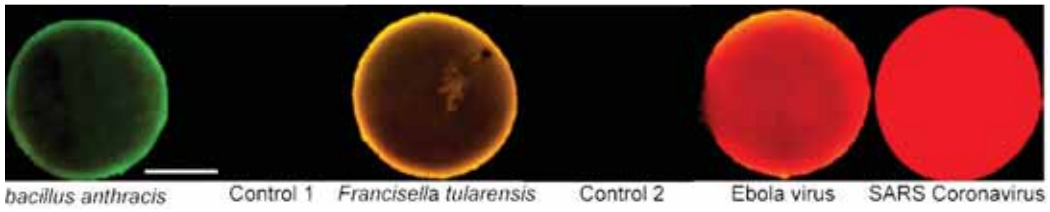
1. Food Safety

DNA Nano-barcodes: Multiplexed Pathogen Detections

detecting different color ratios rather than different colors







***Nature Biotech*, 23,** 885-889, (2005); ***Nature Protocols,* 1,** 995-1000 (2006)

molbel

2. Animal (zoonotic) Disease

Global distribution of H5N1 HA clades

- H5N1 progenitors (closest to gs/Guangdong/1/96) designated as Clade 0
- New clade designations based on phylogenetic tree topology derived from a large tree constructed with 884 sequences.
- This is based on the information provided by H5N1 Evolution Working Group including World Health Organization (WHO), World Animal Health Organization (OIE) and the Food and Agriculture Organization (FAO).

Avian Influenza Biosensor

Novel concepts for the biosensor:

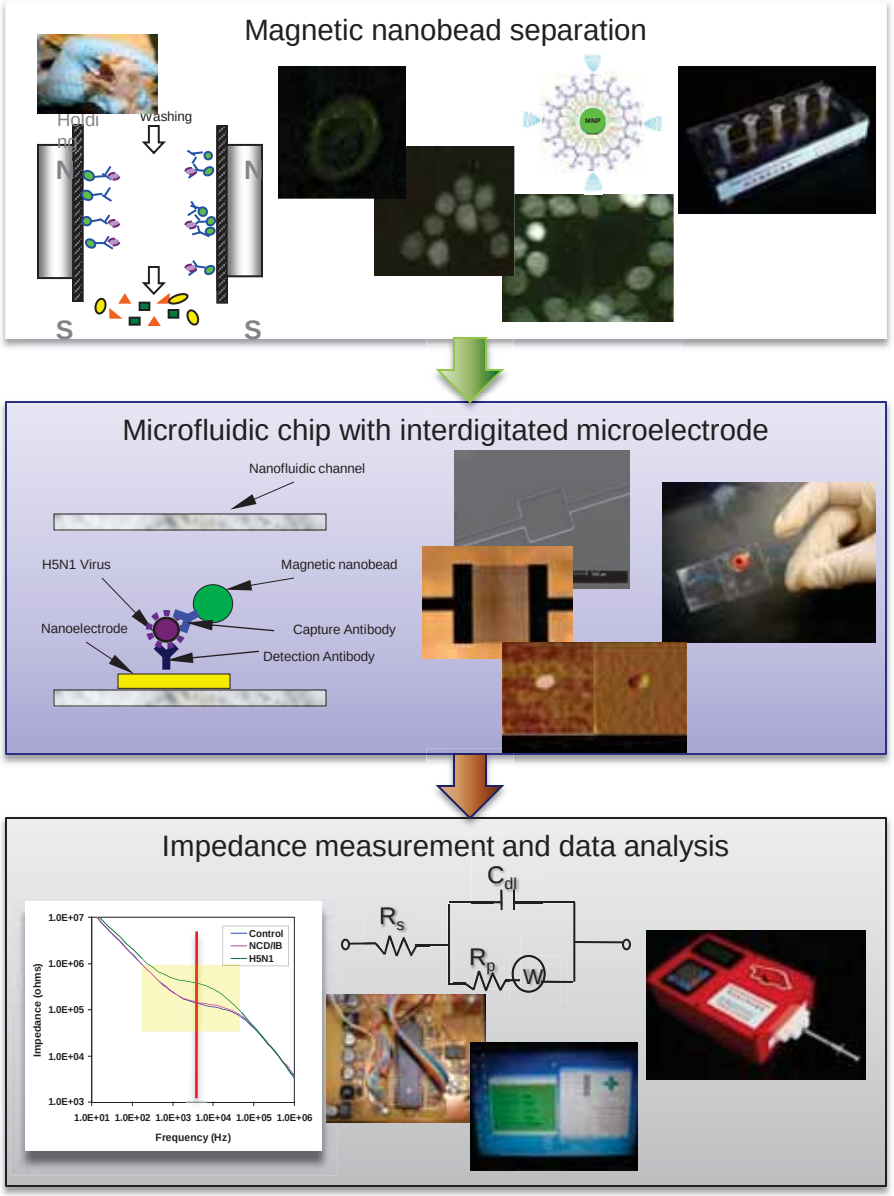
- Magnetic nanobeads (coated with anti-H5 antibody) based sample pretreatment for highly efficient capture and separation of target AI virus
- Micro/nanofluidic chips based sample control for high ratio of surface area/volume with accurate, small volume of sample
- Interdigitated micro/nanoelectrode (immobilized with anti-N1 antibody) based impedance measurement for sensitive, specific detection of AI virus

