

Identifying and Prioritizing Research and Programmatic Needs in the Detection, Mitigating, and Remediating PFAS in Agriculture and Food Systems - A collaboration between USDA ARS - Center of Excellence for Environmental Monitoring and Mitigation and the University of Maine.

Contact: David.Knaebel@usda.gov

Location: Washington DC – Arlington Westin

Dates: September 10, 11, 12 – 2024

Meeting capacity: limited to 150 in-person attendees (virtual attendee and presenter options are available for Day 1 and part of Day 3)

Meeting Goals: This workshop will identify, strategize, and develop approaches for implementation of plans to solve priority problems that PFAS poses to agriculture, agroecosystems, food systems, and farming communities. This three-day event will have the following foci on PFAS: identifying the problems; understanding the context of the problems; and formulating solutions to the problems. Up to 150 researchers and experts are expected to participate in person. The meeting will consist of keynotes/highlight/topical presentations (to elucidate what we know and spark discussions); break out working groups; readout presentations; and vision setting.

Meeting Objectives and Expected Outcomes: This workshop will identify, strategize, and develop approaches for implementation of plans to solve priority problems that PFAS poses to agriculture and food systems.

Potential impact and expected outcomes: This PFAS focused gap and solution meeting - between the powerful USDA research community, other USDA mission areas, University of Maine partners, other university partners, the private sector, and key state and federal agencies - will enable us to address and resolve agriculture-centric problems arising from PFAS. Overarching impacts of this conference will be coordinated engagement of the research community and stakeholders in finding creative and innovative ways to mitigate and remediate a rapidly growing PFAS challenge in U.S. agriculture and food systems.

Format

The meeting will consist of **presentations, breakout sessions, and read-outs** designed to facilitate communications and solution development for problems that fall into **eight broad conceptual areas** where PFAS impacts in agriculture. Those areas are:

1. Abatement
2. Data
3. Environment
4. Food
5. Livestock
6. Materials
7. Plants
8. Socio-economic

Please note that these are broad topics that include several facets, including small farm production, use of agricultural and surrounding lands, habitats used by hunters and fishermen, etc. There may be, by the end of this meeting, several priority areas that the attendees develop a vision to address that create novel powerful intersections between two or more of them. This is intentional.

(Day 1) Overview of PFAS Progress Stories and Critical Challenges



<https://www.zoomgov.com/j/1609738821>

7:00 – 8:00 Doors open; breakfast available/provided

8:00 to 8:45 am: **Opening Remarks and Welcome!**

Simon Liu, Greg Jaffe, Diane Rowland, Joan Ferrini-Mundy (8:30-8:45) Dave Knaebel (Kate Reardon)

(In person attendees: please sign up for breakout sessions at the registration desk)

PFAS Progress Stories and The Speaker's Most Important PFAS Challenge 8:45 - 12:25

1. PFAS Fate in Agricultural Systems (Environment)– 8:45 (Linda Lee -Purdue)
2. PFAS in food animals (Livestock)– 9:10 (David Smith - ARS)
3. Underestimated human exposure to fluoroethers through garden produce near a fluorochemical manufacturer in North Carolina (Plants)– 9:35 (PingPing Meng – ECU [remote])
4. PFAS and Seafood: Success Stories and Challenges (Food)– 10:00 (Stacey Wiggins – FDA)

10:35-10:45 Break

5. Testing PFAS in food packaging: progress and challenges (Materials) – 10:45 (Yelena Sapozhnikova – ARS)
6. Agriculturally Relevant PFAS Abatment Technologies - 11:10 (Daniel Ashworth – ARS)
7. Economic and Social Impacts of PFAS on Farming Communities. – 11:35 (Beth Valentine - State of Maine)
8. SAWGraph: A knowledge graph approach for assembling and linking PFAS Data– 12:00 (Ganga Hettiarachchi – KSU and Torsten Hahmann – U Maine)



Lunch - 12:30 – 1:30

EPA PFAS Biosolids Risk Assessment (Sophie Greene – EPA)

<https://www.zoomgov.com/j/1618734742>

Current and Emerging PFAS Challenges for Agriculture– 1:30 – 4:45 (Magnitude, Urgency, Feasibility) <https://www.zoomgov.com/j/1602249237>



