

NATIONAL
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Medicine

Exploring Linkages Between Soil Health and Human Health

Report Release Webinar

*Presented by Committee Members Nick Basta, Sarah Collier,
Mike Grusak, and Kelly Wrighton*

JUNE 13, 2024



Our New Report

Committee on Exploring Linkages
Between Soil Health and Human Health

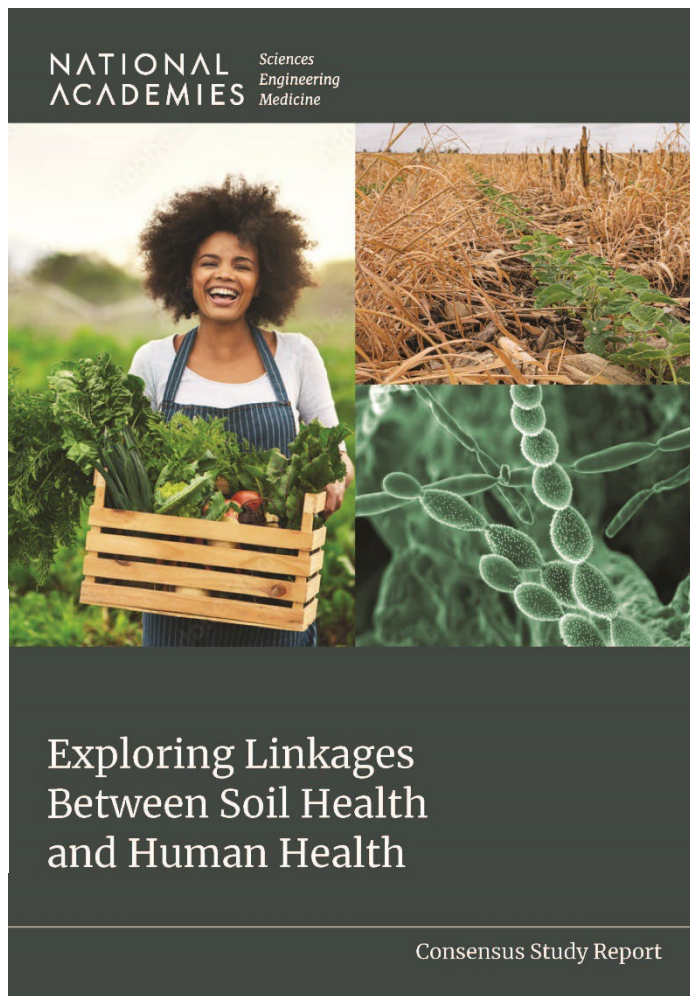
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Report available at <https://www.nap.edu/catalog/27459>



In Memory of Diana H. Wall

- Member of the National Academy of Sciences
- Inaugural Director of Colorado State University's School of Global Environmental Sustainability
- Soil scientist extraordinaire



Consensus Study Committee

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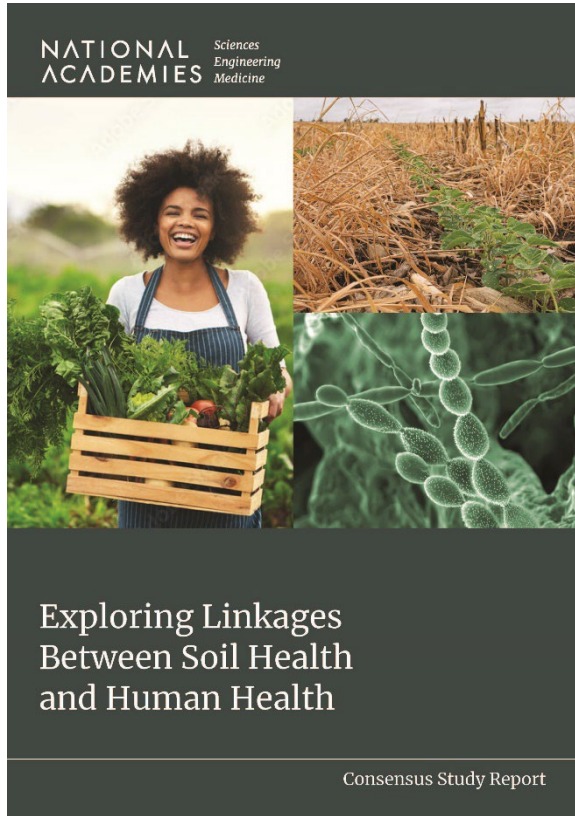
Study Statement of Task

