Harnessing Nature's Allies

Microbial Insights for Optimizing Bamboo Farming

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Key Takeaways

Regenerative biological farming is the way

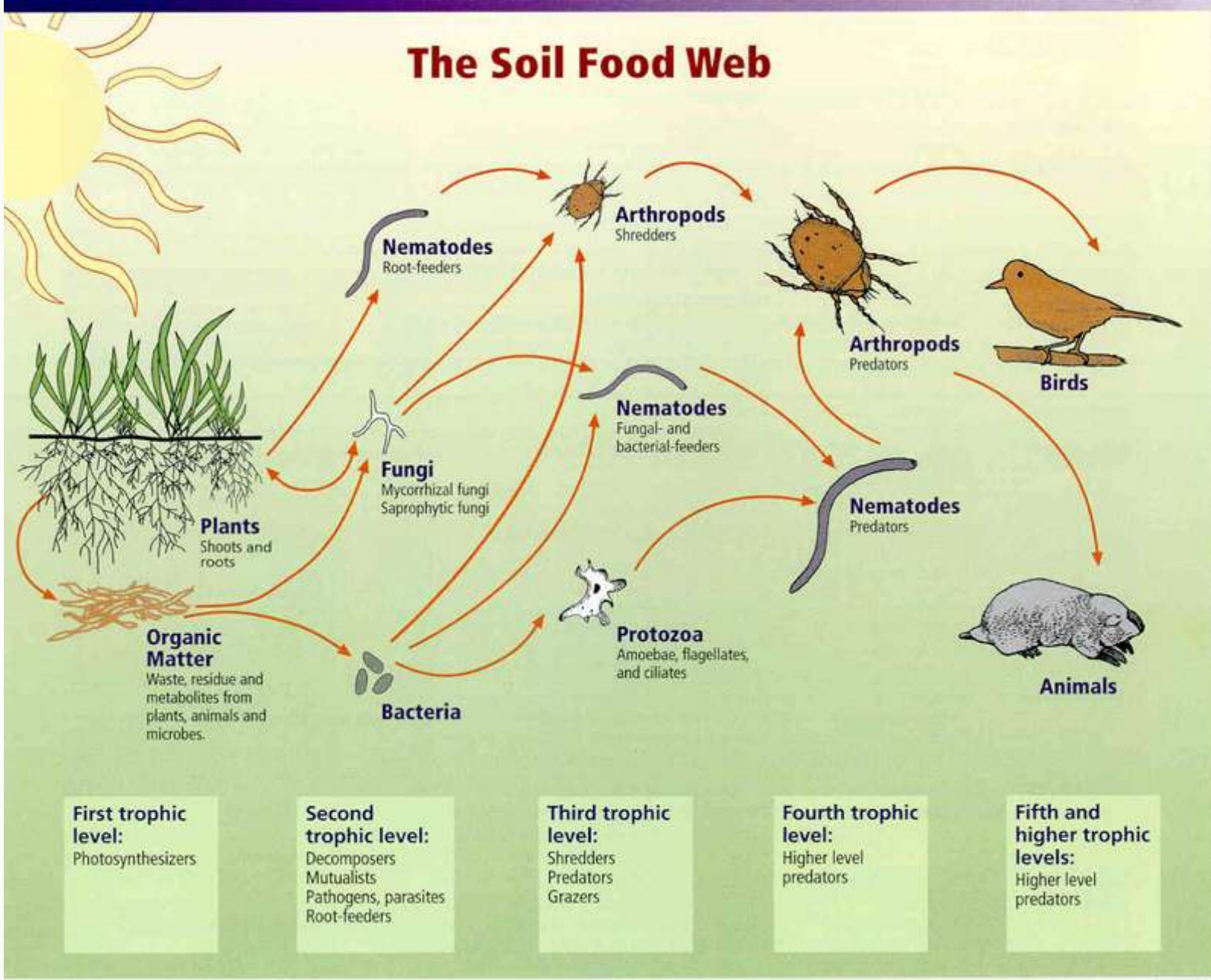
- We have **40 years left** of topsoil worldwide
  - Future of farming is biological
- Microbes in **Tsp of living soil >** # people on Earth
  - Holy grail =1:1 Fungal to Bacterial biomass ratio
  - Going biological is easy and costs less
- Bamboo Farming
  - How to use the biologicals to supercharge my bamboo grove
  - Tips for addressing unhealthy bamboo