1. Environmental PFAS – 1:30 (Clinton Williams – ARS)
2. PFAS Challenges in Agricultural Production: Livestock– 1:55 (Sara Lupton – ARS)
3. PFAS and agriculturally relevant crops and other Plants – 2:20 (Shaun Curtin – ARS)
4. PFAS and Food production – 2:45 (Alex Domesle – FSIS)
5. Post processing: challenges addressing replacing PFAS in food packaging and fabrics (Materials) – 3:10 (Matt Hillyer – ARS)

3:35-3:50 Break

6. Socio-Economic impacts on farming communities 3:50 – (Caroline Noblet - U Maine)
7. The *need* for: Assembling PFAS Data for Access and Use– 4:15 – (Diane Rowland – U Maine)

4:45 – 5:00 – **Day overview** – Special PFAS Information Request and Search Tool (Clinton Williams - ARS)

Adjourn for dinner. Dinner is on your own.

7:00 to 8:30 pm – Meeting rooms open for ad-hoc conversations for attendees.

(Day 2) Digging into the PFAS Problem and Solution Discussions - Breakout group sessions and report out sessions.

7:00 – 8:00 Doors open; breakfast available/provided.
8:00 am **Welcoming remarks and charge to attendees.**
Call for breakout session co-leaders and scribes

1. (8:30) **Break out group session - prioritize research to address challenges – those mentioned in presentations on Day 1 as well as others of priority to the attendees.**

8:30 – 9:30 **first gathering** - The goal of this breakout session is to prioritize (1) the most important challenges, (2) which to address first (low hanging fruit) and (3) to discuss the likelihood of success (e.g., are technologies unavailable or not on the horizon to address those challenges?).

9:30-10:00 **break**

10:00 – 11:00 **second gathering** – continue to identify priority problems, as needed.

11:00 – 11:30 note takers/scribes compose brief statement for each problem area.

This breakout group session is the crux of this meeting; the problems articulated by each group may fall within the 8 conceptual area or may span them. But: the articulated problems will determine the direction of the rest of the meeting and provide the themes to the efforts envisioned by the participants – that lead to solution strategies to solve them.

12:00 – 1:00 Lunch - provided. Working Lunch meeting: **Maine Leadership Lunch Panel** discusses the University of Maine + USDA ARS Center of Excellence and highlights other efforts being led by Maine.

2. **1:00 – 2:30 Large gathering session: Break out groups report out:** their top priorities, binned as above. Discussion follows.

2:30 – 3:00 Break

(Activity) **3:00 – 4:30 Entire attendee population discusses and evaluates and then indicates their top 10 of the identified challenges across all 8 concept areas.** Note: on this evening (Wednesday), the coordinating committee will assess the rankings/votes and evaluate if some of the problem statements in different concept areas have intersections. These will be assembled and shared with the attendees on Thursday morning.

We recognize that the articulated challenges may span conceptual areas and need transdisciplinary solutions. Following this organizational effort, the problems are expected to still be grouped into these eight categories. It is expected that there will be at 5 or more unique important problems per topic area.

4:30 – 5:00 Wrap up by coordinating committee team representatives.

Adjourn for Dinner. On your own.

7:00 to 8:30 pm – Meeting rooms open for ad-hoc conversations for attendees.

(Day 3) Fine Tuning PFAS Solutions and Vision Setting - Breakout group sessions and report out sessions.

7:00 – 8:00 Doors open; breakfast available/provided.

5. 8:00-9:00 Presentation by the coordinating committee of the 8 problem sets.

The coordinating committee will review the top problem areas in each topic area and illustrate which problems from different breakout groups overlap/intersect. Part of the third breakout session will include time for those breakout session groups to meet jointly, to further explore those overlapping problems.

6. 9:00 – 10:00 Break out group session - gather to develop further elucidation of the problems in each topic area and set and the priority problems identified by the attendees in the previous breakout session.

Goals of this break out session for each problem set: what are the key elements of a solution for each subproblem? Which aspects need to be addressed first?

10:00 – 10:15 Break

7. 10:15 – 11:45 **Large gathering session: Break out groups report out:** each break out groups shares their “finalized” problem statements for the new conceptual areas. Discussion follows.

Lunch - provided. 12:00 – 1:00 PM

8. (during lunch) **Special Presentation Session: Funding agencies** will be invited to speak to attendees about PFAS-relevant funding opportunities.

