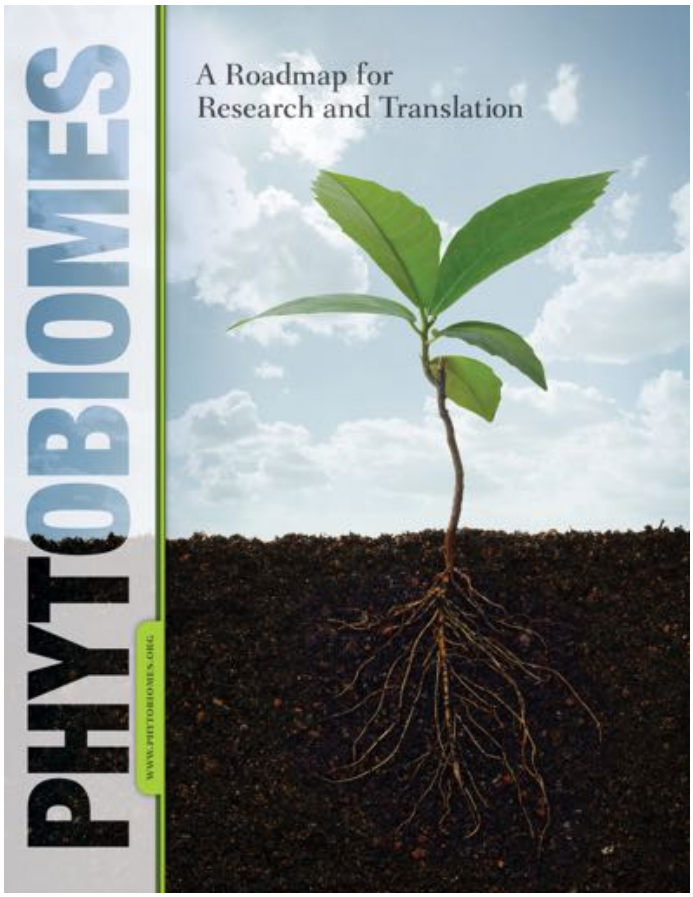
PHYTOBIOMES

A Roadmap for Research and Translation



Press Kit

25 February 2016

Contact
Isabelle Caugant
caugant@eversoleassociates.com
+32 484 750 634

Press Release

Launch of the Roadmap for Phytobiomes Research

A new approach for agriculture to achieve sustainable crop production

25 February 2016 – Washington DC, USA

On 25 February 2016, a group of scientific societies, companies, research institutes, and governmental agencies launched the Phytobiomes Roadmap presenting a new vision for agriculture to increase health, productivity, and sustainability of our current cropping and forest systems.

The Roadmap outlines a strategic plan for acquiring critical knowledge of how all of the components on a farm interact and affect each other. These components – the crops, plants, microbes, animals, soils, and climate – are collectively called the *phytobiome*.

The document lays out an action plan to translate that knowledge into powerful new tools for crop management to produce a sufficient supply of food, feed and fiber to meet global needs in the future.

"The Phytobiomes Roadmap provides a vision of integrating the many diverse components of agroecosystems, including the environment, all of the macroorganisms, and the microorganisms, into a systems-level understanding" explains Gwyn Beattie, Professor & Robert Earle Buchanan Distinguished Professor of Bacteriology at Iowa State University and co-leader of an initiative on phytobiomes.

This Roadmap comes at a critical time in which new innovative approaches are needed to sustainably increase global crop productivity to meet the demand of an additional 2.4 billion people by 2050. During that timeframe, experts predict that current agricultural systems will be facing multiple challenges due to more frequent extreme weather events, plateauing crop yields, and diminishing availability of land, water and other critical inputs.

Interactions within phytobiomes are dynamic and complex. The Roadmap advocates for a systems-level understanding of all the phytobiome components. It proposes to bring together current approaches and leverage and coordinate currently disparate activities to generate critical knowledge on how all constituents of phytobiomes interact with each other to affect crop health and yield.