52 PERCENT
of agricultural soils are already degraded.
(ELD Initiative, 2015)
SAVE SOIL
savesoil.org

Complete Food Web

- Complex
- Delicate
- Resilient
- Cycles nutrients

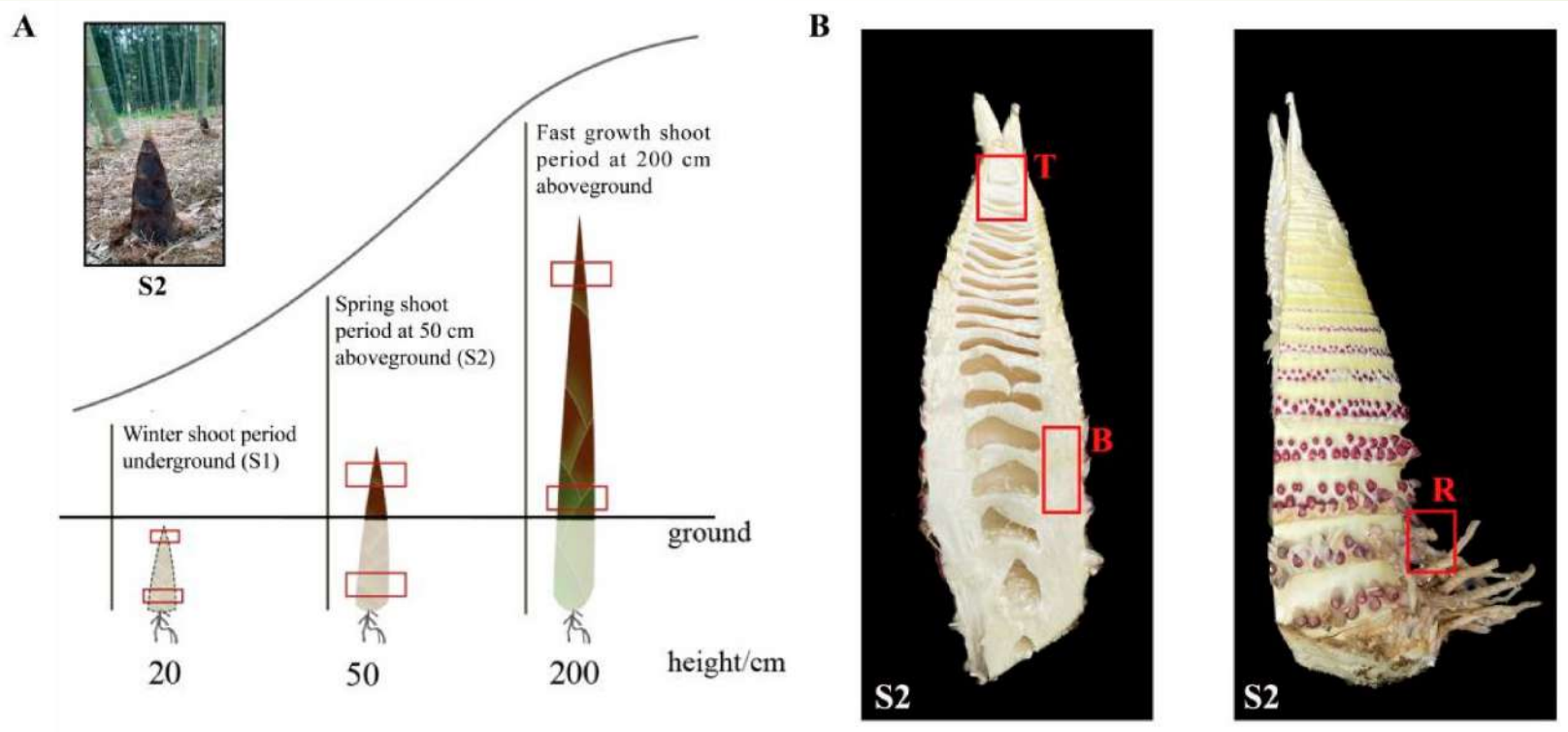
Dr. Elaine Ingham



Relationships between soil food web, plants, organic matter, and birds and mammals
Image courtesy of USDA Natural Resources Conservation Service
http://soils.usda.gov/sqi/soil_quality/soil_biology/soil_food_web.html.