A committee appointed by the National Academies of Sciences, Engineering, and Medicine will review the state of knowledge on linkages between soil health, with particular respect to U.S. agricultural soils, and human health and prepare a report describing the potential to increase the human health benefits from microbial resources in the soil. In the course of its review, the committee will identify current research efforts and examine scientific findings on such topics as:

- Relationships between the human microbiome and soil microbiome including the plant microbiome as part of a continuum;
- Linkages between soil management practices and the nutrient density of foods for human consumption and other effects on food;
- Information on soil-borne human pathogens and microbial compounds such as toxins;
- Information on the interactions of the soil microbiome with soil contaminants that pose risks to human health; and
- Soil management practices that enhance health benefits and reduce adverse health impacts.

The committee's report will describe key findings and knowledge gaps, identify promising research directions, and offer recommendations for enhancing the human health benefits derived from soils.

Organization of the Report



Summary

Chapter 1: Introduction, Approach, and Scope of Report

Chapter 2: The Connectivity of Health

Chapter 3: The Importance of Soil Health to Nature's Contributions to People

Chapter 4: Impacts of Agricultural Management Practices on Soil Health

Chapter 5: Linkages Between Agricultural Management Practices and Food Composition and Safety

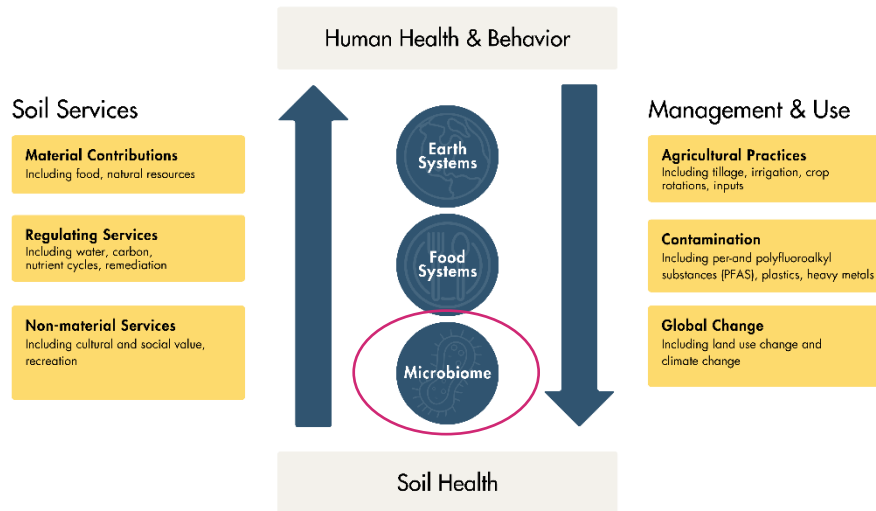
Chapter 6: Interactions of Soil Chemical Contaminants, Soil Health, and Human Health

Chapter 7: Microbiomes and the Soil–Human Health Continuum

Chapter 8: Going Forward

Appendixes

The soil–human health continuum assessed through a One Health framework



Soil biodiversity is essential to soil health and human health.