Jan Leach, University Distinguished Professor at Colorado State University and phytobiomes initiative co-leader stresses that *"the success of this systems approach will require international collaborations of scientists with diverse expertise who can collect and interpret data that integrate interactions among organisms and their environments."*

Current technological developments – such as advances in genomic technologies, computational sciences, system-level approaches and precision agriculture – are enabling unprecedented insights for probing the complex interactions within phytobiomes. These technologies are providing extensive biological and environmental datasets. The Roadmap proposes to integrate these "big data" into predictive modeling systems to provide critical information to drive agricultural innovations.

The primary outcome is expected to be a shift in agricultural production from managing primarily individual components of cropping systems to managing whole systems using comprehensive systems-based knowledge of phytobiomes.

"By bringing together all ongoing initiatives from diverse scientific disciplines and connecting the dots between fundamental science and application, we aim to provide growers with practical tools with

which each farmer manages his/her own crop biomes for maximum efficiency, sustainability, and profitability," explains Kellye Eversole, phytobiomes initiative co-leader.

Translating knowledge of phytobiomes into next generation precision agriculture tools and techniques will empower farmers to produce sufficient crops to meet global demands. For example, it could be envisioned that growers will have at their disposal crop varieties that better exploit phytobiome components in specific environments for stronger resilience to pests and limited water and nutrients. Another application would be new innovative management practices to grow crops on marginal and degraded lands with minimized negative impacts on the environment.

The Phytobiomes Roadmap was developed under the leadership of the American Phytopathological Society (APS), based on discussions and input provided by over 200 academic, industry, and government representatives at a workshop organized in Washington DC in July 2015, as well as from input by the scientific community and the general public through the Phytobiomes website.

The Roadmap has broad support from professional societies, industry, government agencies, private foundations, non-profit institutes, and government-supported research networks.

Contact

Isabelle Caugant
caugant@eversoleassociates.com
+32 484 750 634
Twitter: @PhytoBiomes

About Phytobiomes

Initially developed by the American Phytopathological Society (APS) Public Policy Board, the Phytobiomes vision is an effort to increase interest and funding in phytobiomes research and to apply knowledge of phytobiomes to promote food, feed and fiber production. www.phytobiomes.org

###

Executive Summary

The Phytobiomes Roadmap offers a new vision for agriculture in which sustainable crop productivity is achieved through a systems-level understanding of diverse interacting components.

Phytobiomes consist of plants, their environment, and their associated communities of organisms. Interactions within phytobiomes are dynamic and profoundly affect plant and agroecosystem health, which in turn impacts soil fertility, crop yields, and food quality and safety.

Global demands for food, feed, and fiber are expected to double in the next 35 years. In the same timeframe, we face a world of diminishing arable land, extreme weather events, unsustainable fertilizer inputs, uncertain water availability, and plateauing crop yields. We need new innovative approaches to sustainably increase global crop productivity.

This Roadmap describes a strategic plan for acquiring knowledge of what constitutes a healthy, productive, and sustainable agroecosystem and translating that knowledge into powerful new tools in our crop management toolbox. Integration of these tools is needed to help increase food production from existing farmland while minimizing negative impacts on the environment, increase global arable land by rehabilitating marginal and degraded lands, and ensure sustained productivity and profitability of global food, feed, and fiber.