We Can't Farm Bamboo without microbes

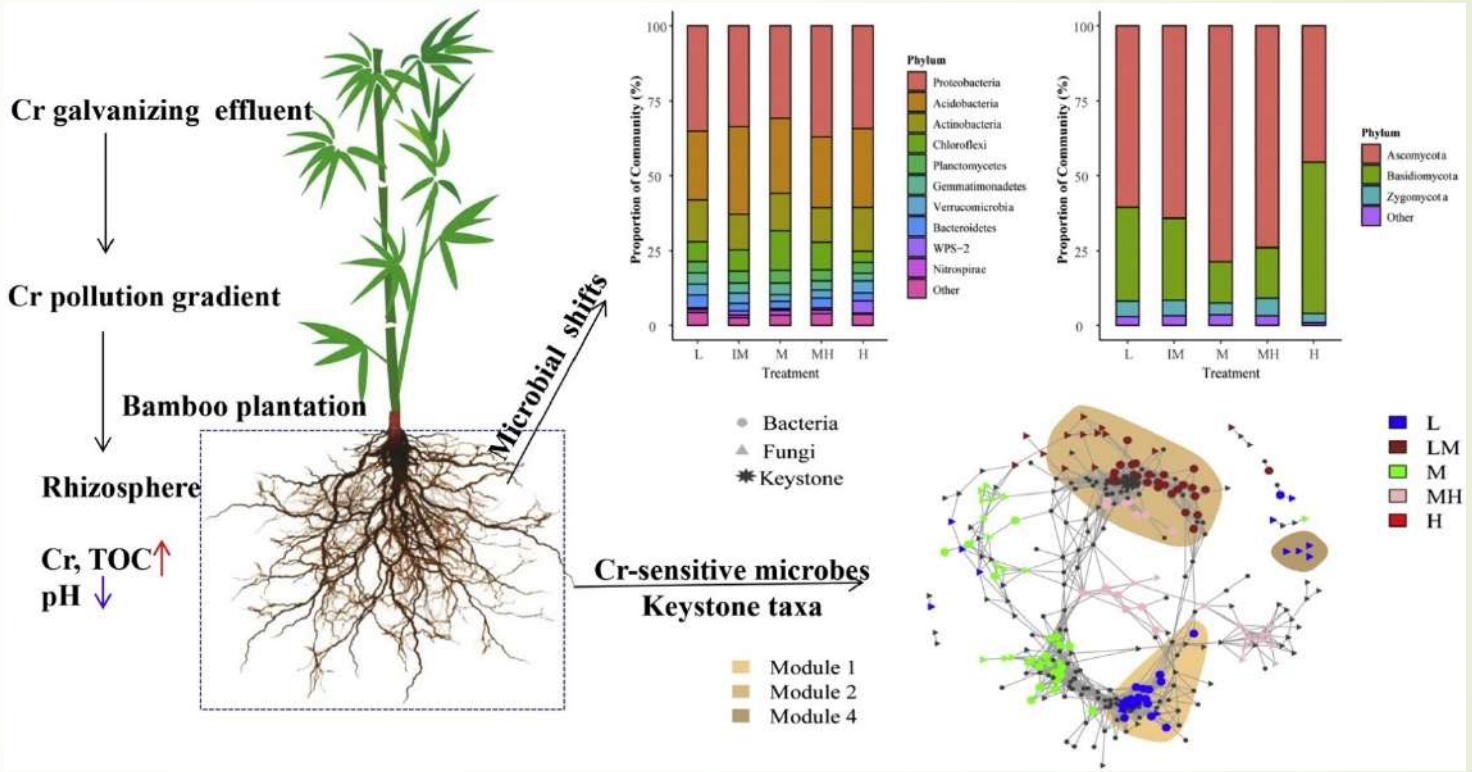
- Microbes are 70% of total Biomass on Earth
- Microbes influence plant health and growth
- Plants farm Microbes



Zhao, Ding, Huang, Cheng (10/16/2023) "Bioprospecting Plant-Growth-Promoting Endophytic Bacteria Isolated from Moso Bamboo Shoots

Bamboo Microbiome

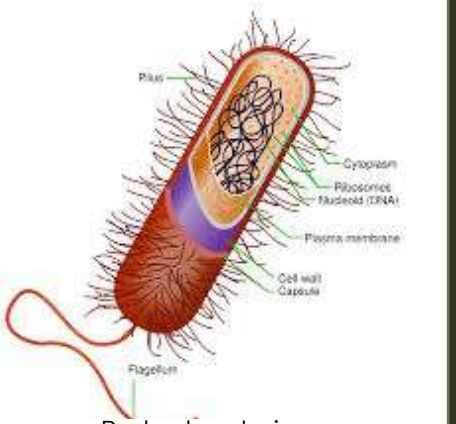
- **Rhizosphere**: The region of soil adjacent to the stems, rhizomes, and feeder roots of runner bamboo
- **Phyllosphere:** Total above ground surface of a plant when viewed as habitat for microbes.
- **Endophytes/Endosymbionts**: Microbes that live inside plant tissue



