

Research Community for Nanotechnology Convergence



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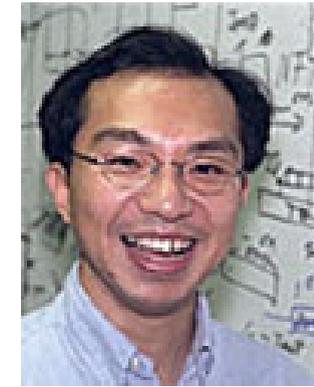
Kevin Walsh
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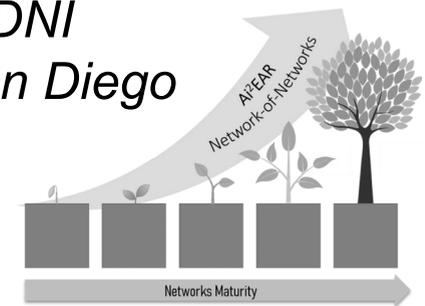
Katya Bogomoletc
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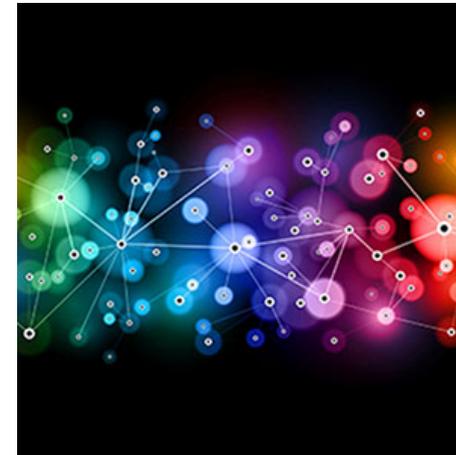
Yuhwa Lo
SDNI
UC San Diego



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In 2018, **Growing Convergence Research** became an NSF “Big Idea”



NSF'S 10 BIG IDEAS

The grand challenges of today—protecting **human health**; understanding the **food, energy, water** nexus; exploring the **universe** at all scales -- will not be solved by one discipline alone. They require **convergence: the merging of ideas, approaches and technologies from widely diverse fields of knowledge** to stimulate innovation and discovery.

Growing Convergence Research

NSF DEFINITION OF CONVERGENCE RESEARCH

1. Research Driven by a Specific and Compelling Problem
2. Deep Integration Across Disciplines



Growing Convergence Research (GCR)

PROGRAM SOLICITATION NSF 19-551



National Science Foundation

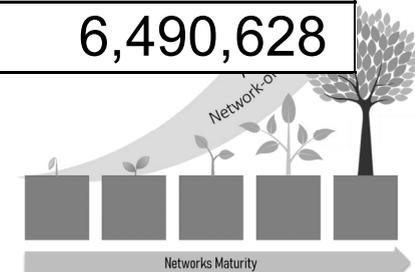
Full Proposal Deadline(s)

May 08, 2019

February 03, 2020

NSF-wide award search for “convergence research”

Start Year	Awarded to Date
2011	\$ 1,750,000
2012	\$ -
2013	\$ -
2014	\$ -
2015	\$ -
2016	\$ 5,400
2017	\$ 763,257
2018	\$ 29,284,513
2019	\$ 68,887,875
2020	\$ 41,811,068
2021	\$ 72,118,139
2022	\$ 6,490,628

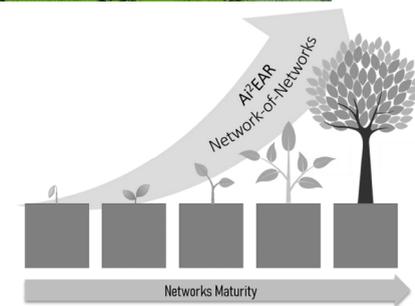


Ripe Applications for Convergence Research

- Micro- and Nanoplastics in the Environment
- Work Beyond Mass Production
- Affordable and Universal Access to Clean Water
- Per- and polyfluoroalkyl substances (PFASs)
- Phosphorus and nitrogen pollution in water resources



Images from <https://avadaenvironmental.com/2019/04/18/microplastics/>,
<http://www.waterencyclopedia.com/Da-En/Desert-Hydrology.html>,
<https://www.conserve-energy-future.com/causes-effects-and-solutions-to-eutrophication.php>

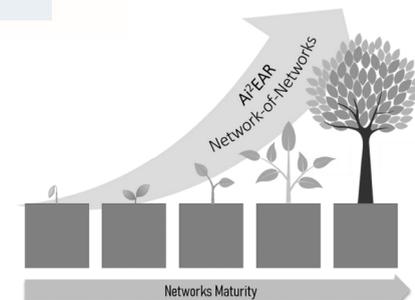


Ripe Applications for Convergence Research

Convergence brings together the ***right people*** at the ***right time***, the ***right place***, and on the ***right topic***.
 For example, disciplines in Phosphorus/Nitrogen Pollution span 17 orders of magnitude in length scale!