Design the biosensor prototype:

- The hardware: biosensor instrument can be either stand-along or connected to a laptop.
- The software: easy way to control the biosensor and to collect and analyze the data.

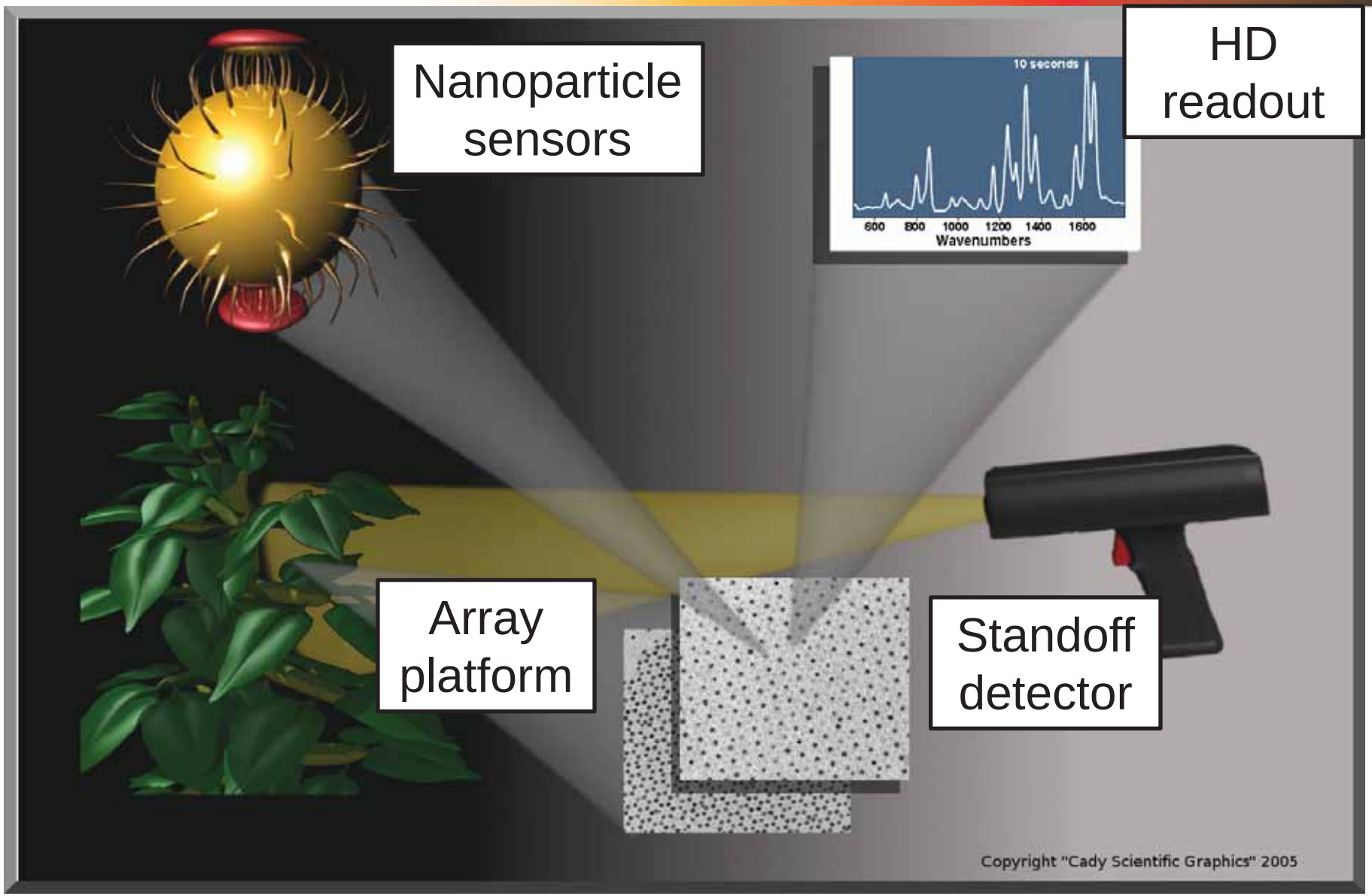
Advantages

- Rapid
- Portable