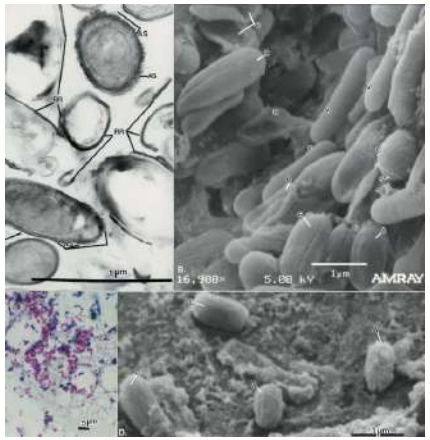
Zhang, Bian, Zhong, Gai, Yang (11/15/2020) Deciphering the Rhizosphere Microbiome of a Bamboo Plant in Response To Different Chromium Contamination Levels

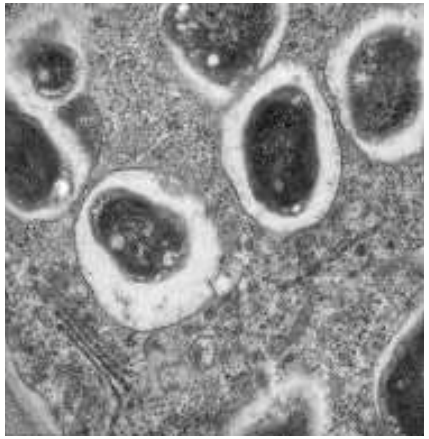
Nitrogen-Fixing Bacteria

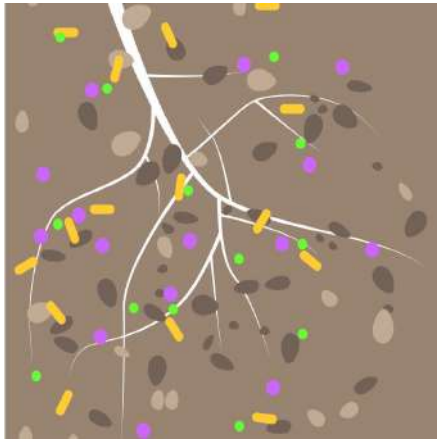
- Importance of Nitrogen:
  - Amino acid protein synthesis
  - Chlorophyll production
  - Stem and leaf growth
  - Nutrient uptake
  - Photosynthesis and energy storage
  - Resilience and disease resistance
  - Bamboo shoot production
  - Leaf Quality