Image is derivative of Jones, Yingling, Reaney, and Westerhoff, <https://doi.org/10.1557/mrs.2020.4>

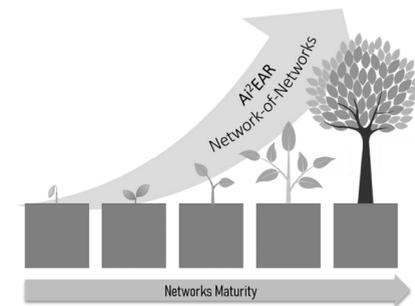


What we DON'T know about Convergence Research



“It should be noted that given the newness of the Convergence Research literature, most of our references are to the antecedents of Convergence Research.”

This means that we still have a lot to learn!

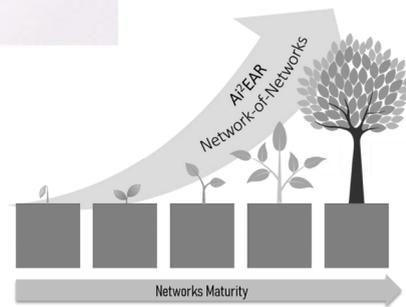
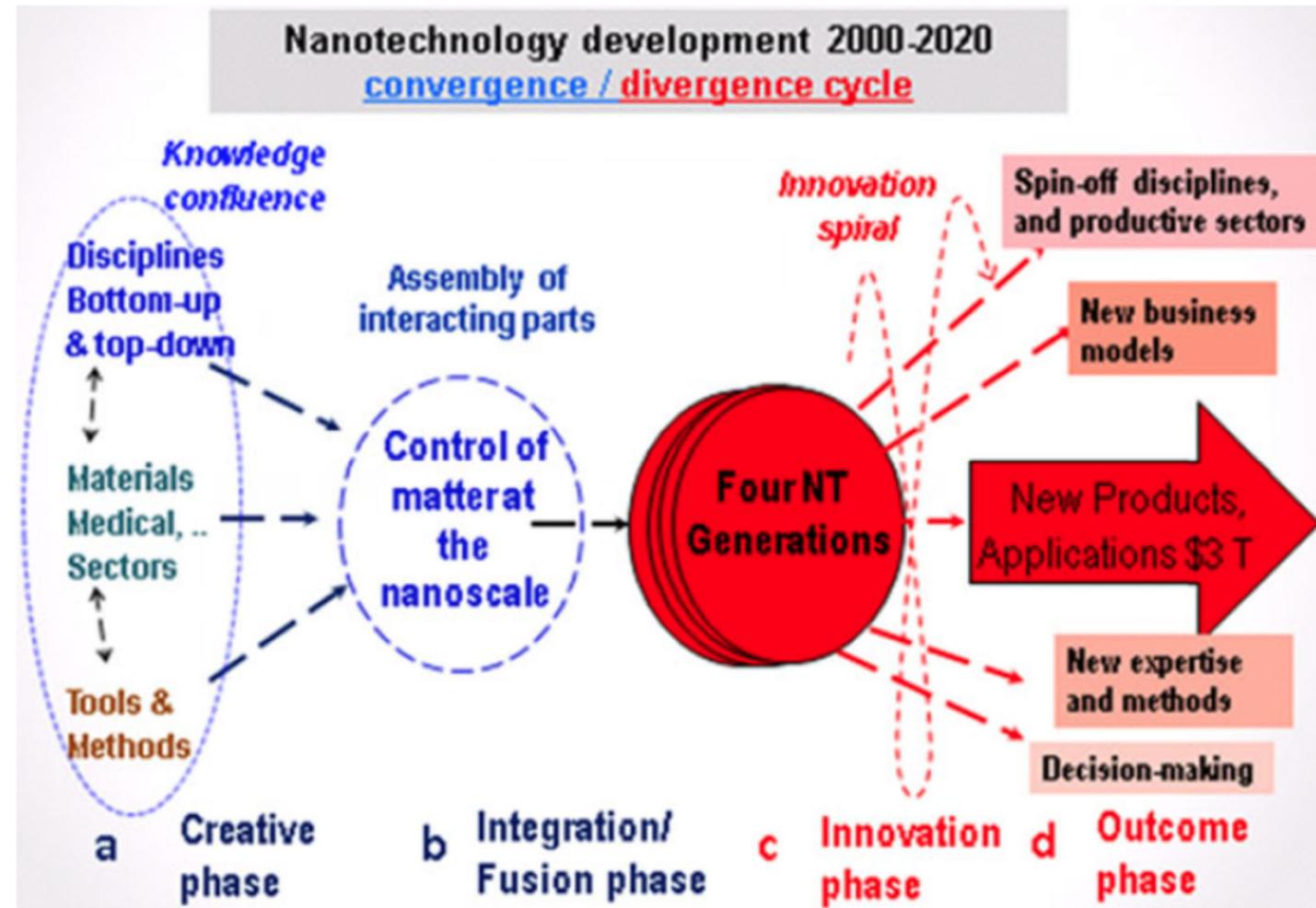


