University of Missouri

Convergence Science, Innovation, and Policy: National Food Security and Innovation (NAFSI) Hub

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Disclosures

Founder of SENS-D LLC that is in early stages with no IP transferred, employees, or funding.

Funding

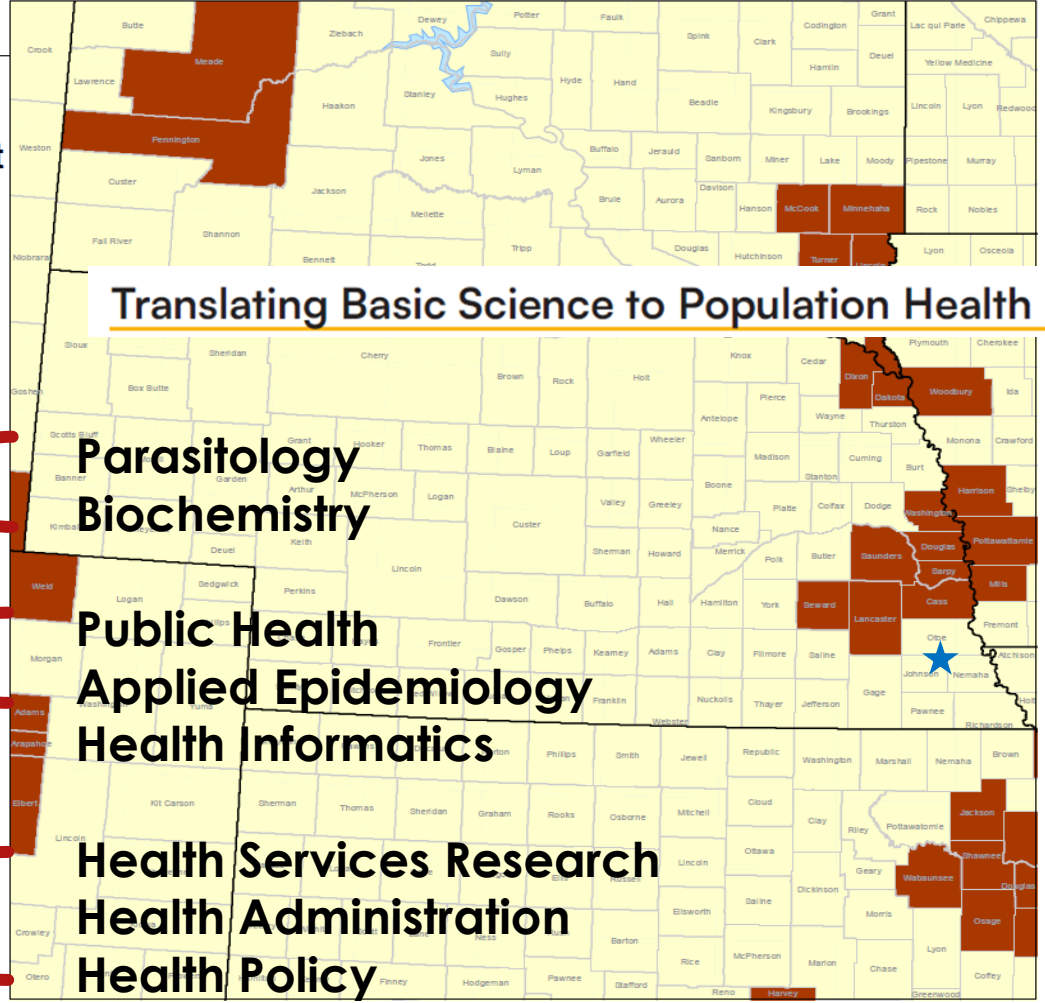
National Science Foundation
Directorate for Technology, Innovation and Partnerships

AWS Social Impact Program

Nebraska

Rural definition based on Office of Management and Budget (OMB) metro counties

Rural: Nonmetro county
Urban: OMB metro county



Basic Sciences-Cellular-level

Population-level

System- & Organization-level

For more information on definitions, see documentation

Biomedical Sciences, Epidemiology, and Public Health

- Courses
  - Microbiology
  - Genetics
  - Human Anatomy
  - Human Physiology
  - Global Health and Social Justice
  - Global Public Health & Health Care Systems
  - Global Health Care Systems
  - Contemporary Health Issues
  - HITs in the United States Health Care System- Chinese Scholars
  - Operational Research to Medical Students in India

Rural Health

Patient-Level Challenges

Environmental & occupational exposures (agriculture, livestock, wildlife)

Limited access to clean water and nutritious foods

Transportation barriers and long travel distances

Lower income, higher unemployment, and lower insurance coverage

Higher burden of chronic disease and multiple co-morbidities

Limited access to specialists and preventive care

Delayed care due to uncertainty about when to seek treatment

Provider & System-Level Challenges

High costs of technology and infrastructure

Lower reimbursement and higher uncompensated care

More complex, expensive case mix

Workforce shortages, high turnover, and retention challenges

Limited broadband access and lower digital literacy

Location matters!

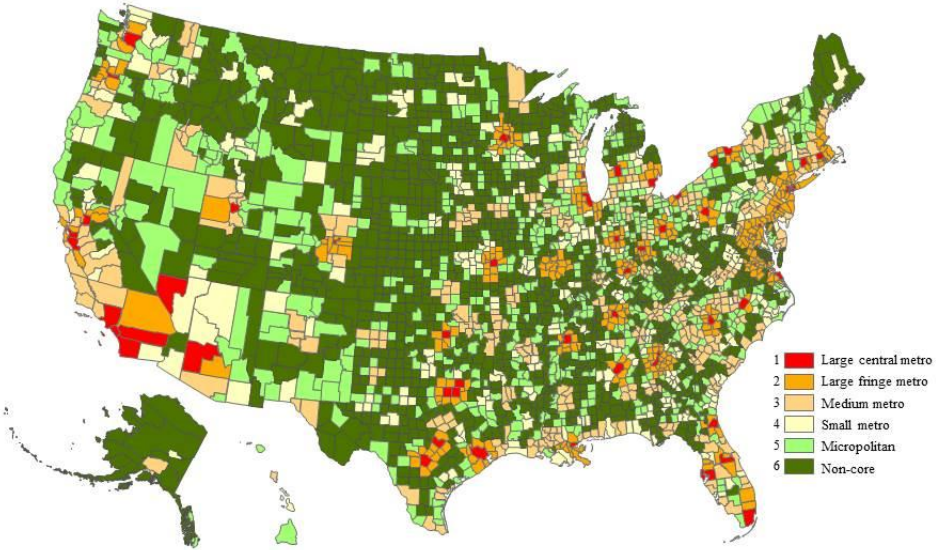
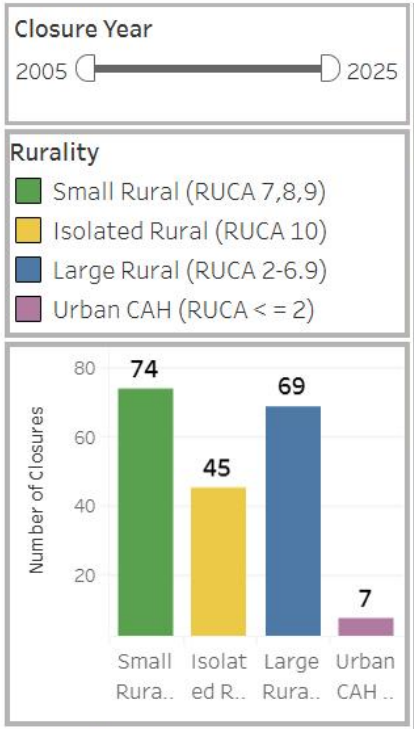
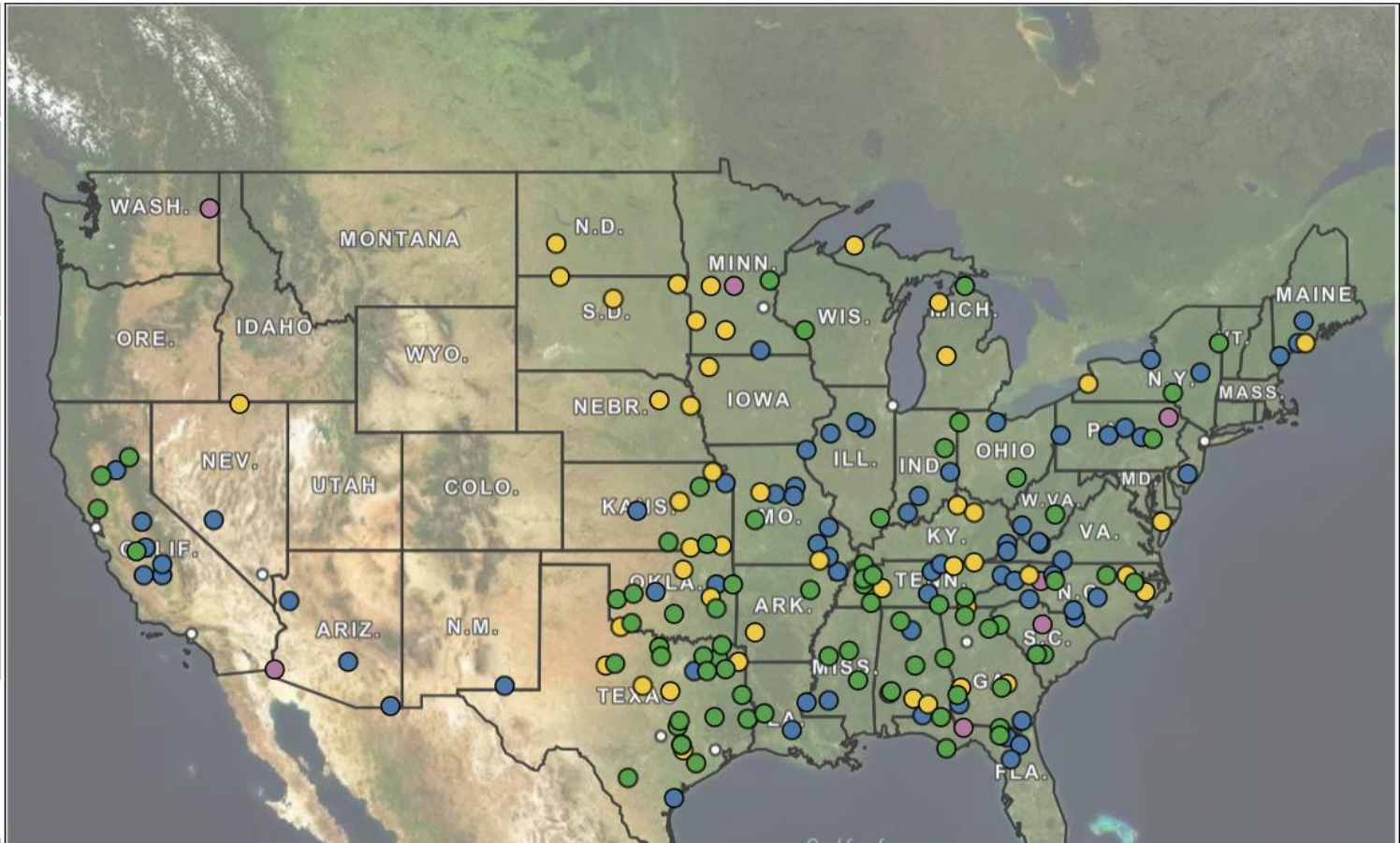