Proteobacteria


Bacillis Lichenformis

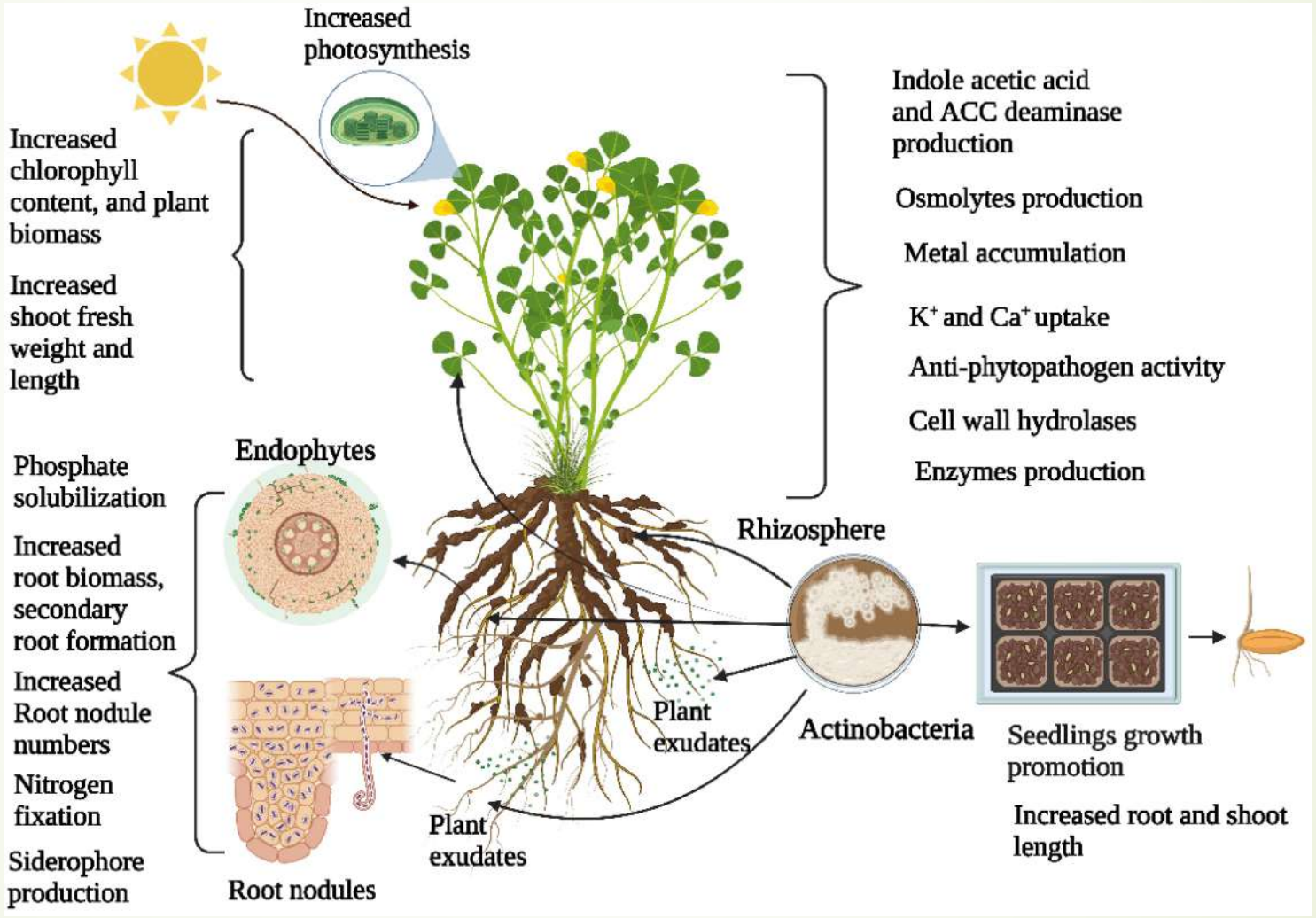

Bradyrhizobium



Nitrogen-Fixing Bacteria

- Nitrogen-fixing bacteria in and on bamboo
  - Free-living N fixers on phyllosphere and rhizosphere
    - Azotobacteria
    - Bacillis
  - Endosymbiont N fixers down into the roots
    - Actinobacteria
    - Bradyrhizobium
    - Proteobacteria
- Reducing synthetic fertilizer dependency
- Inoculating bamboo plantlets promotes better growth

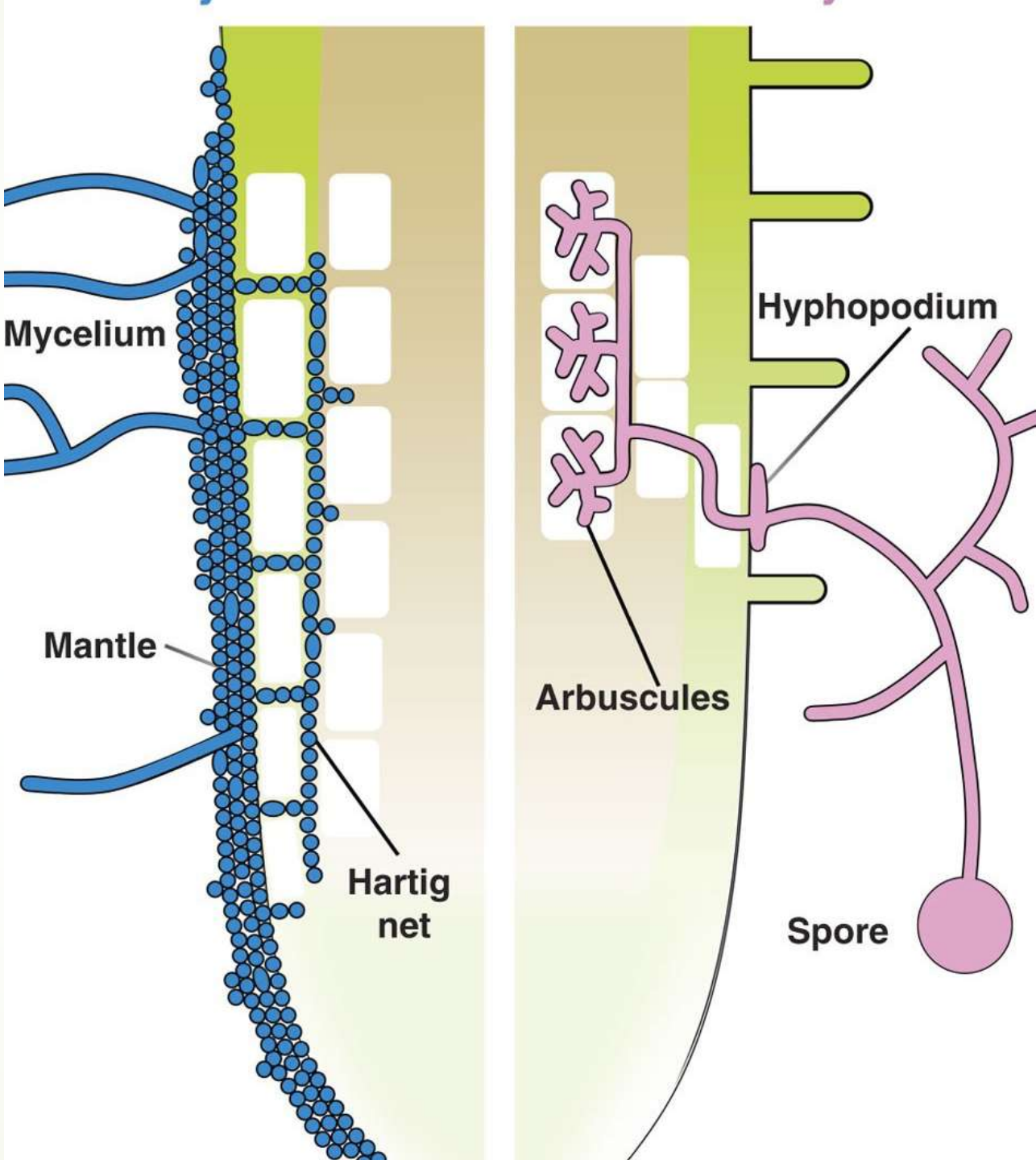
Actinobacteria (Formerly Actomycetes)