What we DO know about Convergence Research

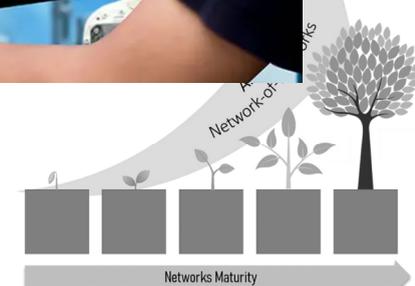
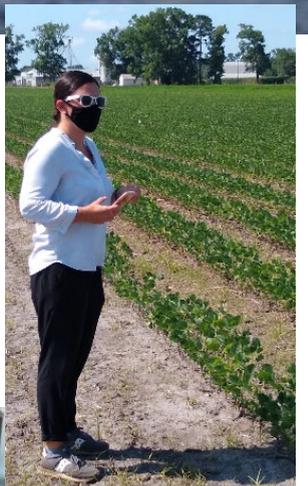
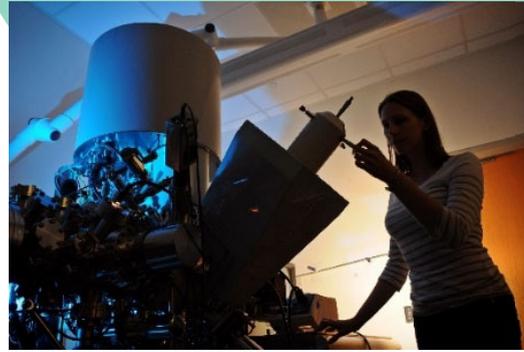
It worked for Nanotechnology!

2000-2020 convergence-divergence cycle for global nanotechnology development

Roco and Bainbridge, J. Nanoparticle Research, 15, 1946 (2013)



Research Community for Nanotechnology Convergence

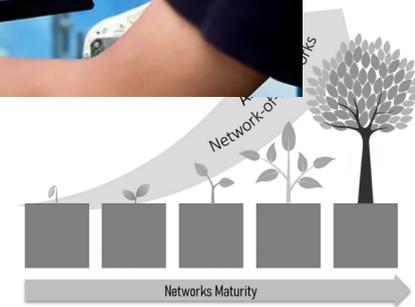
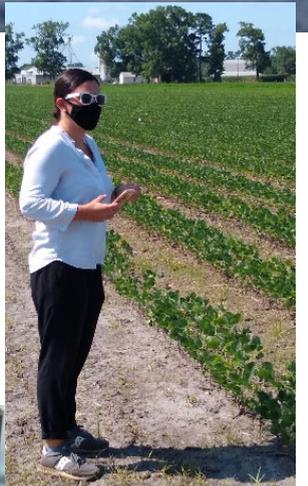


Research Community for Nanotechnology Convergence

Nanotechnology facilities of the future will play central roles in tackling **WICKED** and **GLOBAL** challenges that require convergence approaches and, in many cases, shared facilities may require MAJOR ADAPTATION to facilitate convergence

The R.C. **GOAL** is to bring together researchers and staff from diverse disciplines and perspectives, facilitate their collaboration, and work toward a common vision and **PUBLIC REPORT for the future design and role of university open-access facilities in SPECIFIC research areas**

The Research Community topic is **DYNAMIC** and focuses on new convergence research areas annually



2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

The **PANDEMIC** made food & nutrition security much more obvious to many

Ongoing **SUPPLY CHAIN** issues continue to reinforce the importance

March 16, 2020, during start of global pandemic.
Photo taken by presenter.