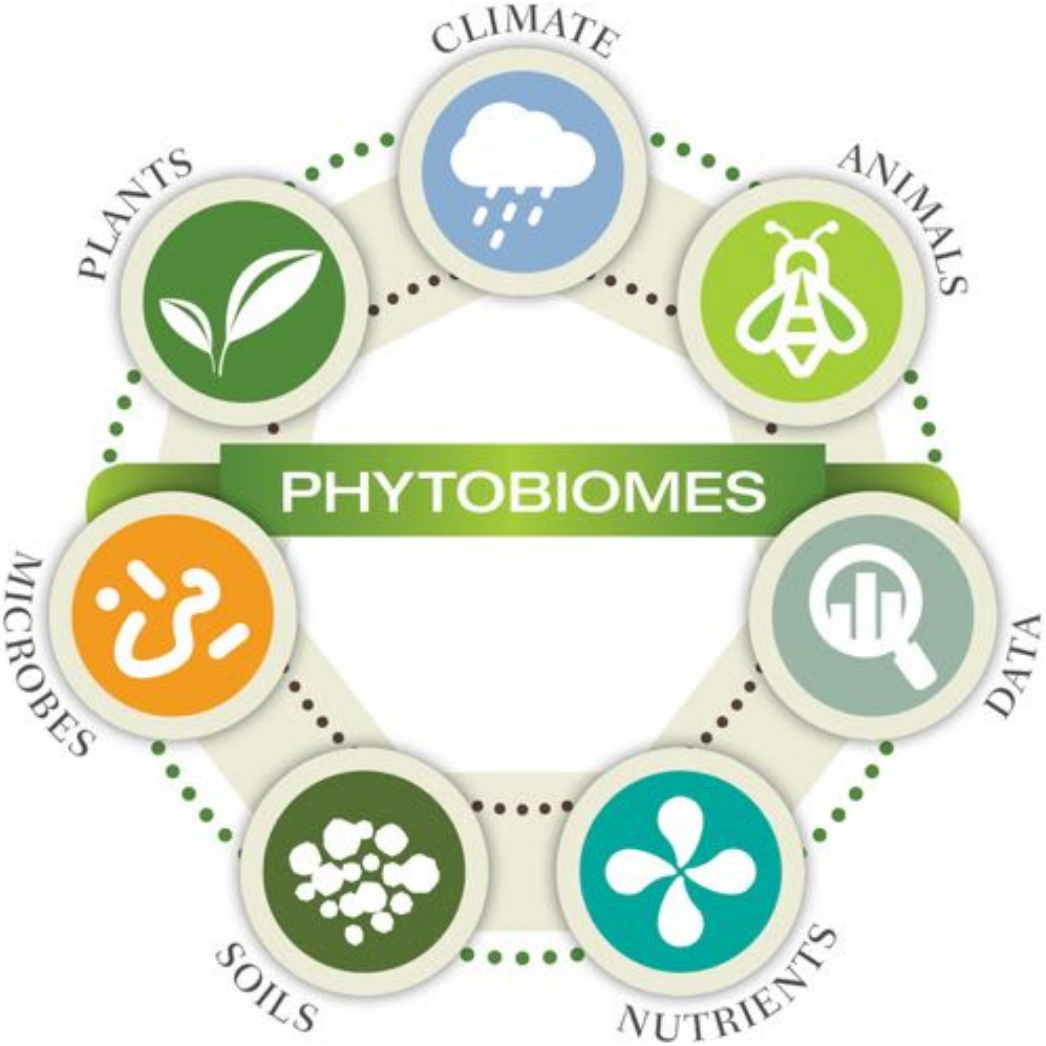
This Roadmap aims at maximizing sustainable food production by generating, optimizing, and translating into practice new knowledge of phytobiomes. Steps to achieve this vision are to explore phytobiome components and their interactions, integrate phytobiome systems-based knowledge, resources, and tools, optimize phytobiome-based site-appropriate solutions, and apply phytobiome-based solutions in next-generation agricultural practices to sustain enhanced food production worldwide, with concurrent efforts to educate and engage scientists, public and private partners, growers, educators, and society.

To help guide these efforts, this Phytobiomes Roadmap outlines major gaps in knowledge, technology, and infrastructure for research and translation and identifies challenges to efforts to educate and train a workforce that will carry this field into the future.

We are currently witnessing a nexus of technologies that will enable advances in fundamental knowledge of phytobiomes and translation into sustainable crop production practices. Conceptual and technological advances in diverse fields of research, including ‘omics sciences, systems biology, microbial ecology, data science, and precision crop management systems, are positioning researchers to achieve major leaps in characterizing, analyzing, and managing phytobiomes as integrated systems.

Strategic funding and public-private partnerships are needed to support critical research and infrastructure for developing phytobiome-based management approaches. Key research areas include fundamental studies of phytobiome components, interactions, dynamics, and functions; the generation of integrated systems-based models for phytobiome analysis and prediction; the development of practical phytobiome- based crop management strategies; and the establishment of collaborative global platforms for open communication among growers, researchers, industry, extension, agricultural consultants and advisors, and consumers. Filling the knowledge gaps will require interdisciplinary cooperation.