Rao, Lohmaneeratana, Bunyoo, thamchaipenet, (11/04/2022) Actinobacteria – Plant Interactions in Alleviating Abiotic Stress

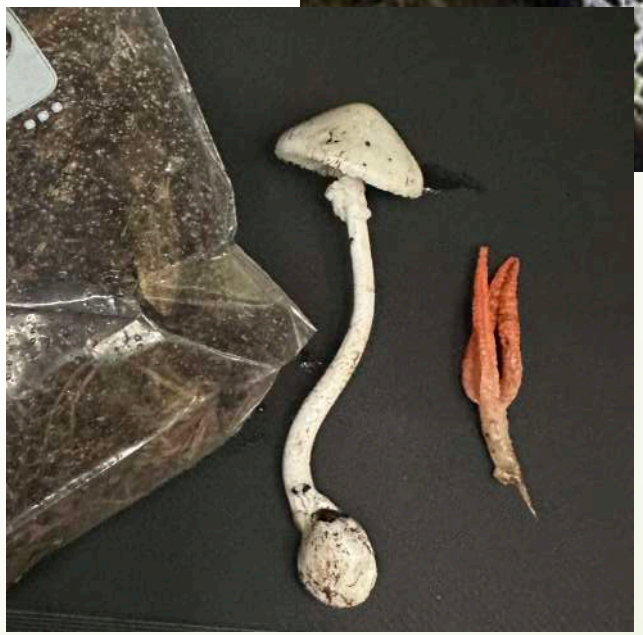
Fungal Associations

- Mycorrhizal fungi:
  - Photosynthetic carbon fixation
  - Nutrients & water transport
- Arbuscular Mycorrhizae (Internal partnerships)
  - associate with 80% of land plants
- Ectomycorrhiza –
  - (External partnerships) associate with 10% of plants
  - Eg. Amanita Bisporigera "Destroying Angel"



Fungal Associations

- Saprophytic Fungi:
  - Break down dead plants
  - Release and cycle nutrients
  - Build topsoil
  - Stinkhorns
    - Bamboo Mushroom