November 2, 2021 (yesterday)

 CNN

China is urging families to stock up on food as supply challenges multiply

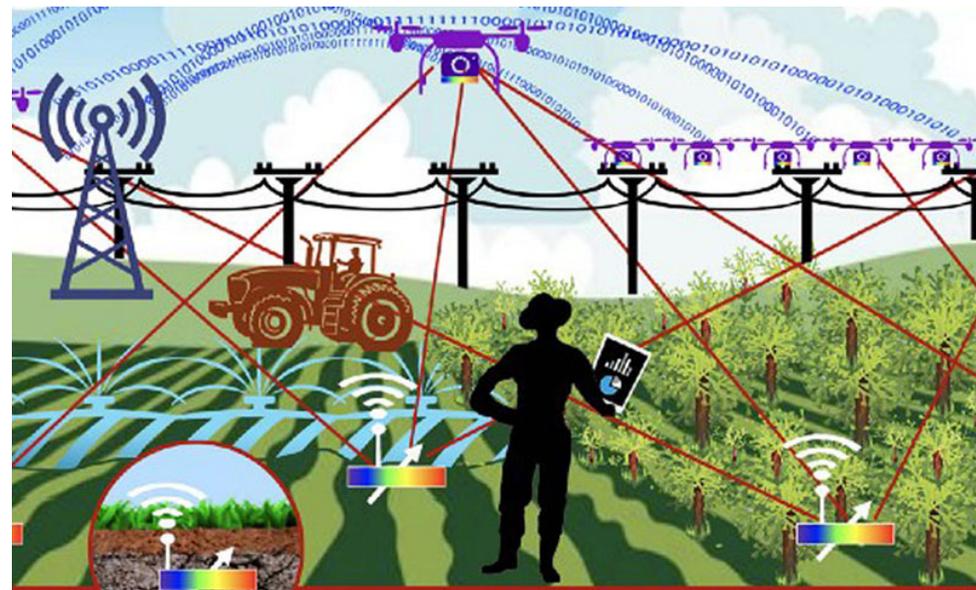
... people to stockpile "daily necessities," including vegetables, ... China has stressed the importance of shoring up food and other daily...



2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

Topic **TIMELY** relative to new ERCs and STCs:

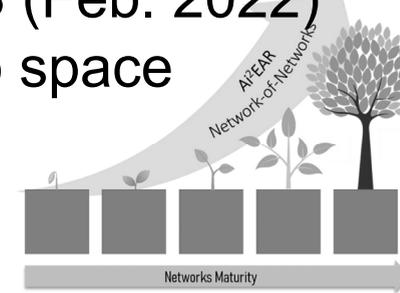
NSF ERC for the **Internet of Things for Precision Agriculture (IoT4Ag)**,
UPenn



NSF STC on **Science and Technologies for Phosphorus Sustainability (STEPS)**,
NC State, ASU, and JSNN



STEPS HQ to be housed in the new PSB (Feb. 2022)
with ~3,000 sq. ft. intersectional lab space



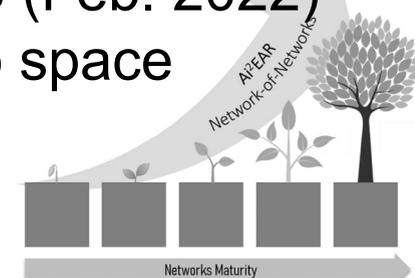
2021: Convergence in Nanotechnology for FOOD & NUTRITION SECURITY

Topic **TIMELY** relative to new ERCs and STCs:

NSF STC on **Science and Technologies for Phosphorus Sustainability (STEPS)**, NC State, ASU, and JSNN



STEPS HQ to be housed in the new PSB (Feb. 2022) with ~3,000 sq. ft. intersectional lab space



March 9, 2021 Event Bringing Stakeholders Together

How can open-access university facilities best support food and nutrition security?