<https://www.zoomgov.com/j/1603068368>

NIFA: Sandeep Kumar (remote)

NSF: Linda Molnar

EPA: Venus Welch-White



9. 1:00 – 2:30 **Break out group session - plan and strategize** - now that we have agreed on the highest priority, most urgent, and most feasible-to-solve PFAS problems, how do we work together to accelerate problem solving efforts? Also: What can we do differently? What do we need?

2:30 – 2:45 Break

10. **2:45 – 4:00 Large gathering session: Break out groups report out** on plans to work to address identified priority and quick win challenges, longer term efforts, and set visions for successes. Discussion follows.

<https://www.zoomgov.com/j/1600394323>

(Zoom is live from 2:30 pm to 5:00 pm Eastern)







11. 4:00 – 4:30 **Closing charges** to the group to work together, develop proposals and plans.




Dave Knaebel, Diane Rowland, Marlen Eve, USDA Deputy Undersecretary Sanah Baig

4:30 pm – **Adjourn**




**USDA and U Maine Leadership and Speaker and Coordinating Committee Biographies
(CC = PFAS Workshop Coordinating Committee Member)**

Name	Narrative
<p>Sanah Baig</p> 	<p>Sanah Baig was named Deputy Under Secretary for Research, Education, and Economics (REE) in November 2022. In her role as Deputy Under Secretary, Baig leads the management a \$4 billion portfolio to advance research to increase food systems’ resilience, promote food and nutrition security, and position agriculture as a key solution to climate change. Prior to this role, Baig was appointed by President Biden to serve as the REE Chief of Staff, a position she served in for 1.5 years. During the Obama-Biden Administration, she worked as an appointee for nearly six years in a variety of capacities at USDA including serving as an advisor in the Office of the Secretary, special advisor in Rural Development, and confidential assistant in the Marketing and Regulatory Programs (MRP) mission area.</p>
<p>Gregory Jaffe</p> 	<p>Gregory Jaffe, Senior Advisor for Regulatory Affairs, Office of the Secretary, USDA greg.jaffe@usda.gov</p>
<p>Simon Liu</p> 	<p>Dr. Simon Liu has served as ARS Administrator since January 2023 and has been with ARS for 14 years. He previously served as Associate Administrator for Research Operations for Research Management and Operations since February 2015.</p> <p>He previously served as Director of the National Agricultural Library (NAL), which serves as the central library for the U.S. Department of Agriculture and is one of the four National Libraries of the United States. NAL is world's largest and most accessible research library specializing in agriculture.</p>
<p>Diane Rowland</p> 	<p>Dr. Diane Rowland is dean of the College of Earth, Life, and Health Sciences and director of the Maine Agricultural and Forest Experiment Station at the University of Maine.</p> <p>She leads a research enterprise that powers transdisciplinary solutions inspired by Maine with global impact and played a critical role in UMaine’s recent R1 designation. She also oversees academic programs that foster health, natural resource, social science professionals for Maine’s workforce.</p>

<p>Daniel J. Ashworth</p> 	<p>Dr. Daniel J. Ashworth. Research Soil Scientist. Agricultural Water Efficiency and Salinity Research Unit, USDA-ARS US Salinity Laboratory, 450 W. Big Springs Rd Riverside, CA 92507-4617 daniel.ashworth@usda.gov</p> <p>Dr. Ashworth's current research focuses on chemicals of emerging concern in agriculture: (i) understanding the transfers of antibiotics and PFAS from treated wastewater and manure/biosolids to soils and crops, (ii) mitigating these transfers using biochar as a soil amendment, and (iii) removing these compounds from treated wastewater using novel biochar-based filtration approaches. The overall goal of Dr. Ashworth's research program is to reduce the human health risks of chemicals of emerging concern by understanding and mitigating their transfers into food chains.</p> <p>https://www.ars.usda.gov/pacific-west-area/riverside-ca/agricultural-water-efficiency-and-salinity-research-unit/people/daniel-ashworth/ https://doi.org/10.1016/j.scitotenv.2024.172275</p>
<p>Shaun Curtin</p> 	<p>Shaun Curtin, PhD, Research Geneticist shaun.curtin@usda.gov Current Research Foci: Identifying genes controlling desirable traits in legume crops; Determining relationships of root architecture with root functions in soybean and alfalfa; Improve legume transformation and gene editing technologies Disciplinary Areas: Genome Editing; Legume and Cereal Transformation; Small RNAs; Legume Genomics</p>
<p>Alexander Domesle</p>	<p>Alexander Domesle Senior Advisor for Chemistry, Toxicology, and Related Sciences & Agency Scientific Integrity Officer, Office of Public Health Science, USDA FSIS</p>
<p>Thomas F Ducey</p>	<p>Thomas F Ducey (PhD) Microbiologist Coastal Plain Soil, Water and Plant Conservation Research, Florence, SC thomas.ducey@usda.gov Foci: Develop biostimulants and other soil amendments and assess their ability to improve soil health, nutrient cycling, and soil fertility and resiliency. CC</p>
<p>Torsten Hahmann</p> 	<p>Torsten Hahmann, PhD, Associate Professor of Spatial Computing and Associate Director, School of Computing and Information Science, University of Maine. 344 Boardman Hall, University of Maine, Orono, Maine torsten.hahmann@maine.edu</p> <p>Torsten Hahmann is a spatial and computer scientist with expertise in information and knowledge integration and sharing (using ontologies and knowledge graphs). His work on SAWGraph focuses on representing and linking data about PFAS sources and test results to help quickly analyze and guide testing priorities, impacts to water and agricultural resources, and to spatially analyze and trace contamination in the environment and its impact on water and agriculture.</p> <p>https://sawgraph.github.io https://onlinelibrary.wiley.com/doi/10.1002/aaai.12043</p>