- Cost-effective
- Reusable
- Easy to operate
- Quantitative
- Multiple uses



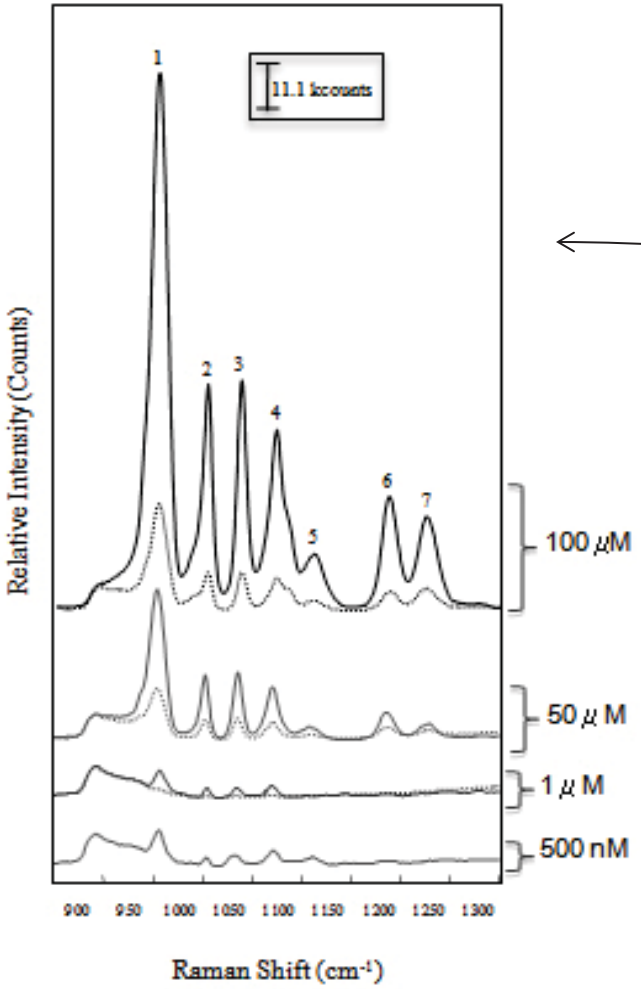
Y. Li, U. Arkansas

3. Crop Stresses

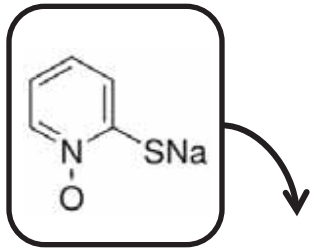


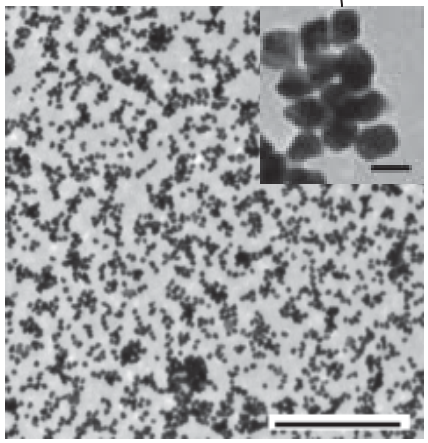
Distributed Sensors, Batt, Cornell University, 2009