A new journal, *Phytobiomes*, will launch this year, and an international phytobiome alliance is being established to contribute to the coordination of research and communication among diverse disciplines and disciplinary initiatives relevant to phytobiomes. Working groups will be established to help develop priorities and standards for phytobiome research. Major thrusts will focus on forging international and public-private collaborations in foundational and translational phytobiome research and on attracting and strengthening the phytobiome workforce. The goal is to generate and integrate knowledge of phytobiomes with next-generation technologies to empower both small- and large-holder farms to produce, sustainably and profitably, sufficient crops to meet the increasing global demand.



Biographies

Jan Leach
University Distinguished Professor, Associate Dean for Research
College of Agriculture, Colorado State University, USA

Jan Leach is a plant pathologist whose research focuses biotic and abiotic factors that impact the durability of plant disease resistance. Questions she addresses are “why are plants more susceptible to disease at high temperatures?” and “how do high temperatures affect the efficacy of plant disease resistance genes?”

Other projects currently underway in her laboratory are related to bioenergy (genetics of biomass production), improving health benefits of crop plants, and the development of novel tools for detection and monitoring of microbes associated with plants.

Jan is a Fellow and a past President of the American Phytopathological Society (APS). She is past chair of the APS Public Policy Board and co-leader of this initiative on phytobiomes.

www.leachlab.colostate.edu

Kellye Eversole
President, Eversole Associates
Executive Director, IWGSC

Kellye Eversole has been a science and technology consultant since 1991 and a leader in agricultural genomics since 1994. She has led several U.S. and international animal, plant, and microbial genome sequencing projects (maize, cow, pig, chicken, and sheep). Currently, she is leading the international effort to sequence the genome of bread wheat as Executive Director and Chaiman of the Board of the International Wheat Genome Sequencing Consortium (IWGSC).

Kellye also serves as the Executive Director of the Specialty Crop Regulatory Assistance initiative and as the Chief Science and Technology Officer of IE-Strategic Crop Services. She is a member of the American Phytopathological Society Public Policy Board and co-leader of this initiative on phytobiomes.

www.eversoleassociates.com

Gwyn Beattie
Professor & Robert Earle Buchanan Distinguished Professor of Bacteriology for Research and Nomenclature
Iowa State University, USA

Gwyn Beattie is a microbiologist whose research explores the genomics and ecology of plant-associated microbes. Her work aims to better understand the factors driving successful plant colonization and the many impacts that microbes have on plant health.

Current projects in her laboratory focus on the influence of bacterial and fungal communities on plant water use efficiency and the molecular mechanisms enabling bacterial pathogens to use light and environmental stress signals to colonize leaves or to adapt to life in the plant vascular system.

Gwyn is a member of the American Society for Microbiology and of the American Phytopathological Society. She is future chair of the APS Public Policy Board and co-leader of this initiative on phytobiomes.

www.plantpath.iastate.edu/people/gwyn-beattie

Linda Kinkel
Professor
University of Minnesota, USA

Linda Kinkel's research focuses on the ecology and evolutionary biology of plant and soil microbes and their effects on plant disease and plant productivity with the aim of devising strategies for better controlling soil-borne plant pathogens.

Current projects in her laboratory focus on the ecological and coevolutionary dynamics of antibiotic-producing bacteria and how they contribute to disease suppression in both agricultural and natural habitats. Linda and her group also evaluate strategies for creating synthetic microbial communities for soil and plant inoculation, and study the ways in which microbial phenotypes vary across diverse plant, soil, and microbial community contexts.

Linda is a member of the American Phytopathological Society and the American Society for Microbiology. She serves on the APS Public Policy Board.

https://plpa.cfans.umn.edu/people/faculty/linda-kinkel

Steve Lindow
Professor, Executive Associate Dean
College of Natural Resources, University of California Berkeley, USA

Steve Lindow is a plant pathologist and microbial ecologist. He studies bacteria that live on plant surfaces as well as those that live within the vascular tissue of plants. His research aims at better understanding the ecology of plant colonists so that biological strategies for plant disease and frost control can be better implemented as alternatives to chemical pesticides.