<p>Ganga Hettiarachchi</p> 	<p>Ganga Hettiarachchi, PhD, Professor of Soil and Environmental Chemistry, Department of Agronomy, Kansas State University. Manhattan, KS 66506 ganga@ksu.edu Ganga Hettiarachchi is a soil and environmental chemist focusing on better understanding the mechanisms and soil chemical reactions affecting contaminant bioavailability or soil quality to improve safe food crop production and the protection of human health. Her work on SAWGraph focuses on PFAS in soil and agricultural products and guides the team with respect to addressing research questions and data analysis needs related to PFAS in soil and agricultural products. https://www.agronomy.k-state.edu/research/faculty-labs/soil-environment-chem/ https://access.onlinelibrary.wiley.com/doi/full/10.2134/jeq2014.09.0400</p>
<p>Matthew Hillyer</p>	<p>Matthew Hillyer, PhD - Chemist Cotton Fiber Bioscience and Utilization Research, New Orleans, LA Foci: Enable, from a technological standpoint, new commercial products and market applications for cotton-containing nonwoven materials; Enable new commercial varieties of cotton exhibiting non-conventional fiber properties for improved functionality and value of cotton-containing textiles; Expand and develop novel metal-based nanotechnology to facilitate new value-added applications for cotton matthew.hillyer@usda.gov</p>
<p>Dave Knaebel</p> 	<p>Dave Knaebel, PhD, Senior Management Advisor Serving the USDA ARS Natural Resources and Sustainable Agricultural Systems Program Area. David.Knaebel@usda.gov From October 2016 to June 2022, I served as the National Program Leader for Soil Biology to the USDA, Agricultural Research Service (ARS). I currently serve as a Senior Management Advisor (SMA) serving and leading primarily efforts related to the intersection of agricultural productivity and sustainability as affected by PFAS. CC</p>
<p>Linda S. Lee</p> 	<p>Linda S. Lee, PhD, Distinguished Professor, Purdue University, Dept of Agronomy, Environmental and Ecological Engineering; Interdisciplinary Ecological And Environmental Engineering Graduate Program, West Lafayette, IN. LSLSEE@PURDUE.EDU Foci: Fate, treatment, and mitigation of chemicals of concern including PFAS in lab and field-based studies, including in multiple biosolids-applied field studies, and associated analytical tools and contaminant management strategies. https://ag.purdue.edu/directory/lislee Linda S. Lee is a Distinguished Professor at Purdue University with a joint appointment in the Colleges of Agriculture and Engineering. Her research focuses on chemical fate, treatment, and mitigation, including in multiple biosolids-applied field studies, and associated analytical tools and contaminant management strategies. PFAS challenges have driving much of her research for the last two decades. She is well-published in top tier environmental journals. Her current research is funded by a diverse portfolio including USEPA, USDA, DOD, NSF, USGS, and WRF.</p>