Image from: National Center for Health Statistics, Urban-Rural Classification Scheme for Counties. https://www.cdc.gov/nchs/data_access/urban_rural.htm

Data Sources: Rural Health Information Hub; Kaiser Family Foundation State Health Facts; U.S. Census Bureau QuickFacts; USDA Economic Research Service: State Fact Sheet

~~195~~
~~163~~ Rural Hospital Closures: January 2005 – Present (152 since 2010)

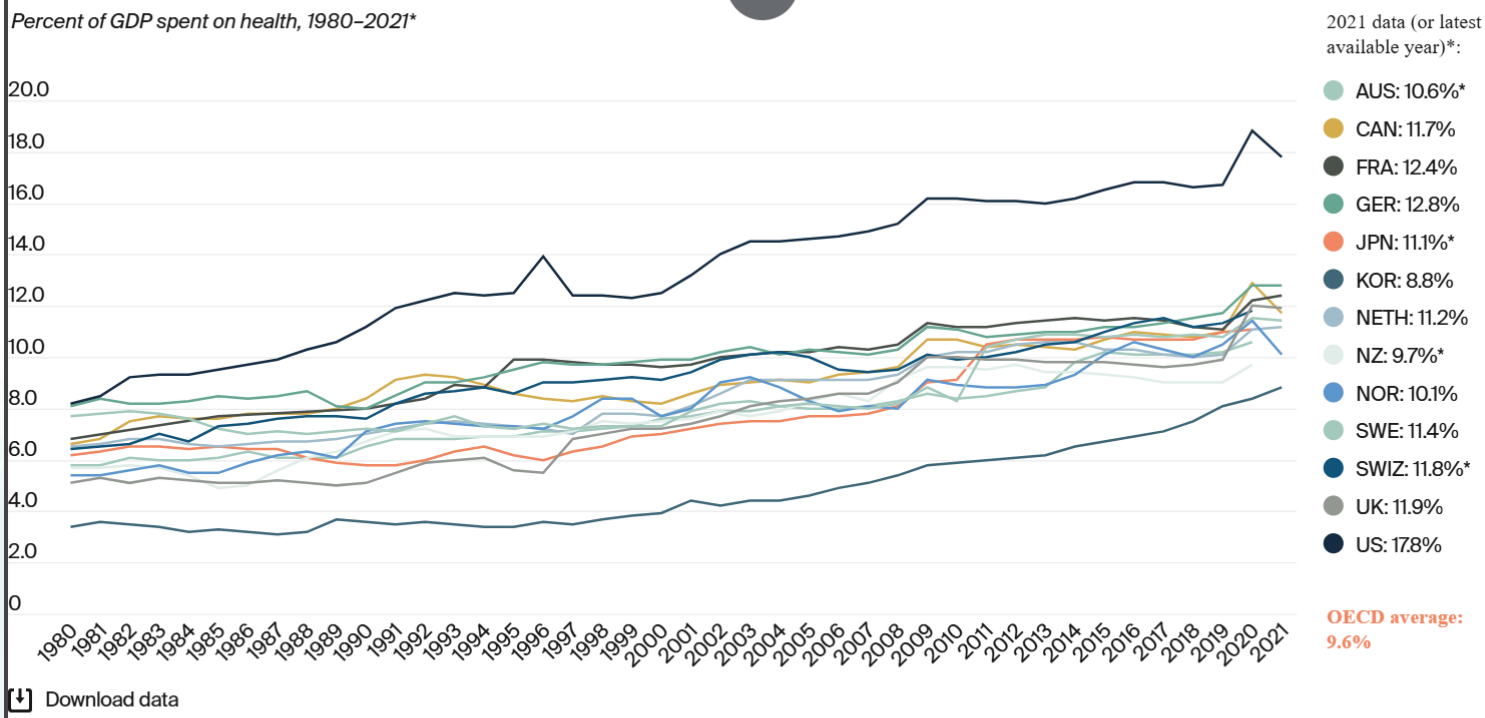




NC RHRP
NC Rural Health Research Program

UNC
THE CECIL G. SHEPS CENTER FOR HEALTH SERVICES RESEARCH

The U.S. is a world outlier when it comes to health care spending.



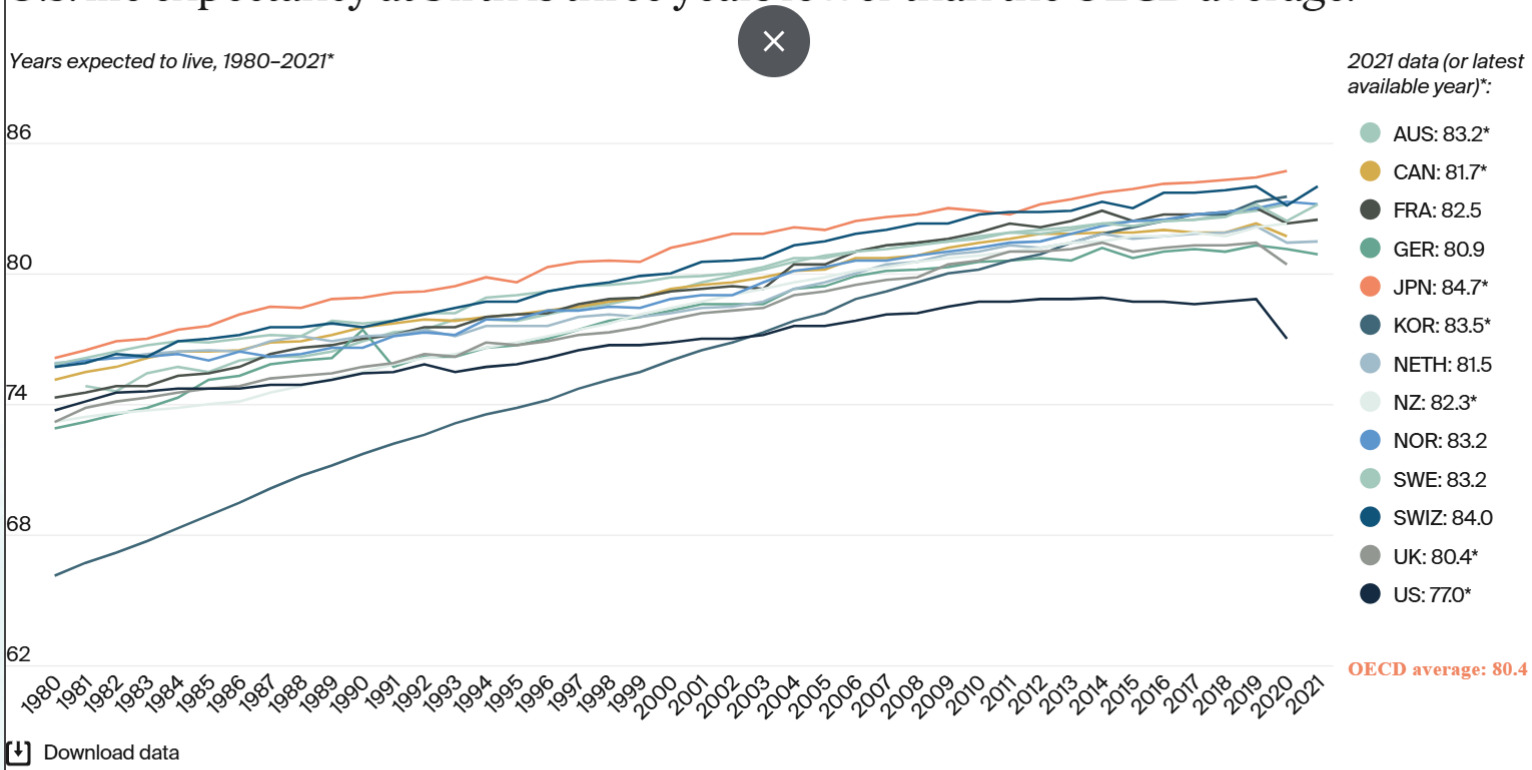
Download data

Notes: * 2020 data. Current expenditures on health for all functions by all providers for all financing schemes. Data points reflect share of gross domestic product. Based on System of Health Accounts methodology, with some differences between country methodologies. GDP = gross domestic product. OECD average reflects the average of 38 OECD member countries, including ones not shown here.