Help Guide Future Efforts by Participating in a Half-Day NNCI Workshop

March 9, 2021
10 am – 2 pm (Eastern)

Learn more at go.ncsu.edu/nano-food-security

PLENARY SPEAKERS



Prof. Antje Bäumner
University of Regensburg
Can distributed nanotechnology as evidenced in new sensor developments enable the advancements required for a sustainable farm-to-fork process?

Dr. Hongda Chen
USDA
Opportunities and challenges of nanotechnology towards sustainable food and nutrition security



NANOTECHNOLOGY-FOCUSED BREAKOUT SESSIONS

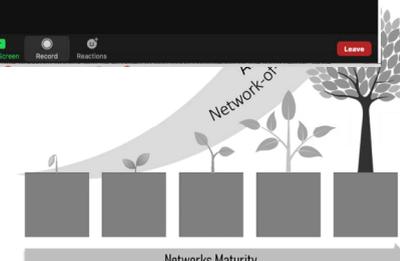
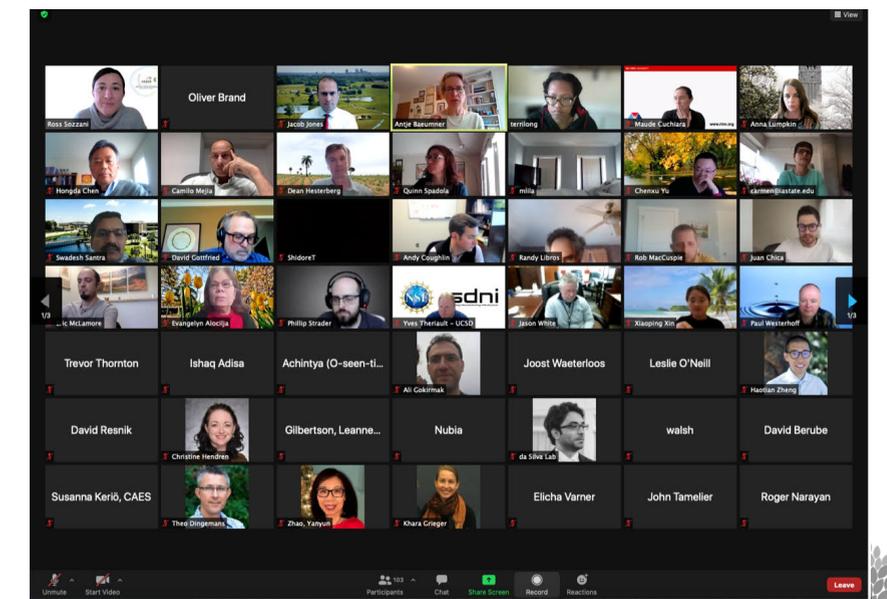
Precision agriculture	Sensors	Enhanced food	Pest management	Packaging
Water treatment	Nutrient management	Animal disease	Climate-change-resilient food	And more!

OUTCOMES

A workshop report with findings from the breakout groups will be broadly disseminated to inform and guide future open-access facility efforts and research.

Two headline speakers to draw in participation
IRB approval to record transcripts of breakout rooms for research purposes
~150 registrants: academics, industrial representatives, government agency employees, NGOs, various partners and stakeholders including consortia, policy fellows and directors, etc.

>100 participants



March 9, 2021 Event Bringing Stakeholders Together

Four topical breakout rooms using pollev to stimulate discussion:

Room 1: Water and Fertilizer

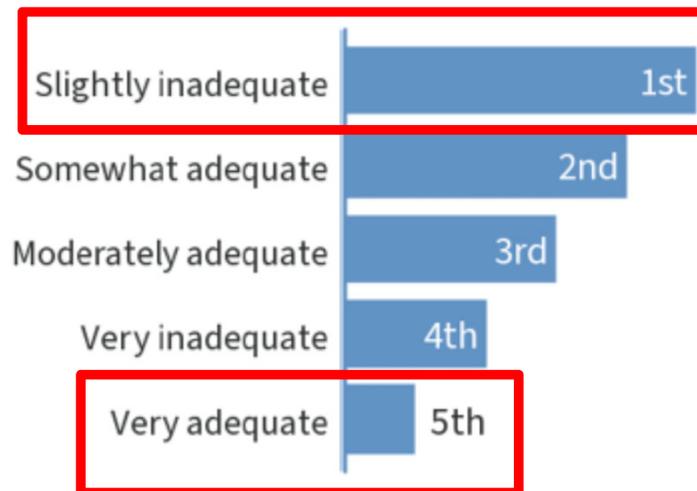
Room 2: Crops and Animals

Room 3: Pests and Pathogens

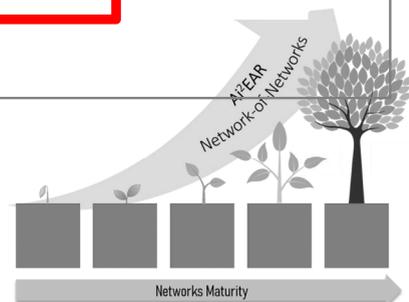
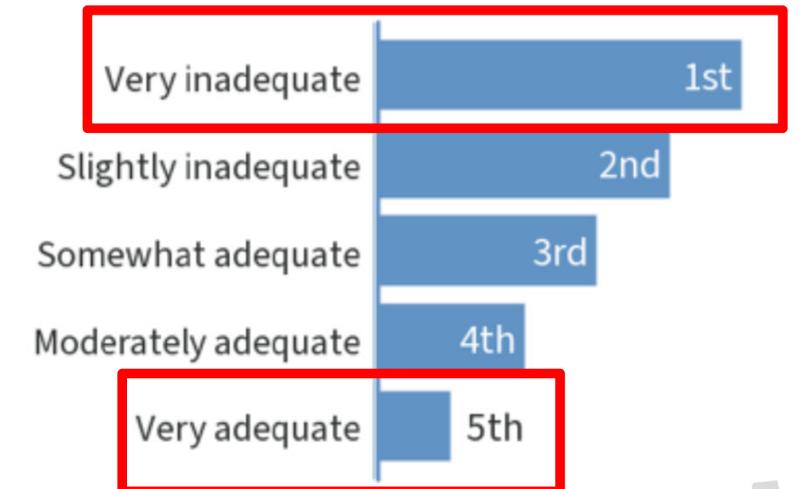
Room 4: Food Products

Example Pollev Questions for Room 4

Are the CURRENT shared instrumentation and facilities (including field sites, research greenhouses, pilot plants, etc.) adequate to support TODAY'S needs in food products?



Are the CURRENT shared instrumentation and facilities (including field sites, research greenhouses, pilot plants, etc.) adequate to support FUTURE needs in food products?



March 9, 2021 Event Bringing Stakeholders Together

Four topical breakout rooms using pollev to stimulate discussion:

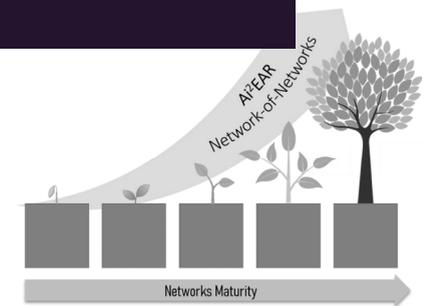
Room 1: Water and Fertilizer

Room 2: Crops and Animals

Room 3: Pests and Pathogens

Room 4: Food Products

*Wordle showing relative frequency of various words and phrases used in Room 1 –
Used to farm codes for content analysis*



Organizers' Take-Away #1:

NNCI Could Accelerate Reaching Non-Traditional Disciplines

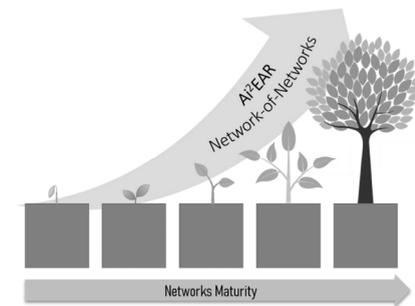
For some attendees, this was the **first-ever invitation** to provide input to a shared facility

May require a **shift in promotional strategies**, e.g. on serving certain research areas instead of organizing ourselves by specific tools or capabilities

“**Concierge**” **mechanism** was suggested to effectively liaison with specific non-traditional research communities, e.g. as a staff member or communications specialist

NNCI was encouraged to consider how to diversify **disciplinary expertise of facility staff**, e.g. through hiring practices or offering professional development opportunities to existing staff members to expand into new areas