Steve is a Member of the National Academy of Sciences, a Fellow of the American Phytopathological Society, a Past President of the International Society for Microbial Ecology, and is a Senior Editor for the ISME Journal.

icelab.berkeley.edu

Comments

About the phytobiomes Roadmap

"The Phytobiomes Roadmap builds on the premise that innovative and sustainable approaches to food, feed and fiber production will be achieved through integrating knowledge of agricultural system at multiple scales. The success of this systems approach will require international collaborations of scientists with diverse expertise who can collect and interpret data that integrate interactions among organisms and their environments. It is such an exciting time to be an agricultural scientist!"

Jan Leach
University Distinguished Professor, Colorado State University

- - - - - - - - - - - - - - -

"By bringing together all ongoing initiatives from diverse scientific disciplines and connecting the dots between fundamental science and application, we aim to provide growers with practical tools with which each farmer manages his/her own crop biomes for maximum efficiency, sustainability, and profitability"

Kellye Eversole
Executive Director, Eversole Associates

- - - - - - - - - - - - - - -

"The last decade has been an exciting time to be a microbiologist, as new technologies are allowing us to probe deeply into vast microbial communities in soils, plants and animals. These tools are like a new telescope that is bringing the blur of these communities into sharp focus. The Phytobiomes Roadmap provides a vision of integrating the many diverse components of agroecosystems, including the environment, all of the macroorganisms, and this new frontier of microorganisms, into a systems-level understanding. This Roadmap provides a framework for generating this understanding and translating it into practices that will support sustainable agricultural productivity into the future."

Gwyn Beattie
Professor, Iowa State University

- - - - - - - - - - - - - - -

"The phytobiomes initiative builds upon the exciting advances in our understanding of the complex networks of interaction that support plant productivity. The Phytobiomes Roadmap provides a clear vision and a `to do' list that will engage scientists from diverse disciplines in building our capacities to sustainably manage phytobiomes to support global food, feed, and fiber needs. It has been a privilege to be a part of this process!"

Linda Kinkel
Professor, University of Minnesota

- - - - - - - - - - - - - - -

"We are at a crossroads in history where there are now many powerful approaches to understand the complex interactions involving the many organisms and the physical and chemical world in which plants grow. The Phytobiomes Roadmap will serve as a call to the international research community to recognize the needs and opportunities to further develop and apply this science to attain more productive and sustainable agricultural systems. I am excited at the prospects that our new-found knowledge of crops will result in a new paradigm in agriculture that enables us to continue to meet future demands for food and fiber."

Steven Lindow
Professor, University of California Berkeley

""We believe the goals of the Phytobiomes Roadmap will help achieve our grand challenge to sustainably improve the human condition for a growing global population in a changing environment."

Ellen Bergfeld
CEO of American Society of Agronomy,
Crop Science Society of America and Soil Science Society of America

- - - - - - - - - - - - - - - -

""The phytobiomes initiative's whole system approach represents the visionary thinking required to solve the pressing problems that face agriculture. Like the Soil Health Institute, the phytobiomes initiative is what the agriculture research sector has been needing for a long time. We appreciate the broad approach and foresight they bring. In addition, the phytobiomes initiative strives to understand the fundamental workings of our natural systems so that we can improve agricultural productivity, while being good stewards of these resources. Their research will produce critical outcomes and shape agriculture globally for generations to come."

Bill Buckner
Board Chairman, Soil Health Institute

- - - - - - - - - - - - - - - -

"Coordinating deep, cross-disciplinary approaches to elucidating, manipulating and ultimately harnessing the phytobiome is a critical approach to enabling science to meet the world's increasing demands for food, feed, fiber and fuels in a sustainable manner."

Steve Evans
Fellow, Dow AgroSciences

- - - - - - - - - - - - - - - -

"Understanding the interactions among plants, microbes and the environment is crucial to develop and maintain a sustainable crop productivity. The phytobiomes initiative, by using cross-disciplinary approaches, will bridge basic research to novel and viable agricultural solutions. I believe the outcome of the Phytobiome research will fill a technical gap, essential to shaping new and sustainable farming systems. "

Magalie Guilhabert-Goya
Head of Global Crop Efficiency, CropScience Biologics Research, Bayer

- - - - - - - - - - - - - - - -

"The American Society of Animal Science (ASAS) supports the vision and strategies described in the Phytobiomes Roadmap. Plants (row crops or pastures) are the main sources of feed for livestock and poultry. ASAS believes that a comprehensive understanding of phytobiomes will improve the productivity and efficiency of crop production and pasture-based grazing systems thereby ensuring sustainable livestock and poultry production systems to meet the growing global demand for animal-sourced foods."