Data: OECD Health Statistics 2022.

Source: Munira Z. Gunja, Evan D. Gumas, and Reginald D. Williams II, *U.S. Health Care from a Global Perspective, 2022: Accelerating Spending, Worsening Outcomes* (Commonwealth Fund, Jan. 2023). https://doi.org/10.26099/8ejy-yc74

U.S. life expectancy at birth is three years lower than the OECD average.



Download data

Note: * 2020 data. Total population at birth. OECD average reflects the average of 38 OECD member countries, including ones not shown here. Because of methodological differences, JPN and UK data points are estimates.

Data: OECD Health Statistics 2022.

Source: Munira Z. Gunja, Evan D. Gumas, and Reginald D. Williams II, *U.S. Health Care from a Global Perspective, 2022: Accelerating Spending, Worsening Outcomes* (Commonwealth Fund, Jan. 2023). https://doi.org/10.26099/8ejy-yc74

Health Care System Performance Rankings

	AUS	CAN	FRA	GER	NETH	NZ	SWE	SWIZ	UK	US
OVERALL RANKING	1	7	5	9	2	4	6	8	3	10
Access to Care	9	7	6	3	1	5	4	8	2	10
Care Process	5	4	7	9	3	1	10	6	8	2
Administrative Efficiency	2	5	4	8	6	3	7	10	1	9
Equity	1	7	6	2	3	8	–	4	5	9
Health Outcomes	1	4	5	9	7	3	6	2	8	10

Note: SWE overall ranking calculation does not include Equity domain. See "How We Conducted This Study" for more detail.

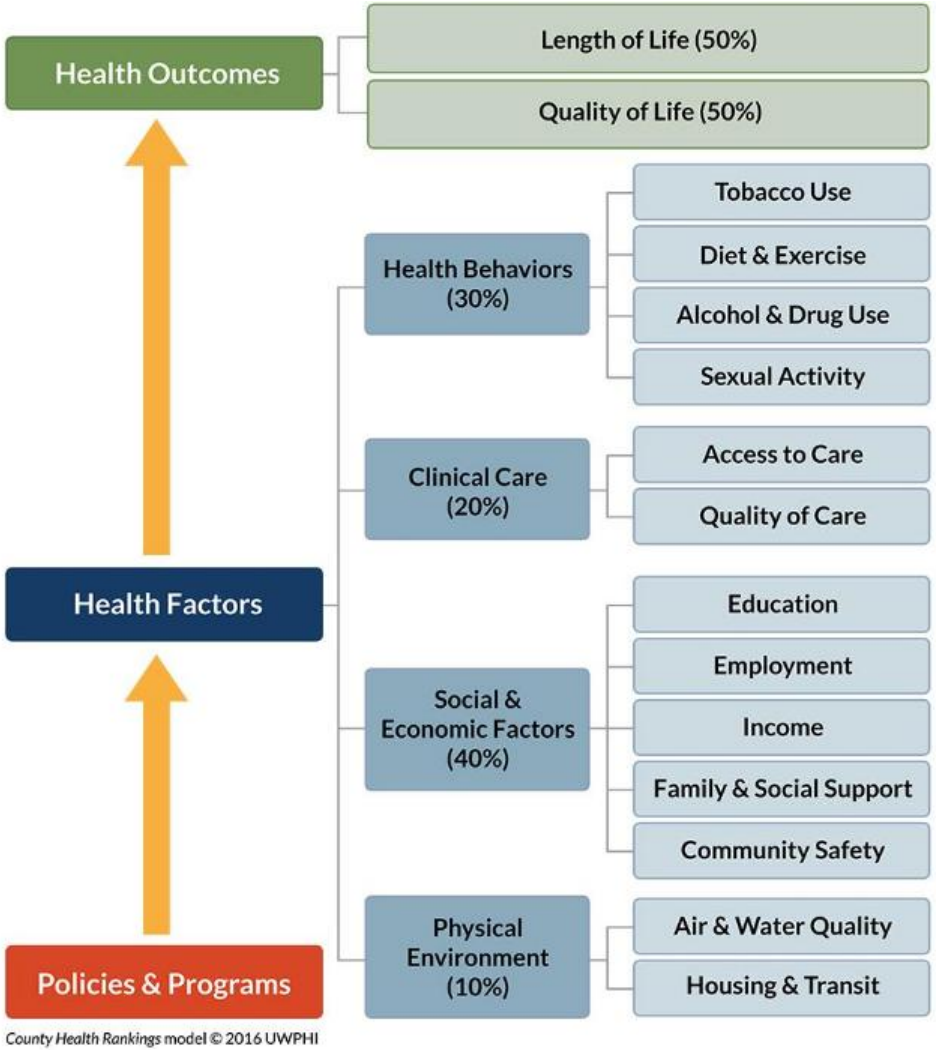
Data: Commonwealth Fund analysis.

Source: David Blumenthal et al., *Mirror, Mirror 2024: A Portrait of the Failing U.S. Health System — Comparing Performance in 10 Nations* (Commonwealth Fund, Sept. 2024). https://doi.org/10.26099/ta0g-zp66

Spend Less… Get More.

Build it from the ground up.

Implement from the top down.



PUBLIC HEALTH INFORMATICS:

SDoH into clinical healthcare

1. Medical care accounts for only 10-20% of modifiable contributors to healthy outcomes

2. Well-designed policies and programs have been associated with better outcomes

3. New payment and health care models that incorporate SDoH & Geospatial Sciences
   ***Difficult if they are not formally incorporate into EHR systems

Image from: County Health Rankings & Roadmaps | *Source: Reprinted with permission from County Health Rankings & Roadmaps, http://www.countyhealthrankings.org/our-approach.*

What role do we play in academia?

**Despite billions invested annually in health/biomedical research,
fewer than 15% of findings are implemented,
fewer than 5% improve population health,
and it takes an average of 17 years for evidence to reach practice.**

Critical need in translational infrastructure to accelerate scientific discovery.

(Morris, Z. S., Wooding, S., & Grant, J., 2011; Ioannidis, J. P. A., 2014; Butler, D., 2008)

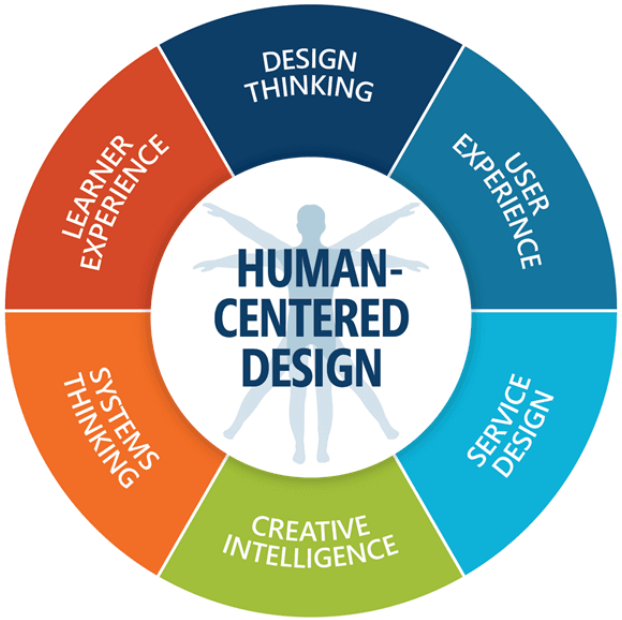
NSF News

NSF announces new initiative to launch and scale a new generation of transformative independent research organizations to advance breakthrough science

NSF invites feedback on its Tech Labs Initiative — a program designed to fund research teams outside of traditional academic institutions — through a request for information.

December 12, 2025

Human Centered Design & Use-Inspired Research



Are we solving the right problem?

Is it meaningful?

Is it useful?

Is it usable?

We must respond to real world challenges.