<p>Sara Lupton</p> 	<p>Dr. Sara Lupton has been a Research Chemist with the Food Animal Metabolism Research Unit at the Edward T. Schafer Agricultural Research Center in Fargo, ND within the USDA-ARS since 2010. Dr. Lupton's serves as the ARS lead scientist for the USDA's Dioxin Survey conducted with FSIS every 5 years in domestic meat and poultry. Her other research includes the fate of animal drugs and environmental contaminants in lab and food animals and investigation of environmental contaminant sources (feed, water, housing, etc.) that contribute to chemical residue levels in food animals. Dr. Lupton has conducted research on bioavailability, accumulation, distribution, excretion, and mitigation of PFAS compounds in food animals for over 10 years. CC</p> <p>Website: https://www.ars.usda.gov/people-locations/person/?person-id=45744</p> 
<p>Jude Maul</p>	<p>Jude Maul, PhD, Research Ecologist, jude.maul@usda.gov Foci: conducting research on plant/soil ecology and biogeochemistry of agroecosystems. His current research focus is on the fundamental differences between organic and conventional farming systems, in particular how changes in microbiome community structure and function influence greenhouse gas flux, organic matter cycling and plant decomposition. CC</p>
<p>Pingping Meng</p>	<p>Pingping Meng, Assistant Professor, Chemistry, East Carolina University (ECU) Greenville, North Carolina mengp22@ecu.edu Foci: The occurrence, transport, human exposure, and remediation of emerging contaminants in the environment, such as per- and polyfluoroalkyl substances (PFAS), pesticides, pharmaceuticals, etc. https://chemistry.ecu.edu/pingping-meng/ https://pubs.acs.org/doi/abs/10.1021/acs.jafc.1c07665https://www.nature.com/articles/s41467-024-49753-5</p>
<p>Caroline L. Noblet</p> 	<p>Associate Professor; School of Economics, College of Earth, Life & Health Sciences, University of Maine; Foci: Socio-economic impacts and communication regarding PFAS contamination on individuals, communities https://umaine.edu/soe/noblet/</p> <p>Moavenzadeh Ghaznavi, S., Zimmerman, C., Shea, M. E., MacRae, J. D., Peckenham, J. M., Noblet, C. L., Apul, O.G. & Kopec, A. D. (2023). Management of per-and polyfluoroalkyl substances (PFAS)-laden wastewater sludge in Maine: Perspectives on a wicked problem. <i>Biointerphases</i>, 18(4).</p> <p>Zimmerman, C. H., Noblet, C. L., & Shea, M. (2022). Forever Chemicals Needing Immediate Solutions: Mainers' Preferences for Addressing PFAS Contamination. <i>Maine Policy Review</i>, 31(1), 55-63. https://digitalcommons.library.umaine.edu/cgi/viewcontent.cgi?article=1920&context=mpr</p>

<p>Kate Reardon</p> 	<p>Catherine (Kate) Reardon, Research Microbiologist, USDA-ARS, Pendleton, OR Catherine.Reardon@usda.gov Dr. Kate Reardon is a Research Microbiologist with the USDA-ARS in Pendleton, OR. Her research evaluates the response of soil microbial communities to dryland cropping systems with the goals of stimulating beneficial microbial communities, promoting resiliency to drought, and overall enhancing soil quality, soil health and crop productivity. https://www.ars.usda.gov/pacific-west-area/pendleton/columbia-plateau-conservation-research-center/people/reardon/ CC Key papers of interest: https://access.onlinelibrary.wiley.com/doi/full/10.2136/sssaj2018.09.0344 https://www.nature.com/articles/s42003-024-06594-8</p>
<p>Yelena Sapozhnikova</p> 	<p>Dr. Yelena Sapozhnikova is a Research Chemist at the United States Department of Agriculture (USDA), ARS in Wyndmoor, PA. Her research focuses on the development of novel methods for the analysis of chemical contaminants in foods and food packaging to improve their analysis and enhance food safety. CC https://www.ars.usda.gov/people-locations/person/?person-id=55783</p>
<p>David J. Smith</p>	<p>David J. Smith, PhD, Supervisory Research Physiologist, United States Department of Agriculture, Research, Education, and Economics Mission Area, Agricultural Research Service. Edward T. Schafer Agricultural Research Center, 1616 Albrecht Blvd N, Fargo, ND 58102-2765, david.j.smith@usda.gov Foci: Investigate the absorption, distribution, and depuration of PFAS residues in food animals for which few data exist, and determine the fate of PFAS during carcass composting; determine the absorption, distribution, metabolism, and excretion of emerging and legacy chemicals in food animals; develop and validate sensitive and accurate rapid analytical tools to detect emerging and legacy residues in food animals and food animal systems.</p>
<p>Kurt Spokas</p> 	<p>Dr. Kurt Spokas is a research soil scientist with the United States Department of Agriculture – Agricultural Research Service (USDA-ARS) in St. Paul, MN. His main research areas are: 1) impacts of management practices (particularly fungicides and biochar additions) on the cycling of carbon, nitrogen, and other greenhouse gases and 2) development of farming practices to reduce agrochemical leaching and transport to groundwater. Website: https://www.ars.usda.gov/midwest-area/stpaul/swmr/people/kurt-spokas/</p>