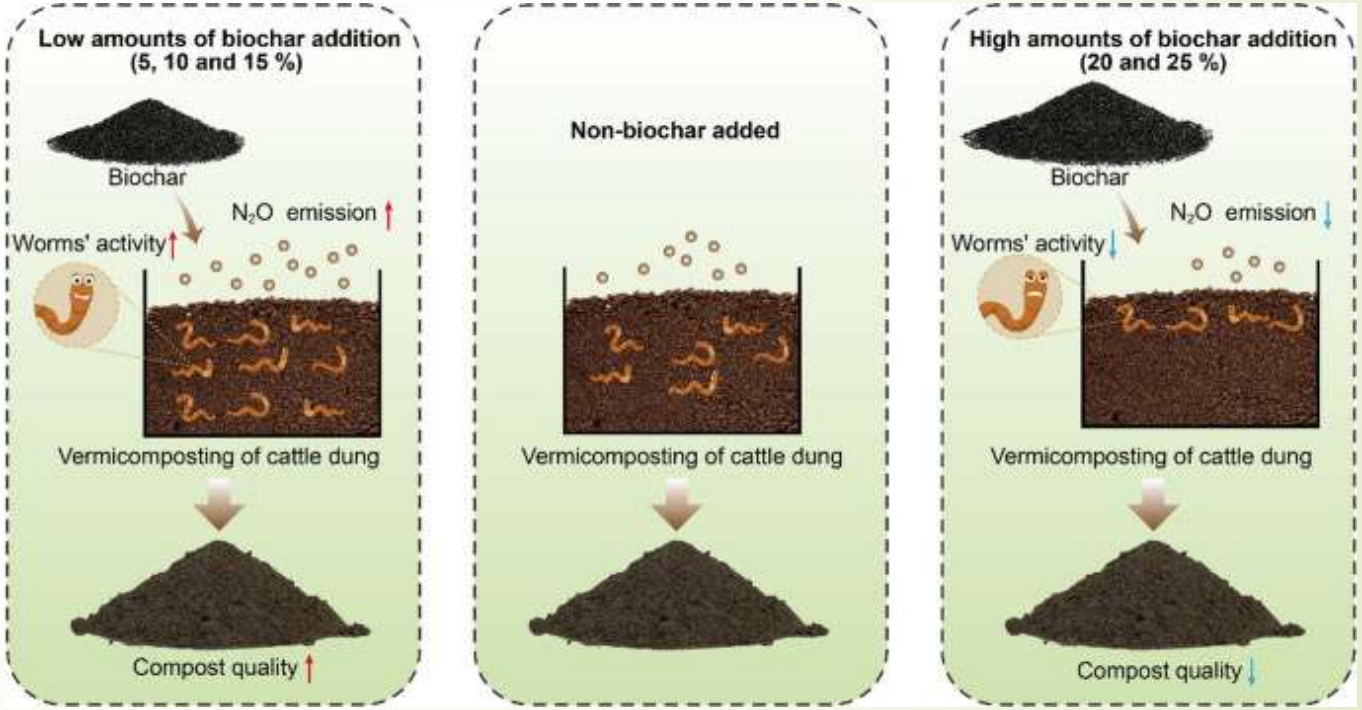


Disease Suppression

- System mimics nature
  - Plants are in control
  - Higher Soil Fertility
  - Farm is an ecosystem
  - Pathogens are outcompeted
- Vs. Intensive management
  - Synthetic chemical dependency
  - Increased disease pressure and lower water availability

Bio-amendments and Compost

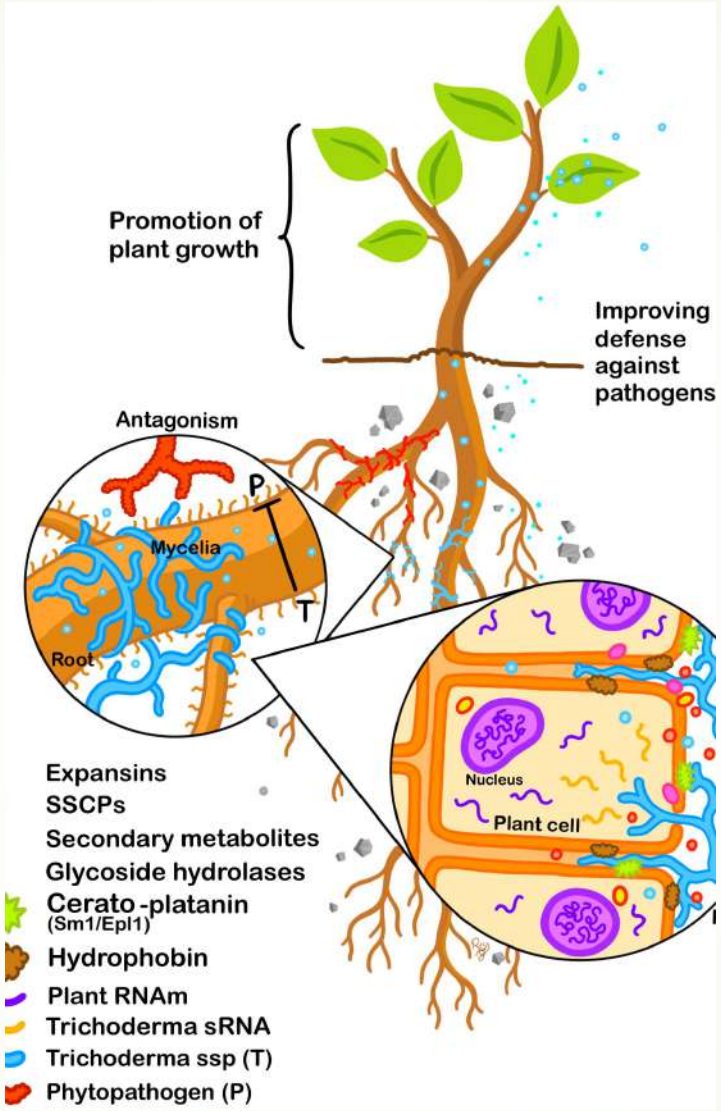
- Not all compost is equal
  - Biologically rich and diverse
- Worm Castings
- Biochar