SENS-D

Rapid Detection Technologies And Decision-Support Systems For Safe, Accessible Food Systems

NSF's Convergence Accelerator

Grand Challenge

Salmonella infections have not declined.

In the US, *Salmonella* alone causes 1.35 million infections; 26,600 hospitalizations; with **$4.1 BILLION ECONOMIC IMPACT ANNUALLY**.

Annual Food Safety Incidents (US)

48M Illnesses | 128,000 Hospitalizations | 3,000 Deaths | $152B Cost | Vast Food Inequities

Why Have *Salmonella* Infections Not Declined?

Existing testing methods are time-consuming and costly

No end-to-end food supply chain solution

No integrated data environment

Timely Decisions

Informed Decisions

National Priority & Efforts

FSIS GOAL: REDUCE SALMONELLA INFECTIONS LINKED TO POULTRY PRODUCTS

HEALTHY PEOPLE 2030

↓25%

USDA United States Department of Agriculture

Roadmap to Reducing *Salmonella*, 2020

USDA Proposes Sweeping Changes to Poultry Production to Fight Salmonella Outbreaks

Analyzed comments with AI– under review.

The agency is proposing a regulatory framework that would include testing incoming flocks of chickens and turkeys for the bacterial disease

By David Pitt • Published October 14, 2022 • Updated on October 14, 2022 at 8:18 am

FILE - People working at a chicken factory

Trending Stories

PARENTING
Mom of 9 wanted her kids to eat healthy — so she installed a salad bar in her kitchen

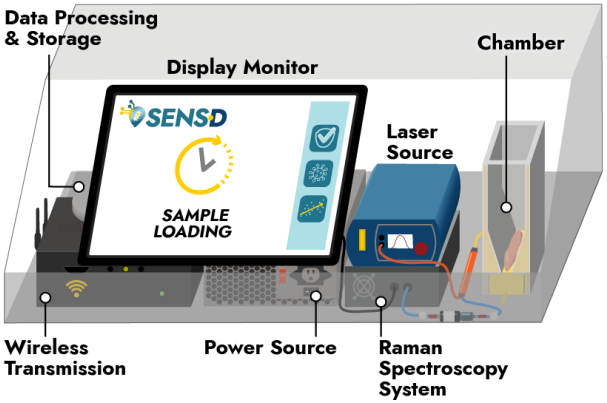
The biggest diamond in over a century is found in Botswana — a whopping 2,492 carats

SOUTHLAKE
Gateway Church fires pastor over vague 'moral failure'

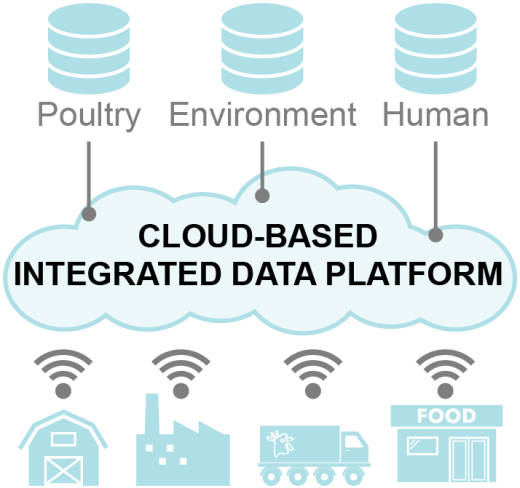
COLLIN COUNTY
Princeton community encouraged to attend meeting

What Does SENS-D Bring?

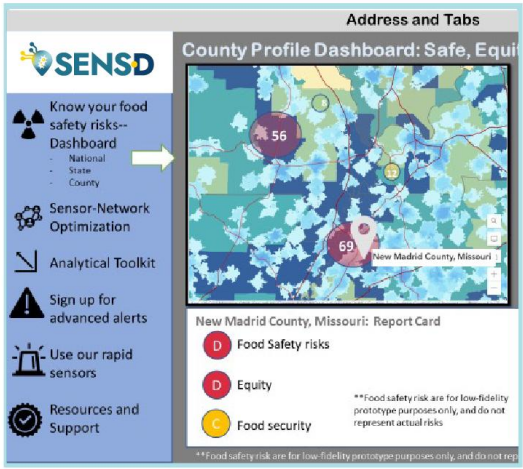
SENSORS & SENSING SYSTEM



ONE HEALTH DATA ENVIRONMENT



DECISION SUPPORT SYSTEM



LINCOLN University

AUBURN UNIVERSITY

UMSL University of Missouri–St. Louis

University of Missouri

UNIVERSITY OF NOTRE DAME

Targeted Market Segment

Current industry standard

24 hours to 5 days

Disconnected data across supply chain

SENS-D: Target Segment
Large Integrated Poultry

Product Loss & Waste | Company Reputation | Product Recall | Regulatory Compliance

Competitive Advantages

Our *Salmonella* Sensors

Rapid
10-60 minutes

Multiplex

Low Cost
$1-5 production per sensor

Portable

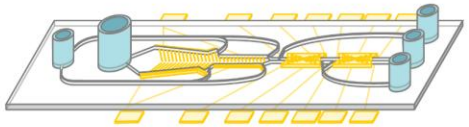
User-Friendly

Integrated
into One Health data

Fiber Optics SERS Sensor • Microfluidic Based Impedance Biosensor
Nanopore Checkpoint Sequencing Sensor

Technical Convergence

SENSOR FABRICATION
TESTING AND VALIDATION



POULTRY SCIENCE
FOOD SAFETY

EXTENSION

EXTENSION

ARTIFICIAL INTELLIGENCE
INFORMATION SYSTEMS

SUPPLY CHAIN
PUBLIC HEALTH
DATA ANALYTICS

Team Convergence

Rohl
Program Manager

SENSOR FABRICATION TESTING AND VALIDATION

Almasri
PI

Gu

CH Lin

Kinzel

Anderson

Anand

ARTIFICIAL INTELLIGENCE INFORMATION SYSTEMS

EXTENSION

Morey
Co-PI

Safranski
Co-PI

Fisher

Roberts

Speller-
Henderson

Trout
Co-PI

Li
Co-PI

EXTENSION

POULTRY SCIENCE FOOD SAFETY

Mustapha

Zhang

MS Lin

Hoang

Vought

Westhoff

SUPPLY CHAIN PUBLIC HEALTH DATA ANALYTICS

Committed Partners & Stakeholders

Industry

BUTTERBALL

Cargill

WAYNE FARMS SANDERSON
TOGETHER, WE MAKE CHICKEN AMAZING

save a lot

American Meat Science Association

LTI Trucking • Logistics Services

MANTARO
Product Development Services

Community Outreach

THE FOOD BANK FOR CENTRAL & NORTHEAST MISSOURI

Foodbank
St. Louis Area Foodbank

Operation Food Search
40 Years Of Healing Hunger

UNIVERSITY OF MISSOURI
MU Extension
Live. And Learn.

Data Contributors

CDC

ERS
ECONOMIC RESEARCH SERVICE
United States Department of Agriculture

NORS
National Outbreak Reporting System

United States® Census Bureau

USDA Food Safety and Inspection Service

PulseNet USA
The National Molecular Subtyping Network for Foodborne Disease Surveillance
CDC

Types of Data

Real World

Supply Chain Mapping & Operations
Operations: Costs, Lead time, etc.

Food Insecurity
Human Food Safety Illness Data
Population Attributes
USDA FSIS Regulated Facilities Pathogen Data

Location USDA FSIS Establishments Data
Climate Data
Food and Agriculture projections
Transportation outages
Power outages
Real time weather alerts

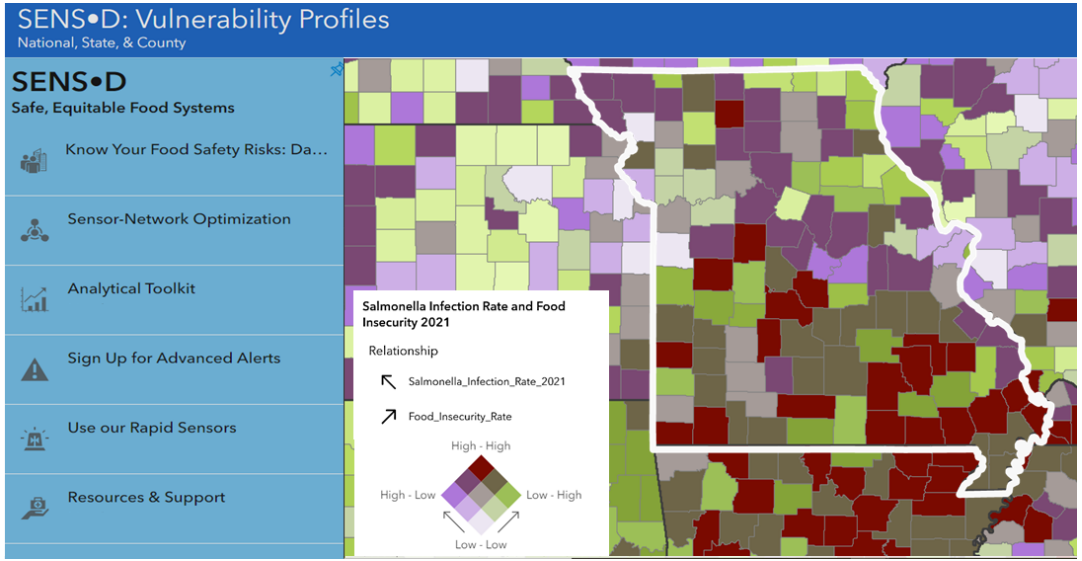
Experimental

Spoilage bacteria growth
Spoilage metagenomics
Impedance vs frequency experimental data
SERS Spectra library for pathogen detection
Sensor attributes