SERS signal from arrayed NPs



2-mercaptopyridine

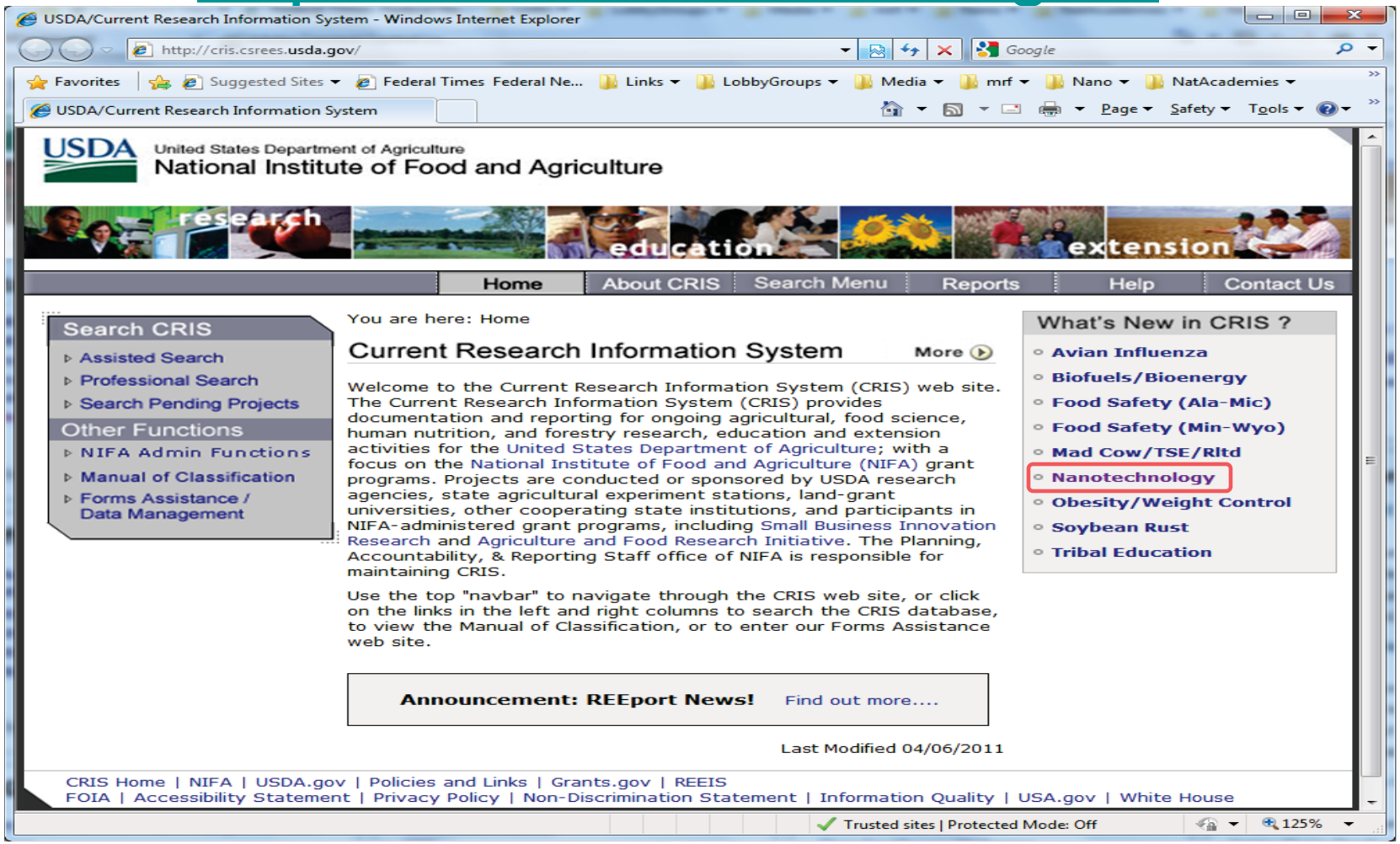




Distributed Sensors, Batt, Cornell University, 2009

Nanotechnology Projects funded by NIFA

http://cris.csrees.usda.gov/



T h a n k y o u !

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