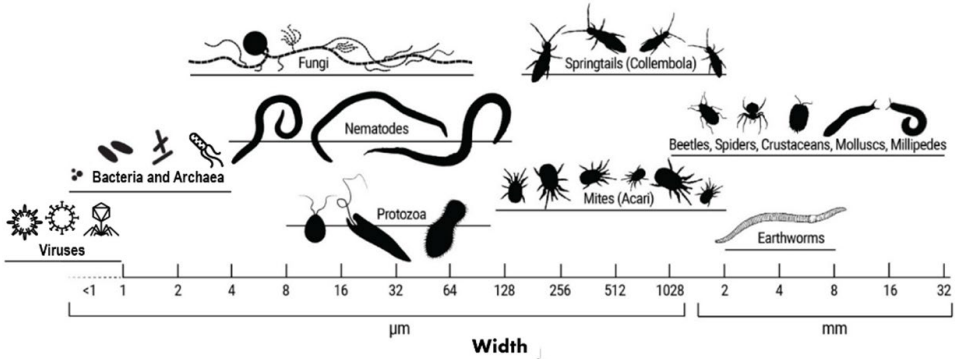


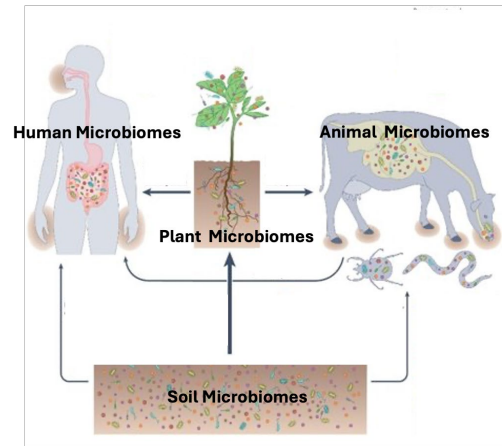
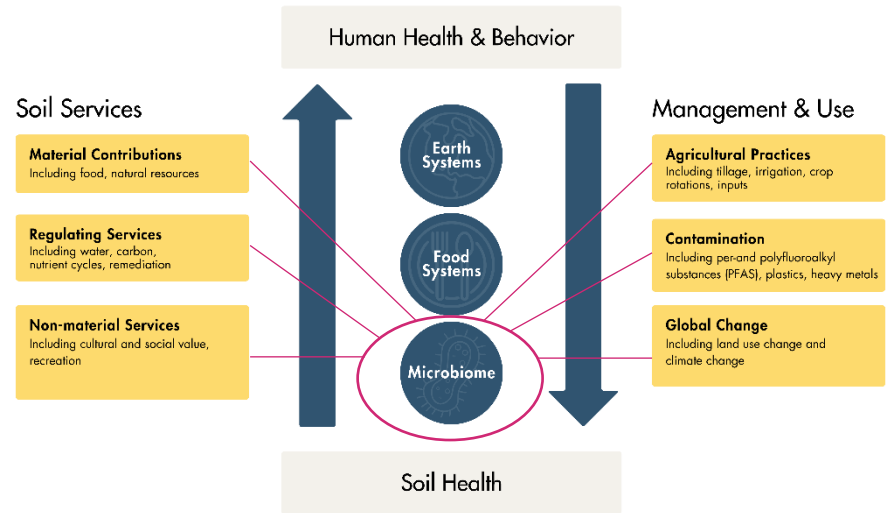
Illustration showcasing the vast biodiversity in soils. 2024, generated by DALL-E

Adapted from Brackin et al., *International Sugar Journal* 119 (1426) 2017

Microbiomes and the Soil–Human Health Continuum

Evidence strongly suggests that microorganisms create a link between the health of soils and the health of humans, but the processes by which microbiomes are established and influenced across these systems are still unexplored.

- Environmental exposure can have health outcomes
- Soils are untapped resources for medicinal discovery
- Microbiomes have promise for diagnosing and augmenting health in soils and humans
- Unclear relationships between human and soil microbiomes as part of a continuum via plants



Advancing our understanding of linkages between soil microorganisms and human health requires:

- More robust sampling with enhanced data re-usability that will quantify the microbial roles in human and soil health
- Improved decoding and diagnostic platforms to more effectively monitor the heterogeneity and dynamics in microbiomes
- Support for cross-domain collaborations to provide an integrated microbiome understanding that spans the soil to human continuum