Sensor Streams

Pathogen Sensor Streams
System Stability
Humidity
Temperature Sensors

Broader Impacts: For Society



Data from: *PulseNet (CDC), US Census Bureau, Social Vulnerability Index (CDC), Feeding America. Visualization curated by SENS-D team.*

Safe, Adequate, Nutritious Food Supply **FOR ALL**

SALMONELLA PREVENTION	
Economic Cost	**$4.1 BILLION**
People Impacted in the US	**1.3 MILLION**
Burden of Foodborne Illness*	**$152 BILLION**

*Adaptability to other food products reduces this burden

STEM *Training a Diverse Workforce in Convergence Science*

Track Integration: NAFSI Hub

AquaSteady

Seaweed-based biopolymers that retain water and reduce erosion

nourish

AI + geospatial platform supporting small businesses put fresh food retail in low-income urban communities

CropSmart

AI-powered digital twin for crop decision optimization via remote sensing + physics models

NourishNet
A FOOD RECOVERY TOOLBOX

Smart surplus food distribution network with a user-friendly food quality sensor & real-time app

CULTIVATE IQ
EMPOWERING REGIONAL FOOD SYSTEMS

Farm-to-market AI platform for supply chain integration, sales prediction & planning

SENSD

Sensor-enabled decision support system platform for rapid food safety detection, prediction, and decision support

Dairy NutriSols

Dairy innovation consortium enhancing quality, nutrition, and global supply efficiency

Committee Process

CORE INSTITUTE

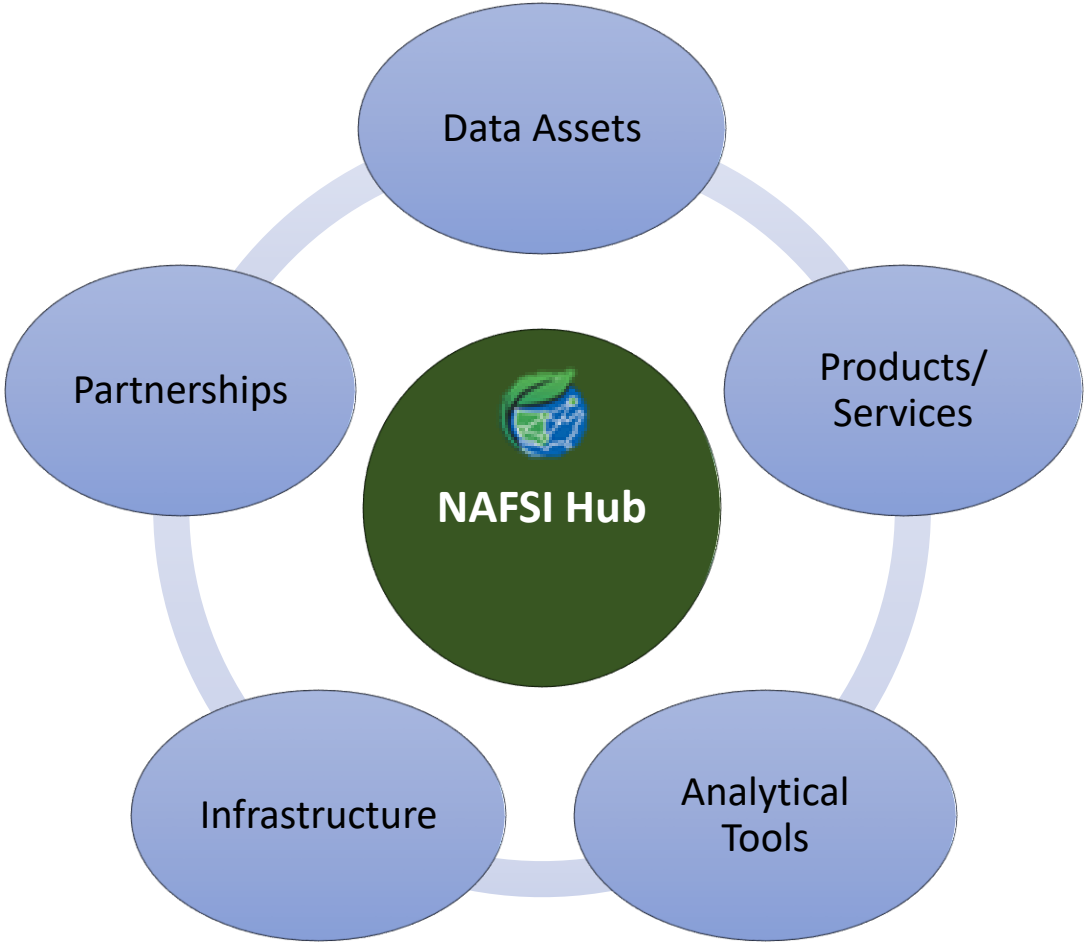
Methods:

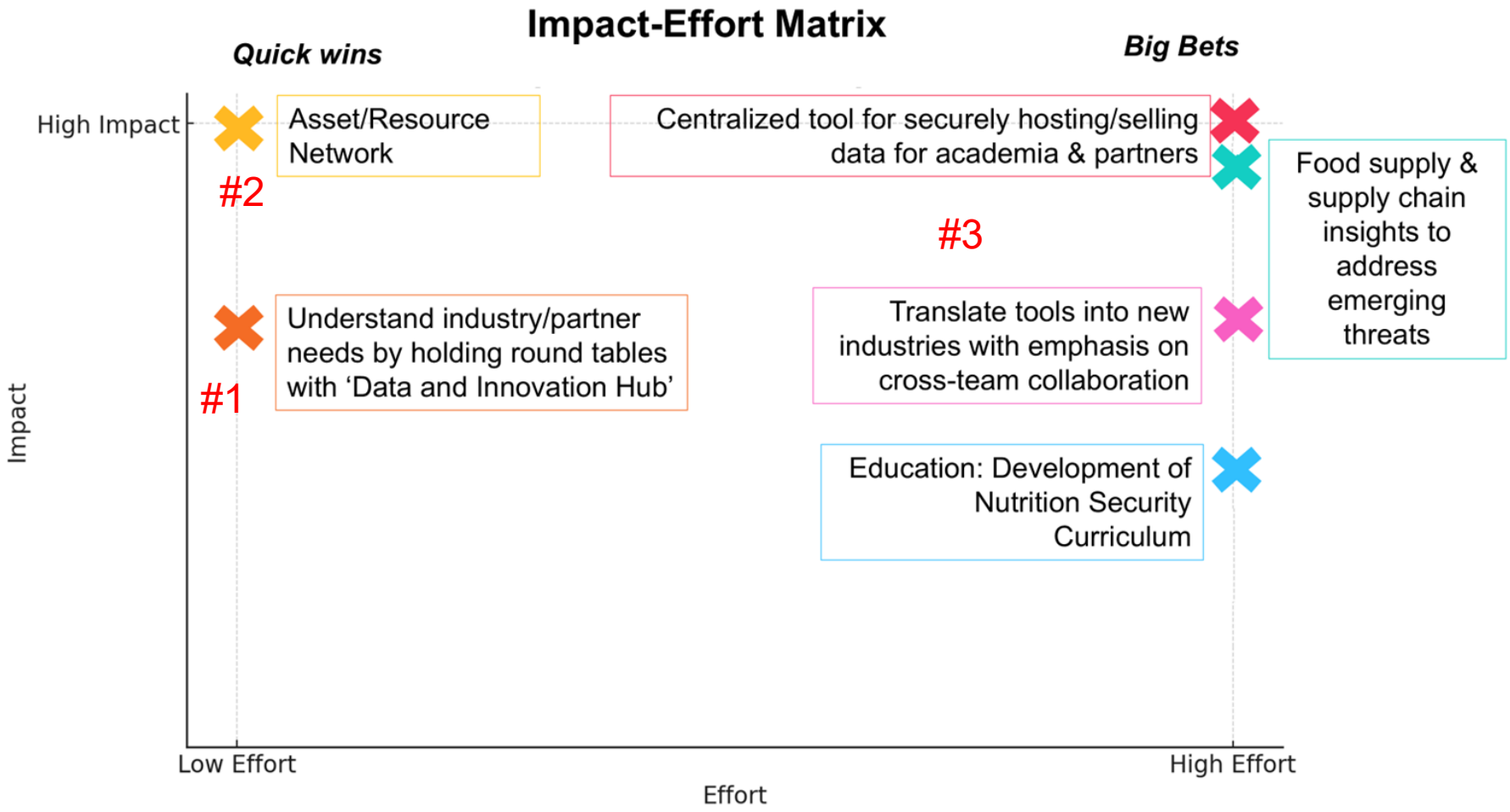
- Workshop with CORE Institute
- Planning sprint
  - Sprint #1 Group brainstorming
  - Collected assets from teams
  - Sprint #2 SWOT based on assets
  - Spring #3 Post-SWOT 1-on-1 opportunities synthesis
  - Feasibility assessment based on opportunities identified

Design real use-cases, identify key team players, and define activities.