Beth Valentine



Beth Valentine, Esq., is the director of the Fund to Address PFAS Contamination established within the Maine Department of Agriculture, Conservation and Forestry. The PFAS Fund provides substantial financial support for producers impacted by PFAS, purchases PFAS-contaminated real property, funds academic research to help inform on-farm management decisions, and supports health-related initiatives. Beth is a lawyer and environmental planner. She can be reached at beth.valentine@maine.gov. Also see, <https://www.maine.gov/dacf/ag/pfas/index.shtml>

Stacey Wiggins



Stacey Wiggins, Ph.D., Science Advisor, Division of Seafood Safety, Office of Food Safety, FDA, College Park, MD Stacey.Wiggins@fda.hhs.gov
Focie: I focus on known and emerging chemical and microbiological hazards that may impact seafood safety. Areas of focus include PFAS, marine and freshwater toxins, microplastics and nanoplastics, climate change, and Vibrio ecological forecasting.
Seafood Safety Website: www.fda.gov/seafood
[Analysis of Per- and Poly\(fluoroalkyl\) Substances \(PFASs\) in Highly Consumed Seafood Products from U.S. Markets - PubMed \(nih.gov\)](#)

Clinton Williams



Dr. Clinton Williams is the Research Leader of Plant and Irrigation and Water Quality Research units at US Arid Land Agricultural Research Center. Dr. Williams has been actively engaged in environmental research focusing on water quality and quantity for over 20 years. He looks for ways to increase water supplies through the safe use of reclaimed waters. His current research is related to the environmental and human health impacts of biologically active contaminants (e.g. PFAS, pharmaceuticals, hormones and trace organics) found in reclaimed municipal wastewater and the associated impacts on soil, biota, and natural waters in contact with wastewater. His research is also looking for ways to characterize the environmental loading patterns of these compounds while finding low-cost treatment alternatives to reduce their environmental concentration using byproducts capable of removing the compounds from water supplies. CC
<https://www.ars.usda.gov/pacific-west-area/maricopa-arizona/us-arid-land-agricultural-research-center/water-management-and-conservation-research/people/clinton-williams/>

Critical Outcomes:

The seven groups (day 3) developed new PFAS problem statement focal points that were built from the cross-breakout sessions (day 2) analysis of the 8 critical areas. They also developed high level roadmaps on what a solution timeline would look like, what the milestones along that timeline would be, what the outcomes would be, and what the beneficial impacts would be. Then they reported out on those.

The topic areas and those roadmap titles are:

1. Focal Point Topic: **Analytical Methods and Validation needs for PFAS**
Roadmap title: *The need for rapid quantitative methods for PFAS*
2. Focal Point Topic: **PFAS Alternatives, Abatement & Remediation**
Roadmap title: *Reduce PFAS from agroecosystems while optimizing resource inputs.*
3. Focal Point Topic: **PFAS Thresholds and Action Limits**
Roadmap title: *Where and when to apply Thresholds and Action Limits to PFAS in Agroecosystems*
4. Focal Point Topic: **Data Tools and Mapping**
Roadmap title: *Development of a data integration structure and harmonization system for PFAS in agriculture and food production*
5. Focal Point Topic: **The Problems of PFAS Scale, Scope and Source Tracking Arising from Biosolids**
Roadmap title: *Development of a Science-based Biosolids Management Program (The BMP)*
6. Focal Point Topic: **PFAS Fate and Transport in Agricultural Systems**
Roadmap title: *Development of solutions to the PFAS problems - in whole production systems: fate, transport and effective engagement*
7. Focal Point Topic: **Communication and Education**
Roadmap title: *Consolidation of PFAS "lessons learned"; questions, and unknowns for Development of Targeted Communication Tools to help address uncertainty and provide evidence that generates assurance of good alternatives for PFAS-safe paths forward - for diverse audiences.*