Deb Hamernik
President-Elect, American Society of Animal Science

Roadmap Sponsors

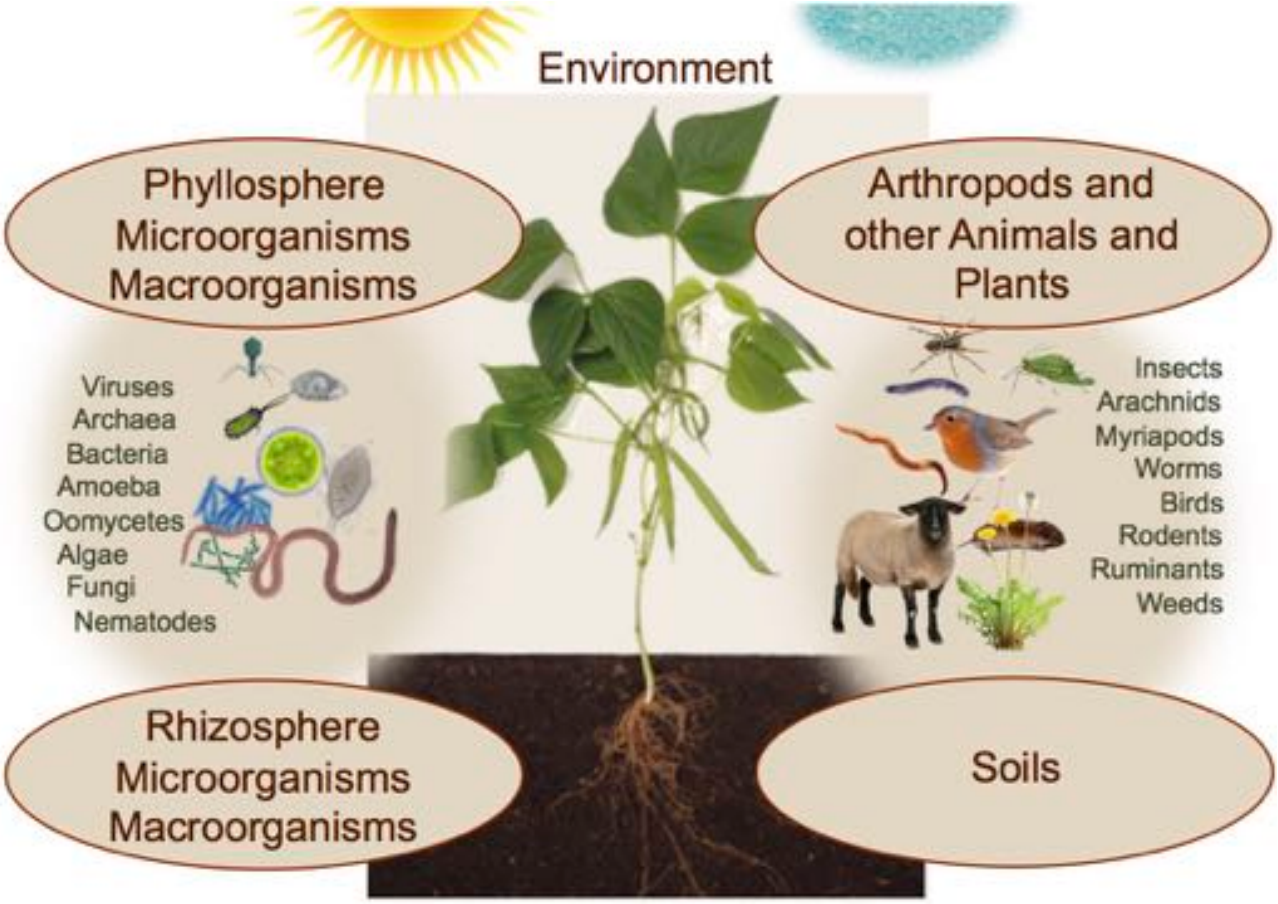
The following organizations and companies have endorsed the Phytobiomes Roadmap