Key Findings

1. Leading group of interdisciplinary researchers and tech developers trained in convergence science for food security
   - Expertise across entire value chain and production ecosystem from soil to waste
2. 72 Diverse Partnerships
   - Govt, financing, food production, academic, food charity, supply chain, retail, etc.
3. Collaborations with current users; Idenfied cross-collaboration gaps
4. Smart tools and support for open science
5. Workforce training/Extension partnerships
6. Diverse expertise and technical skillset
7. Mix of experimental data and real world data
8. Significant spatio-temporal data
9. Diverse nutritional needs assessments
10. Supply chain common theme


Data Assets
Products/
Services
Analytical
Tools
Infrastructure
Partnerships
NAFSI Hub


Impact-Effort Matrix
Quick wins
Big Bets
High Impact
Asset/Resource Network
#2
Centralized tool for securely hosting/selling data for academia & partners
Food supply & supply chain insights to address emerging threats
#3
Understand industry/partner needs by holding round tables with 'Data and Innovation Hub'
#1
Translate tools into new industries with emphasis on cross-team collaboration
Education: Development of Nutrition Security Curriculum
Impact
Low Effort
High Effort
Effort

Advances food security by unifying the nation's most impactful food systems data and solutions into one powerful, accessible hub. We aggregate and steward diverse, high-impact datasets — including real-time sensor outputs, AI/ML tools, digital twins, and geospatial dashboards with varied levels of security and privacy to serve industry needs.

By standardizing and centralizing these assets, NAFSI enables seamless access to data-driven solutions that accelerate discovery and impact across the food security landscape.

60 leading scientists, 70 industry and community-based partners, > 100 students and post-docs

NAFSI Hub: Principles

User Control & Data Ownership
Users retain control over their data, access, and use.

Attribution & Credit
Ensure clear recognition and credit to data and solution owners.

Tiered Access & Governance
Role-based, time-bound access aligned with data sensitivity and use.

Secure, Flexible Infrastructure
Scalable storage and computing with strong cybersecurity, integrated with AWS.

Easy to use
User-friendly for programmers and non-programmers alike

Accelerated Innovation
Enable rapid development, testing, and deployment of data-driven solutions.

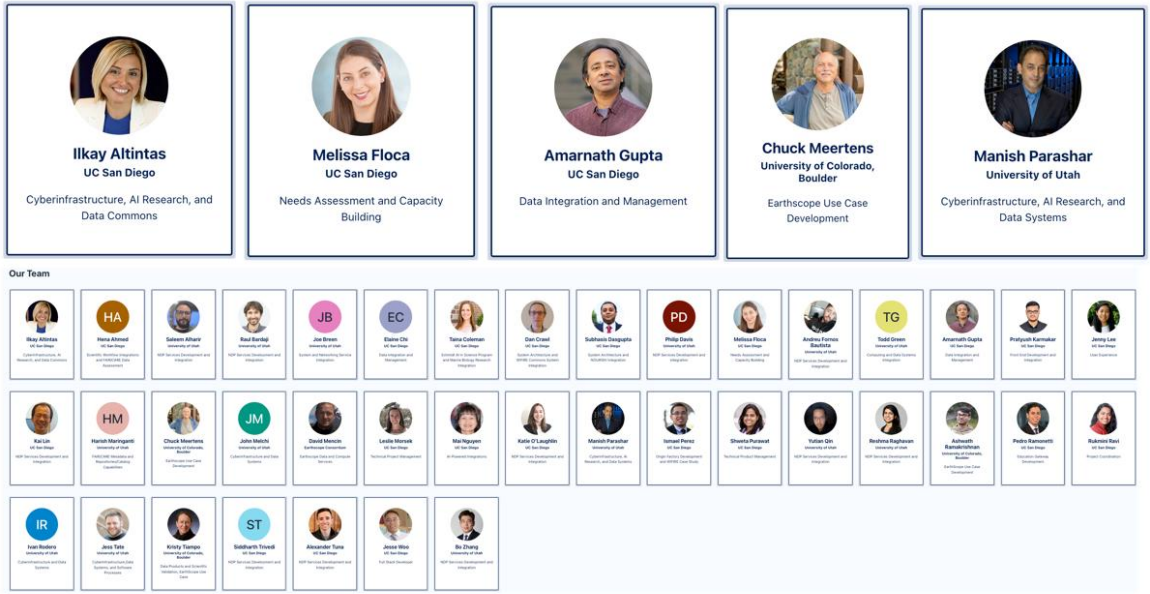
End-to-End Value Chain Integration
Connect industry, academia, and communities to drive real-world impact.

Enabling AI-Ready Platform

NATIONAL DATA PLATFORM

https://www.nationaldataplatform.org/

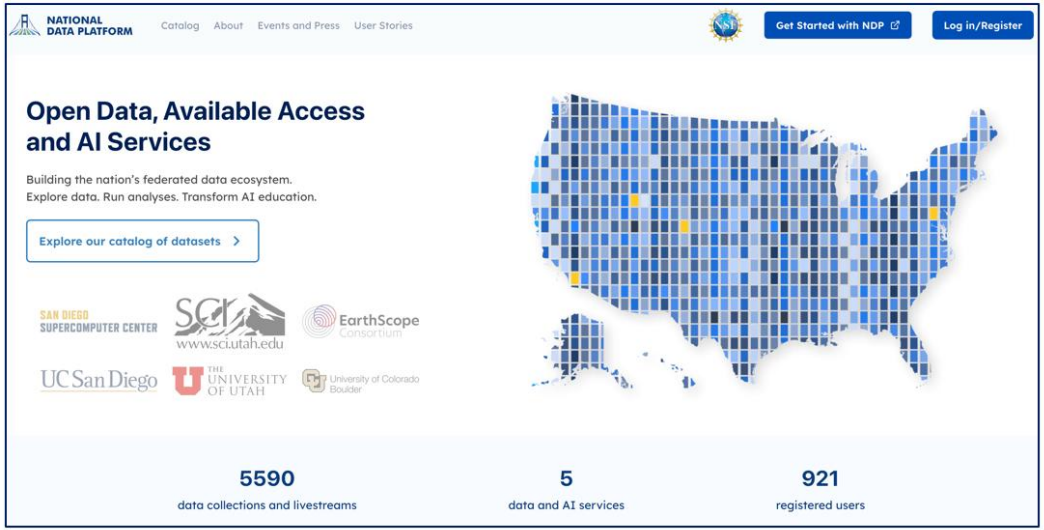
(PI: Altintas)



İlkay ALTINTAŞ, Ph.D. (ialtintas@ucsd.edu)

National Data Platform

…. enabling interoperable data and AI integrated workflows.



NATIONAL DATA PLATFORM

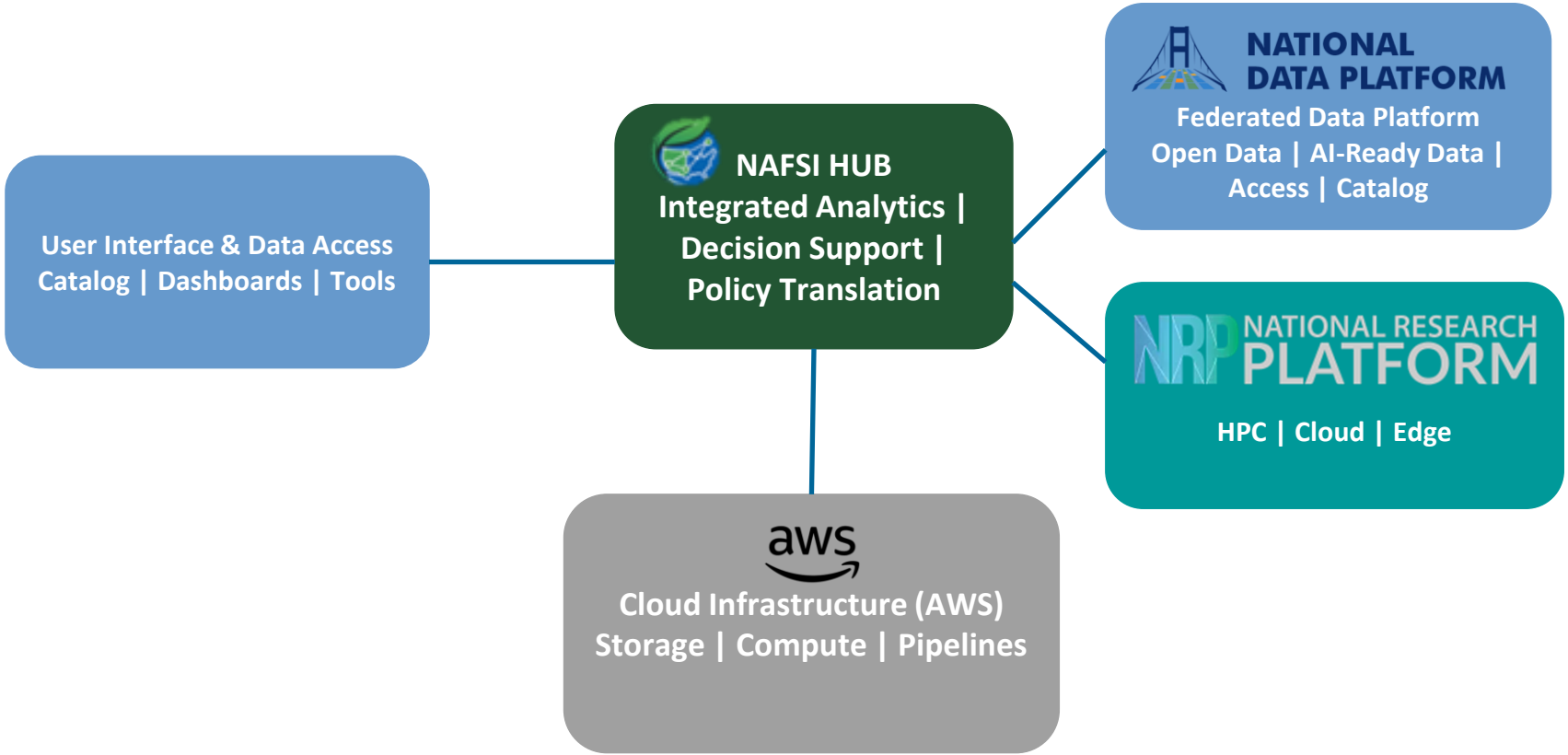
A **broad**, **federated** and **extensible** data ecosystem to promote collaboration, innovation and customizable use of data on top of existing national infrastructure capabilities.