The Multiple Functions of Soil

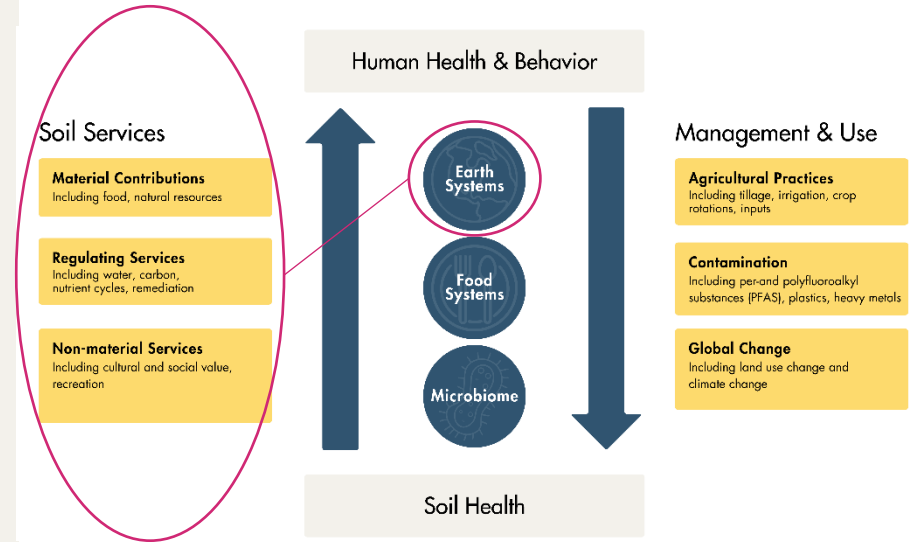


Food and Agricultural Organization of the United Nations. Reproduced with permission.

Soil's Contributions to Human Health

Soil-derived Nature's Contributions to People: Material contributions, regulating services, and non-material services from soil that benefit people

- Food supply, sustainability, and security
- Nutrient cycling and climate regulation
- Water regulation
- Suppression of plant disease
- Genetic, medicinal, and biochemical resources



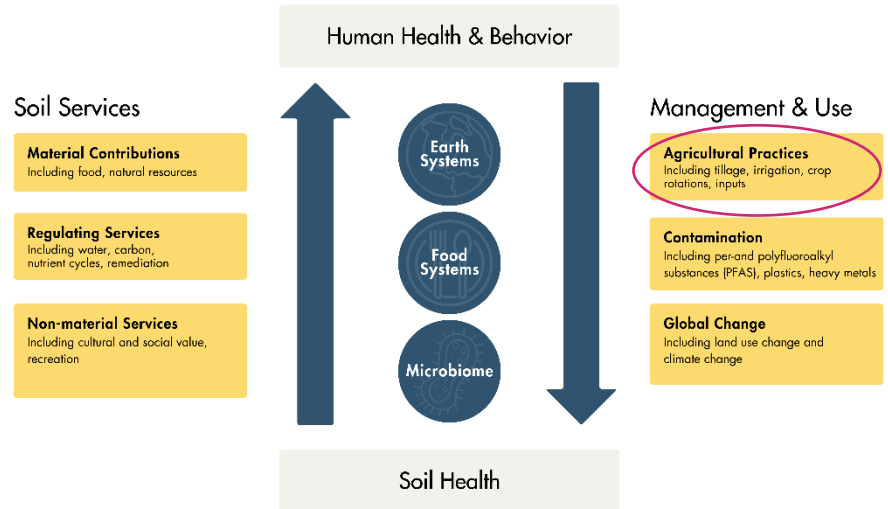
Advancing our understanding of soil-derived Nature's Contributions to People (NCP) requires:

- Better characterization and monitoring of NCPs
- Preservation of soil habitat and biodiversity
- Research that explores the mechanisms driving soil-derived regulating NCPs and approaches through which their benefits can be enhanced

Impacts of Agricultural Management Practices on Soil Health

Understanding how management practices influence physical, chemical, and biological attributes of soil health is key to fostering sustainable agricultural production systems that balance the need to produce food with the provision of other non-food related services.

- Tillage
- Water management
- Crop choice and rotation
- Nutrient application
- Biostimulants
- Pesticides



Soil Health Principles and Tradeoffs

MAXIMIZE CONTINUOUS LIVING ROOTS

- Crop Rotation
- Relay Crops
- Forage and Biomass
- Planting
- Perennial Crops
- Cover Crops

MINIMIZE DISTURBANCE

- No-till
- Reduced Tillage
- Controlled Traffic
- Avoid Tillage When Wet
- IPM

MAXIMIZE BIODIVERSITY

- Crop Rotation
- Rotational Grazing
- IPM
- Pollinator Plantings
- Organic Fertilizers
- Legumes in Mix
- Agroforestry
- Cover Crops
- Crop/Livestock Integration