NNCI was encouraged to **engage stakeholders from non-traditional areas in future planning**, e.g. advisory boards, steering committees or the Research Communities themselves



Organizers' Take-Away #2:

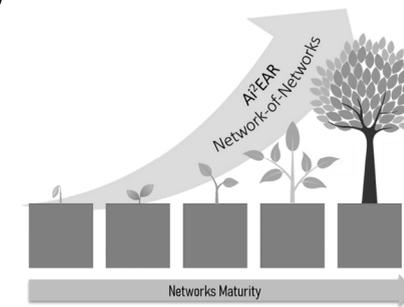
NNCI Could “Go Outside” & Work With Messy Matrices

Analytical capabilities are needed **“in the field”**, i.e. on farms, greenhouses, air outdoors, etc. for real-time measurements in dynamic environments (in contrast to bringing samples to NNCI labs)

New tools and techniques could increase **compatibility with the following unusual or messy matrices:**

- Air
- Soft tissue including living plant roots
- Soils
- Water

“Higher-hanging fruit” would be **on-site nanofabrication in the field**, e.g. for sensors or functional materials that interact with *specific environments* in intentional ways



Ongoing Work and Activities

Social Science Research: Interviews with experts

Publication: We will publish a report on future needs in nanotechnology to support food and nutrition security.

Topics Supported Moving Forward:

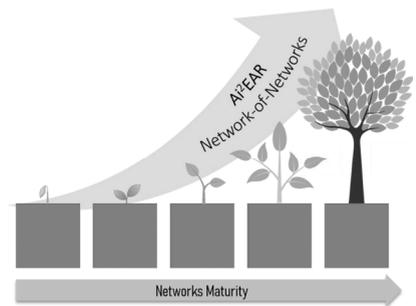
Food and Nutrition Security continues into 2022

Considering/vetting new topics to start in 2022

- Convergence of Additive Manufacturing with Nanotechnology
- We welcome additional suggestions!



August 9-10, 2022 in Louisville, KY



Convergence Research Seminar TOMORROW



STEPS

Science and Technologies for Phosphorus Sustainability

STEPS Monthly Seminar is open to our NNCI colleagues and friends.

THIS THURSDAY (1 PM EDT):

Pramod Khargonekar

“On Convergence Research”

Contact Maude Cuchiara for Zoom link:
maude_cuchiara@ncsu.edu

STEPS SEMINAR SPEAKER

Thursday, Nov. 4
1 PM Eastern Time

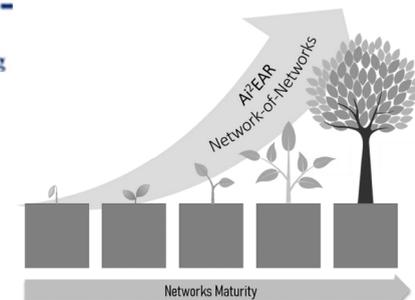
Currently:

UC Irvine
Vice Chancellor of Research
Distinguished Professor

Formerly:

2001-2009 Univ. Florida Dean of Engineering
2012-2013 Deputy Director of Technology at ARPA-E, U.S. DOE
2013-2016 NSF Assistant Director for the Directorate of Engineering
- led the ENG with an annual budget of more than \$950 million
- **helped spearhead Convergence Research paradigm at NSF**

Pramod Khargonekar



Thanks to the team for your contributions!

NNCI Organizing Team: Maude Cuchiara, Jacob Jones, Ross Sozzani, David Berube, Katya Bogomoletc, Kevin Walsh, Trevor Thornton, Paul Westerhoff, Yuhwa Lo, Yves Theriault

Event Speakers: Antje Bäumner and Hongda Chen

Event Moderators: Paul Westerhoff, Greg Lowry, Ross Sozzani, Dean Hesterberg, Jason White, Carmen Gomes, Yves Theriault, Leanne Gilbertson, Eric McLamore, Mary Ann Lila, and Owen Duckworth

Event Technology Support: Anna Lumpkin, Toby Tung, Phillip Strader, Maude Cuchiara, Katya Bogomoletc, George Martell

Event Notetakers: Trevor Thornton, Alex Lin, Catherine McKenas, Ana Sanchez, Ahmed Darwish, Gabby Barajas, Rachel Peters, Mariah Gobble