https://www.nationaldataplatform.org/

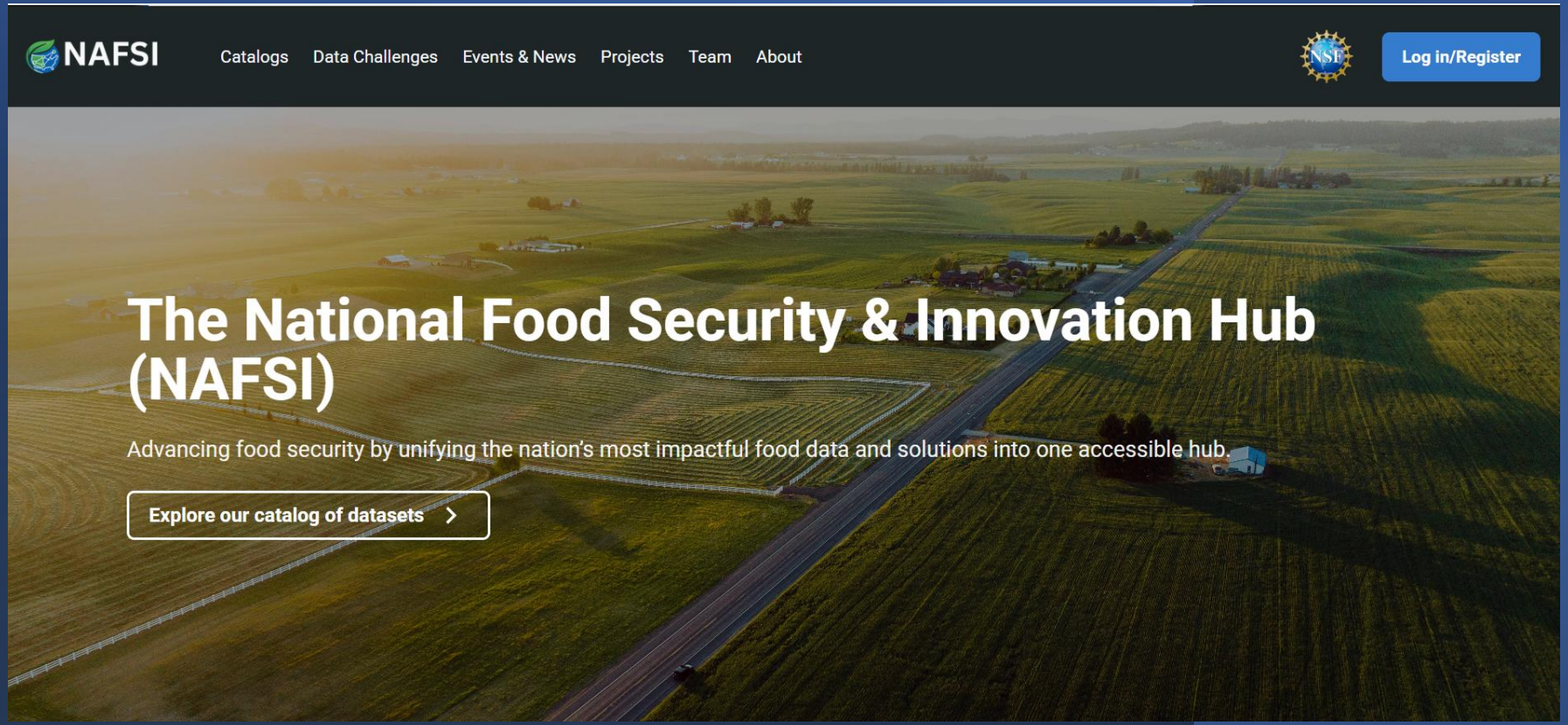
UC San Diego
UTAH
University of Colorado Boulder
SDSC SAN DIEGO SUPERCOMPUTER CENTER
SCI www.sci.utah.edu
EarthScope Consortium

İlkay ALTINTAŞ, Ph.D. (ialtintas@ucsd.edu)

NAFSI Hub: Integrated Data & Compute Ecosystem



NAFSIHUB.ORG



National Food Security Innovation Hub Student Data Challenge

Spring 2026

aws

CORE INSTITUTE

NATIONAL DATA PLATFORM

NSF

NAFSI STUDENT DATA CHALLENGE

NAFSI Hub: Student Data Challenges

TRACK #1: 🌾 YieldSense Challenge

Smarter Forecasting & Smarter Farming: Predictive Modeling for Agricultural Resilience

TRACK #2: 🍎 NutriNet Challenge

Healthier Outcomes for All Through Food Access: Building Data Tools for Targeted Nutrition Interventions

TRACK #3: 🚚 AgriTrace Challenge

End-to-End Food Supply Chain Intelligence for Regional Resilience

Meet the Team

Kate Trout
University of Missouri

NAFSI Director

Grace Crow
University of Missouri

Senior Program Coordinator

Melissa Floca
UC San Diego

SCIL Lead

Pedro Ramonetti
UC San Diego

SCIL Educator

Chen Zhang

CropSmart

Stephanie Lansing

NourishNet

Mitesh Rajpurohit

One Health Data Manager

NAFSI STUDENT DATA CHALLENGE

NAFSI Hub

CropSmart

SENSD

"Accelerate innovation, foster cross-sector collaboration, and empower researchers, industry, policymakers, and communities with cutting-edge data, tools, and insights to create resilient and sustainable food systems."