About Phytobiomes

PHYTO = related to plants
BIOME = a community of plants, microbes and animals living together in a particular climate and physical environment

PHYTOBIOMES consist of plants, their environment, and their associated micro- and macroorganisms. These organisms, which may be inside, on the surface, or adjacent to plants, include a wide diversity of microbes (viruses, bacteria, fungi, oomycetes, and algae), animals (arthropods, worms, nematodes, and rodents), and other plants. The environment includes the physical and chemical environment influencing plants and their associated organisms, and therefore, the soil, air, water, and climate.

The sphere of relevance of phytobiomes is quite broad, spanning from crops (commodity crops, fruits, vegetables, forest, and specialty and bioenergy crops), rangelands, grasslands, and natural ecosystems to consumer products, including the quality, nutritional value, and safety of our foods.



Phytobiomes website: www.phytobiomes.org

Press clips

Farm & Ranch Guide
14 October 2015

FARM&RANCH GUIDE

Soil community studies phytobiomes to aid in farming

OCTOBER 14, 2015 10:15 AM • ANDREA JOHNSON, FARM & RANCH GUIDE

Scientists hope to unlock nature's age-old secrets through a new field of study – phytobiomes research.

Phyto (plant) biome (environment) refers to everything that surrounds a plant and affects how it grows.

Farmers have to be knowledgeable in agronomy, engineering, weed science, varietal selection and more to be successful.

In that same way, the study of phytobiomes provides a path for scientists to work together to improve the plant's environment.

"We don't need just plant pathologists, plant biologists, agronomists, soil scientists, physicists or engineers. We need to have people who understand cropping systems and what it takes to produce the crop in a healthy way," said Distinguished Professor Jan Leach, Ph.D., Colorado State University.

Phytobiomes studies the system of influences affecting the health and productivity of plants and plant ecosystems.

For instance, as a plant pathologist, Leach studied one crop – rice, and looked at one disease – bacterial blight of rice. But she recognized that the bacteria and the plant didn't interact in an isolated system. Factors affecting the way the bacteria and the rice interacted include the soil, the microbes in the soil, insects, soil nutrients, the environment, temperature, rain, humidity and wind.

Now Leach is co-chair of a group of scientists that have formed "The Phytobiomes Initiative."

They are developing a plan to generate a comprehensive, systems-level understanding of all of the components in agronomically important plant biomes.

In addition, the group hopes to achieve a $100 million net increase per year in agricultural research funding across agencies dedicated to phytobiomes.

The initiative was initially developed by the American Phytopathological Society and has received support from USDA, U.S. Department of Energy, National Science Foundation,

The Samuel Roberts Noble Foundation, Bayer CropScience and USDA Forest Service.

The scientists feel this a great time to study phytobiomes due to technological developments and super computers that can sort out complexities and provide an unprecedented view of nature.

In addition, precision agriculture may offer practical applications for phytobiome findings by placing probiotic agents and other items only where they are needed in the field.

The members of the Initiative think they can attain a comprehensive understanding of phytobiomes by 2025 to help ensure sustained crop productivity.

They hope to translate the data into broad improvements in productivity and sustainability on farms and forests around the world. In addition, they hope to offer management strategies that create disease-suppressive communities.

Leach and others will be sharing the vision of The Phytobiomes Initiative at the "Synergy in Science" meeting in Minneapolis in November. This meeting is sponsored by the American Society of Agronomy, Crop Science Society of America, and the Soil Science Society of America.

They hope to work with farmers to better understand cropping systems and what it takes to produce crops in a healthy way.

"We're trying to get teams of scientists to study a more holistic approach to all of these factors that influence plant productivity or its ability to survive or persist in the environment to the betterment of agriculture," Leach said.