MAXIMIZE SOIL COVER

- Mulching
- Reduced Tillage
- Forage and Biomass Planting
- Residue Retention
- Cover Crops
- Green Manures



USDA-NRCS

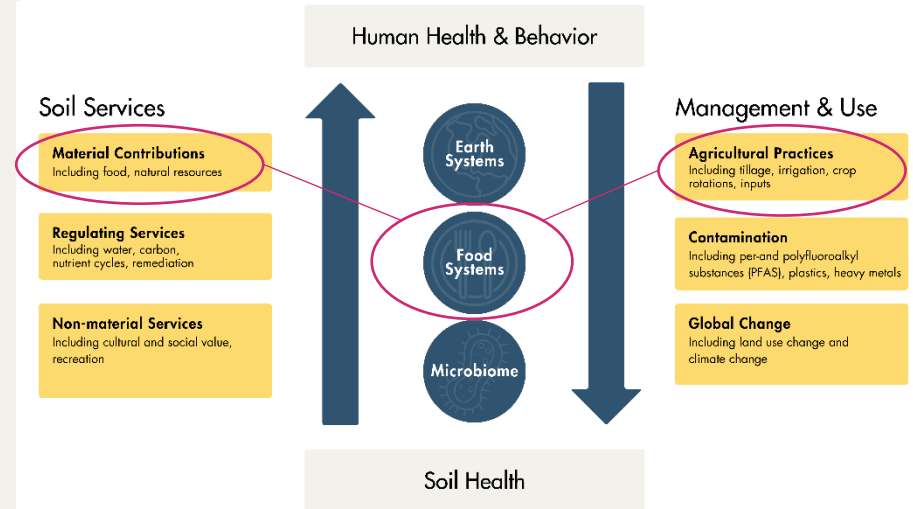
Improving soil health to improve human health requires:

- Better quantification of soil health through a coordinated national monitoring approach
- More long-term and on-farm research to better understand the underlying mechanisms of soil health
- Research into management practices that overcome potential trade-offs from common agricultural practices
- Research that increases the safe and effective use of underutilized resources
- Investment in plant breeding for more complex systems
- Farm-program support for practices that improve soil health and increase crop spatial and temporal diversification

Linkages Between Agricultural Management Practices and Food Composition and Safety

Nutrient availability in the soil, environmental conditions, management practices, and plant genetics all play a part in determining nutrient density in the food supply. Additionally, pre- and post-harvest variables affect the nutritional quality of food consumed, making it difficult to identify direct linkages from soil health to crop nutritional quality and on to human health.

- Food composition
- Food processing
- Foodborne pathogens
- Mycotoxins
- Consumer food choices



Challenges in Linking Agricultural Management Practices to the Nutritive Value of Food

- Studies of the effects of different production systems on nutrient density have not yielded consistent results
- Nutritional quality is determined by what ends up in the edible part of the plant, which is not always the part influenced by management practices
- Changes in yield affect the nutrient density in the edible part of the plant
- Health-beneficial phytochemicals often increase when plant stress increases, which may be mitigated by management practices
- Plant genetics play a large role in nutrient density
- Food-processing techniques affect nutrient density and availability in the consumed product

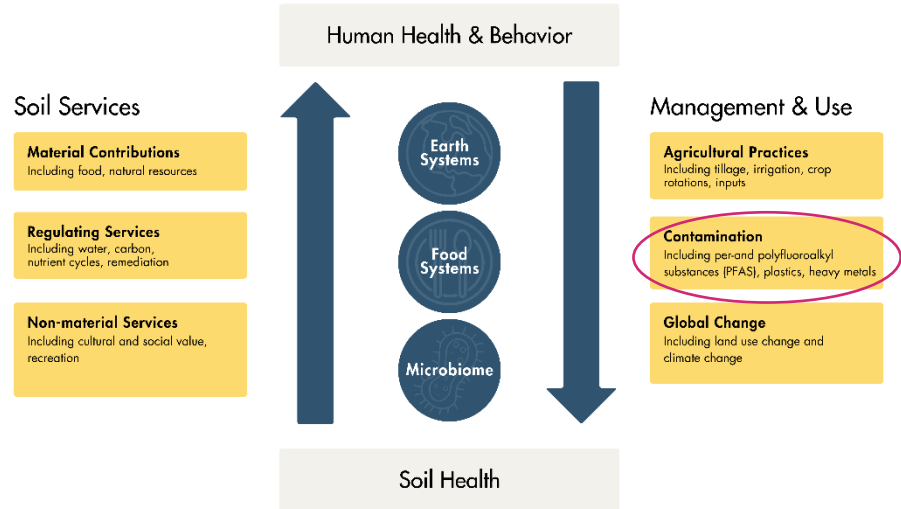
Advancing our understanding of linkages between agricultural management practices and the nutritive value of food requires:

- Translational research to understand the effect of practices on nutrient and bioactive density of crops
- Research to understand how food composition can be influenced by management or breeding to achieve higher levels of health-beneficial compounds
- Research to understand the utility of biostimulants in nutrient uptake and yield and potential effects on indigenous soil microbiome
- Research in food-processing technologies that enhance profile of health-beneficial nutrients and compounds

Interactions of Soil Chemical Contaminants, Soil Health, and Human Health

Soil is a significant repository for chemical contaminants that pose substantial threats to both human health and the environment.

- Heavy metal and metalloids (lead, arsenic, and cadmium)
- Microplastics
- Per- and polyfluoroalkyl substances (PFAS)

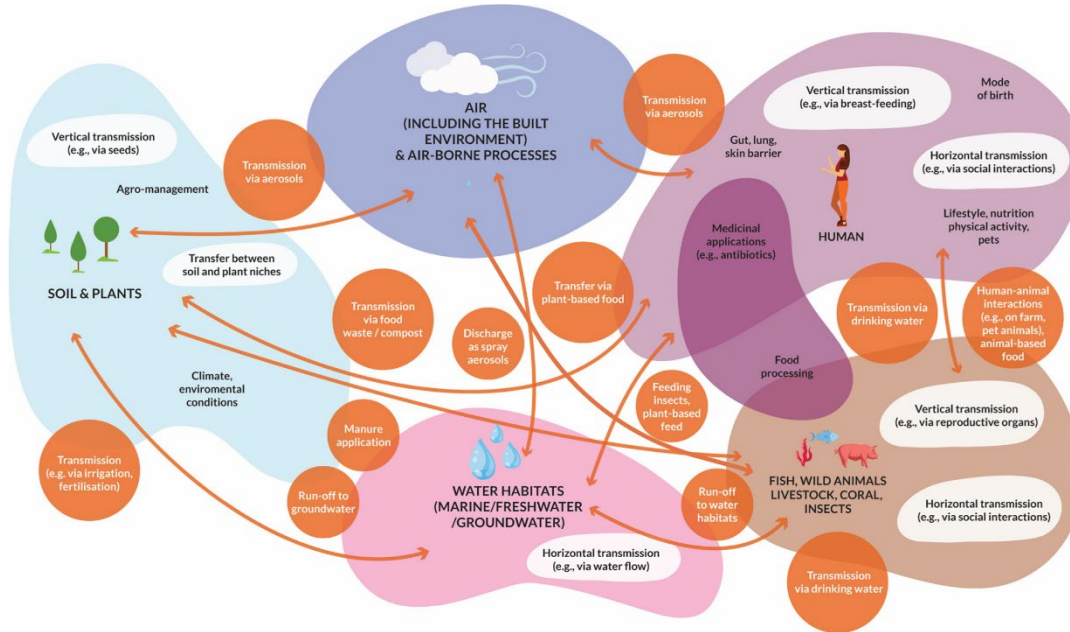


Advancing our understanding of soil chemical contaminants, soil health, and risks to human health requires:

- Mapping soil chemical contaminants to identify where levels may be particularly high
- Reducing knowledge gaps about exposure pathways to contaminants in soil and compound effects from exposure to multiple contaminants
- Mitigating contaminants in wastewater and biosolids
- Converting biosolids into biochar
- Adopting practices that increase soil organic matter content and biodiversity

Increasing awareness

Federal agencies and scientific societies should continue their work to promote the public awareness of the importance of soil health and its societal value beyond its immediate material benefits.



Thanks for listening!

We invite your questions.



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