CULTIVATE IQ
EMPOWERING REGIONAL FOOD SYSTEMS

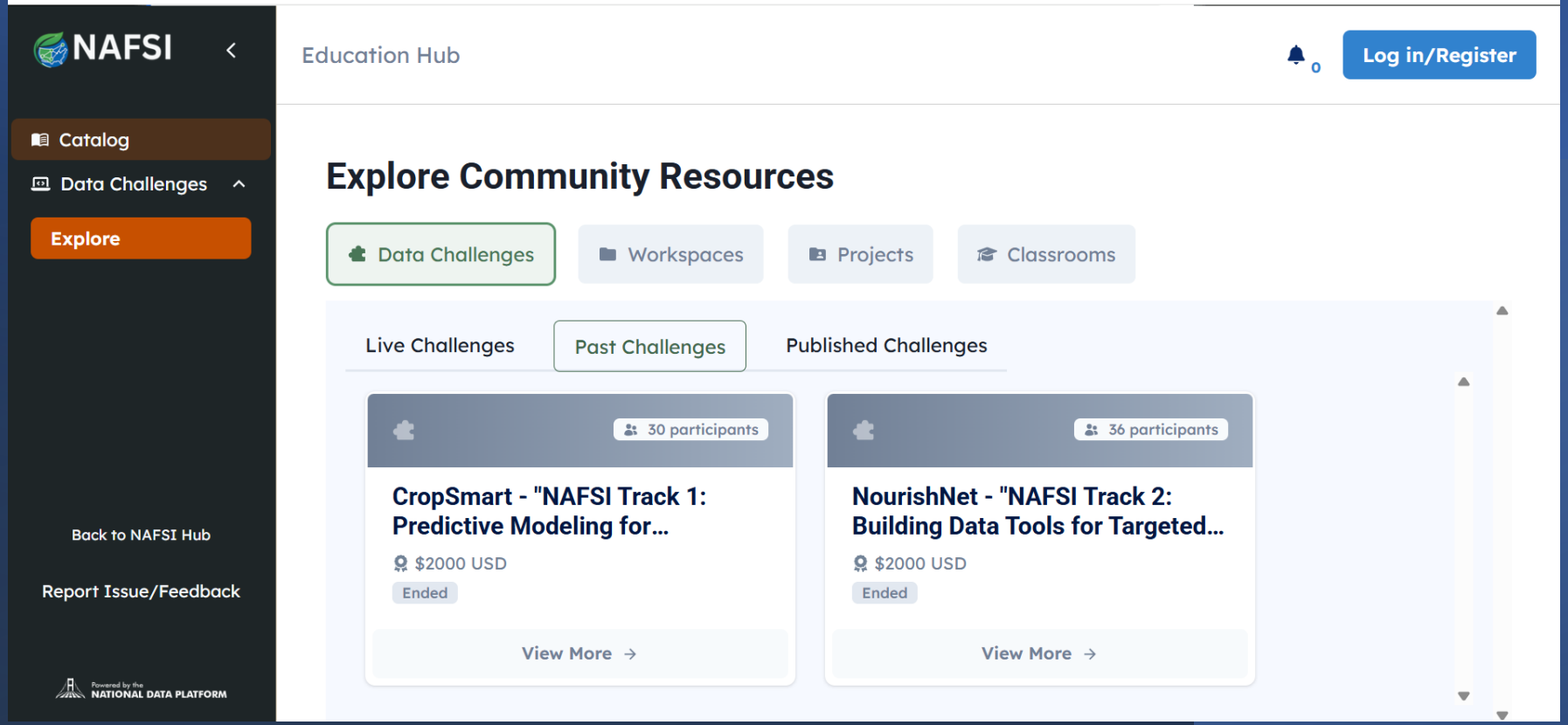
NourishNet
A FOOD RECOVERY TOOLBOX

Dairy NutriSols

nourish

AquaSteady

https://nafsihub.org/educationhub/explore



Track 1:
Predictive Modeling for Agricultural Resilience

Led by *George Mason University*, the CropSmart digital twin provides on-demand, decision-ready solutions optimized to users' cropping goals. The technology are available to users through both web portals and smartphone apps. The optimal solutions are derived from near-real time remote observations of cropping systems with physics and AI or machine learning-based modeling and simulations.

CropSmart, a digital replica of real-world cropping systems provides on-demand science-based and data-driven decision solutions optimized for the cropping goals of decision-makers, including farmers, agro-business operators, government agricultural officials, without burdening them on data processing or instrument investments

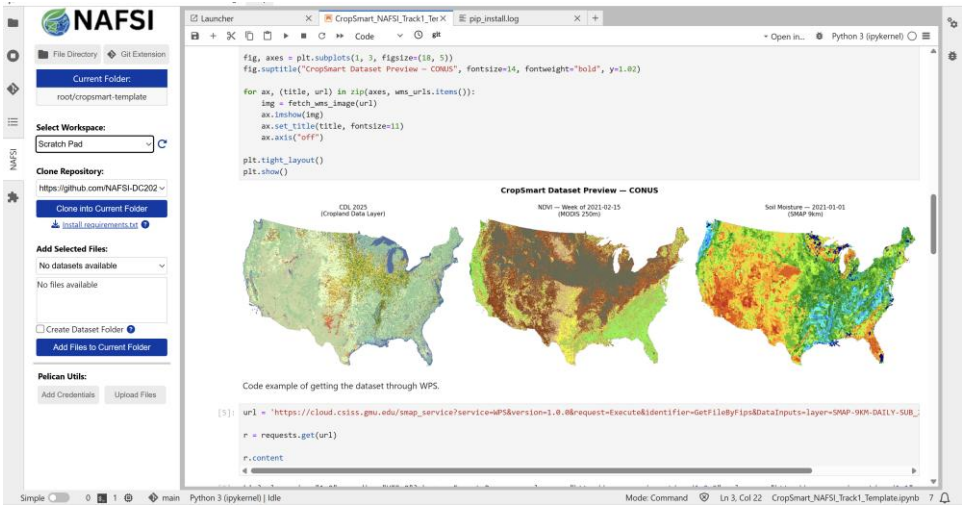
Challenge Context

The **NAFSI Track 1 Challenge** leverages this ecosystem to:

- Analyze multi-source geospatial data across the contiguous United States
- Develop predictive models for crop monitoring and classification
- Generate actionable insights to improve agricultural resilience

.

CropSmart Digital Twin; (https://cloud.csiss.gmu.edu/CropSmart)



CropSmart

Track 2:
Building Data Tools for Targeted Nutrition Intervention

NourishNet
A FOOD RECOVERY TOOLBOX

Led by the *University of Maryland*, NourishNet provides connections between producers, donors, distributors and those experiencing food insecurity.

The NourishNet toolbox includes a portable and user-friendly food quality sensor, QuantumNose, and a real-time app, FoodLoops, that optimizes surplus food distribution.

A decision support tool helps institutions choose the most sustainable food waste diversion strategies.

NourishNet's bilingual consumer education equips distribution personnel and recipients with practical skills to reduce wasted food.

nourishnet.umd.edu

Track 2:
Building Data Tools for Targeted Nutrition Intervention

Food distribution events are critical—but coordination is fragmented across nonprofits, community groups, and local agencies.

- Information is scattered across many channels
- Households struggle to find accurate, timely event details
- Donors lack clarity on where support is needed
- Volunteers have low visibility into priority areas
- Poor alignment between event locations and community need

For:

- 🏠 Food Insecure Families
- 💰 Food Donors
- 🤝 Volunteers

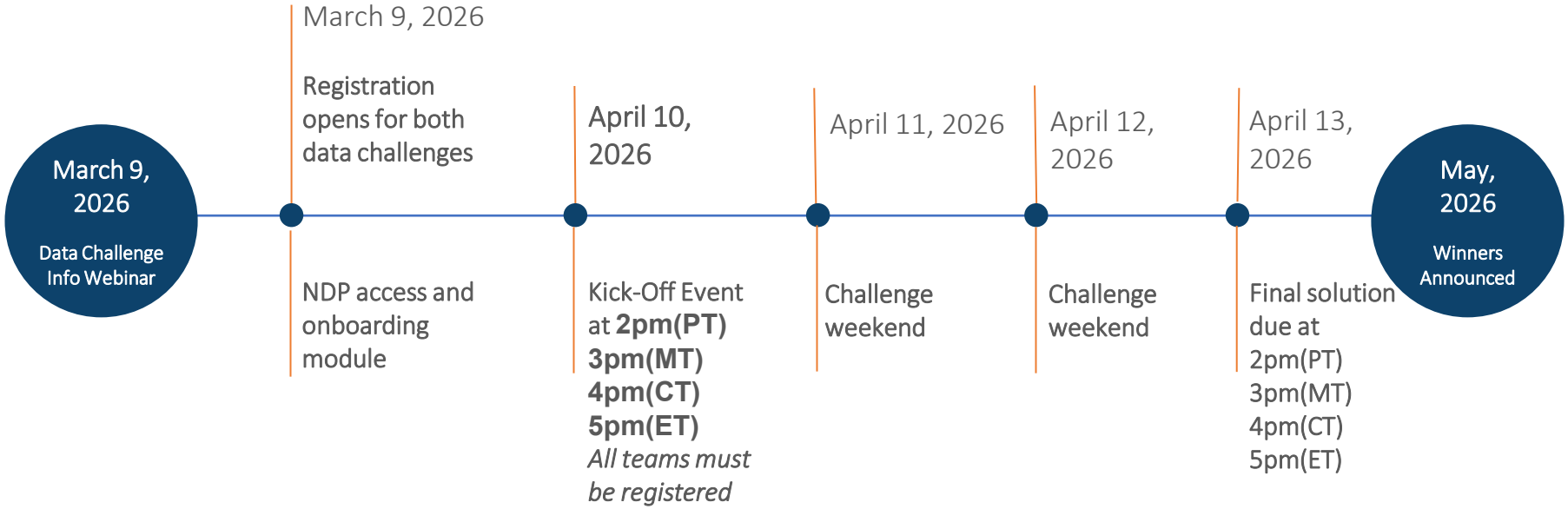
Solution Direction (Challenge Task)

Develop a user-friendly tool using Kiro that:

- Ingests unstructured web data from food assistance sources
- Transforms it into a single, accessible platform

NourishNet
A FOOD RECOVERY TOOLBOX

Challenge Timeline



Next steps & Lessons Learned

01 **Build a module on building interdisciplinary teams.**
Align incentives (e.g. $500 per person)

02 **Partner with AWS to provide tooling and tutorials ahead of challenge.**

03 **Extend challenge over 10 days.**

04 **Hold in person orientation sessions early to help team formation**

05 **“Requirements” vs. Encouraging Participation**
Team size

NAFSI Hub International

Joint FAO/IAEA Centre

Nuclear Techniques in Food and Agriculture

npr Marketplace

Salmonella testing can be a slow process. These researchers want to change that.

Eric Schmid | Aug 29, 2023

Heard on: MARKETPLACE

stl|p|r

Researchers see new salmonella sensors shaking up the entire chicken supply chain

Food Safety Africa

Africa's No.1 Food Safety, Quality & Compliance Magazine

Sensor-based system aims to tackle Salmonella across poultry supply chain

Translating Basic Science to Population Health and Sustainability

Basic Science → Use-inspired Research → Human-Centered Design → Population Health → Sustainability Planning → Societal Benefit

Thank you