Article link: http://www.farmandranchguide.com/news/agri-tech/soil-community-studies-phytobiomes-to-aid-in-farming/article_73507a34-7284-11e5-abc1-17c8dce9f15c.html

The bright-line brown eye (*Lacanobia oleracea*) is just one of many potential tomato residents.

BOTANY

Plant dwellers take the limelight

Researchers seek holistic view of botanic ecosystems.

BY HEIDI LEDFORD

A plant may be rooted in place, but it is never lonely. There are bacteria in, on and near it, munching away on their host, on each other, on compounds in the soil. Amoebae dine on bacteria, nematodes feast on roots, insects devour fruit — with consequences for the chemistry of the soil, the taste of a leaf or the productivity of a crop.

From 30 June to 2 July, more than 200 researchers gathered in Washington DC for the first meeting of the Phytobiomes Initiative, an ambitious proposal to catalogue and characterize a plant's most intimate associates and their impact on agriculture. By the end of the year, attendees hope to carve out a project that will apply this knowledge in ways that will appeal to funders in industry and government.

"We want to get more money," says plant pathologist Linda Kinkel at the University of Minnesota in St Paul. "But beyond that, let's just all try to talk the same language and come up with some shared goals."

The effects of microbes and insects on plant health have often been studied in pairs — one microbe and one plant. But advances in genetic sequencing have opened up ways to survey entire microbial communities. Meanwhile, engineers and computational biologists have developed better ways to manage large data sets, merge disparate recordings into cohesive models and rapidly collect information on the physiology of every plant in a field. "Historically, we haven't had the capacity to look at this as a system," says plant pathologist Jan Leach at Colorado State University in Fort Collins. "Now we need to begin to integrate not just the data about the plant and the plant's environment, but all the biological components in that system."

Leach coined the term phytobiome in 2013, at a retreat about food security. She defines the phytobiome broadly, to encompass microbes, insects, nematodes and plants as well as the abiotic factors that influence all these.

Since then, she has visited companies, funding agencies and universities to call for a unifying phytobiomes initiative. She has teamed up with Kellye Eversole, a consultant based in Bethesda, Maryland, and the co-owner of a small family farm in Oklahoma, who has experience working on large agricultural genomics projects, including the US National Plant Genome Initiative. That initiative was launched in 1998 and continues to crank out databases and other tools for analysing plant genomes.

Leach hopes that the Phytobiomes Initiative will leave a similar legacy, but she is mindful that federal funding has tightened considerably since 1998. Still, she notes that the project can build on several emerging trends in agriculture. Industry has shown renewed interest in boosting plant growth by manipulating associated microbes (*Nature* **504**, 199; 2013). Companies and farmers are also investing in 'precision agriculture', which uses high-tech monitors to track conditions in a field or even around individual plants, allowing farmers to water and fertilize in exactly the right places.

HIGH-TECH FUTURE

Eversole foresees a day when tractors will carry dipstick-like gauges that provide a snapshot of the microbial community in the soil. Data from the Phytobiomes Initiative would then help farmers to manipulate that community to their advantage, she says.

But first, the initiative needs to standardize protocols and metrics, the meeting's attendees determined. Kinkel says that efforts are likely to focus initially on cataloguing microbes and insects and their interactions with different crops and habitats. "We're where plant biologists were 150 years ago," she says. "We're still trying to inventory things."

Work has already begun along these lines: for example, a group at the International Rice Research Institute in Los Baños in the Philippines is fishing for microbial DNA in data discarded from an effort to sequence the rice genome. The goal is to determine which microbes prefer which strains of the crop.

Kinkel, meanwhile, has begun experimenting with manipulating carbon levels in the soil to alter the microbial population, with the aim of improving plant productivity. "If we can understand better who lives on and within plants, we have the potential to manage them to have healthier, more resilient plants," she says.

Projects such as these would move faster under an organized, cohesive framework, says Sarah Lebeis, a microbiologist at the University of Tennessee in Knoxville who is studying how plants manipulate microbial communities by secreting antibiotics into the soil. "Right now we're working as individuals," she says. "Having an initiative will give us focus and hopefully we'll progress further, faster, better." ■

Article link: http://www.nature.com/news/plant-denizens-get-the-big-science-treatment-1.17920