Wu, Li, Zheng, Xiong, Chen, Shaaban, Hu (01/17/2023)
Optimixzing biochar addition for vermicomposting: a comprehensive evaluation of earthworms' activity, N2O emissions and compost quality

Bio-control Agents

- Reducing chemical fertilizer & pesticide use
- Bacillus Thuringiensis (BT)
- Trichoderma
- Entomopathogenic Fungi
- Plant based extracts
  - Korean Natural Farming - Fermented Plant Juice (FPJ)
  - Phytochemicals – bamboo



Ramirez-Valdespino, Casas-Flores, Olmedo-Monfil (05/15/2019)
Trichoderma as a Model to Study Effector-like Molecules

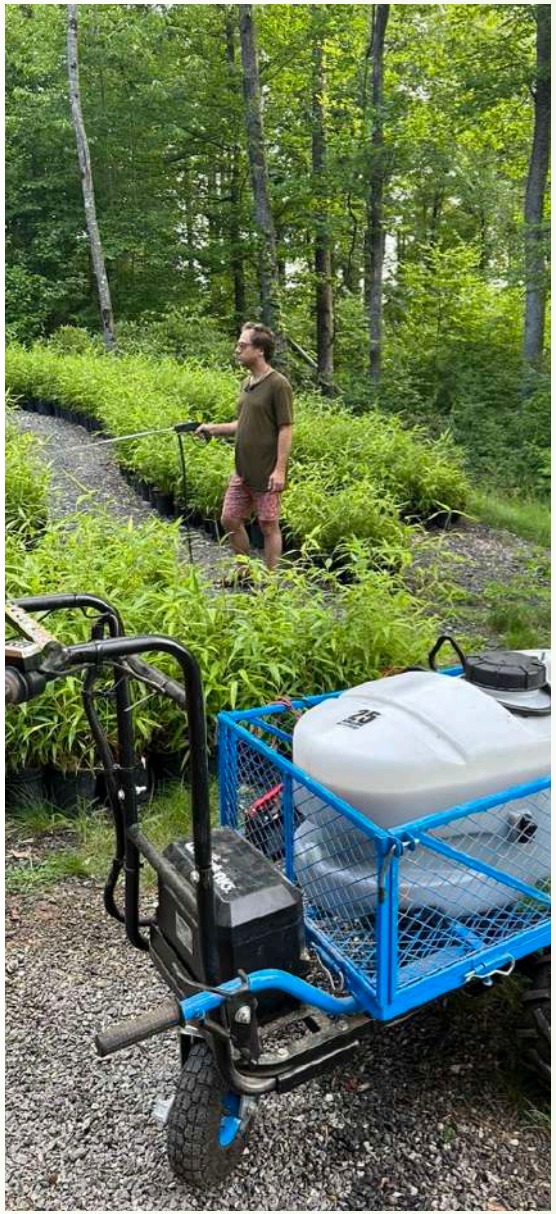
Stefan Jaronski (2009) Grasshoppers killed by the fungus Beauveria bassiana Agricultural Research Service, USDA

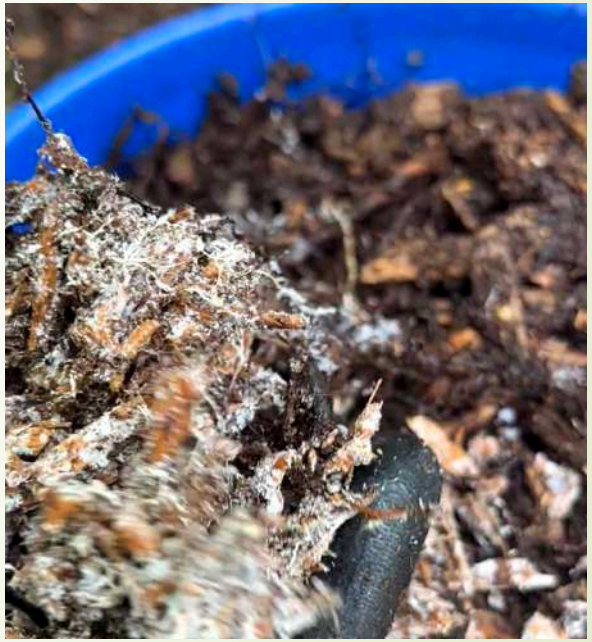
Microbial Diversity and Biodiversity

- Ecosystem Resilience
  - No silver bullet
  - Pathogens < 10% = food for plants
  - Multispecies cover crops
  - Riparian buffer zones
  - 10% Native Species Borders/forest islands

Applying Ecology

- Enhancing Soil Health
  - Fungal Mulch
  - Compost Extracts & Teas
- Increasing Organic Matter
  - CEC / fertility
- Improving Aggregate Structure
  - Water Availability
- Reduced Erosion



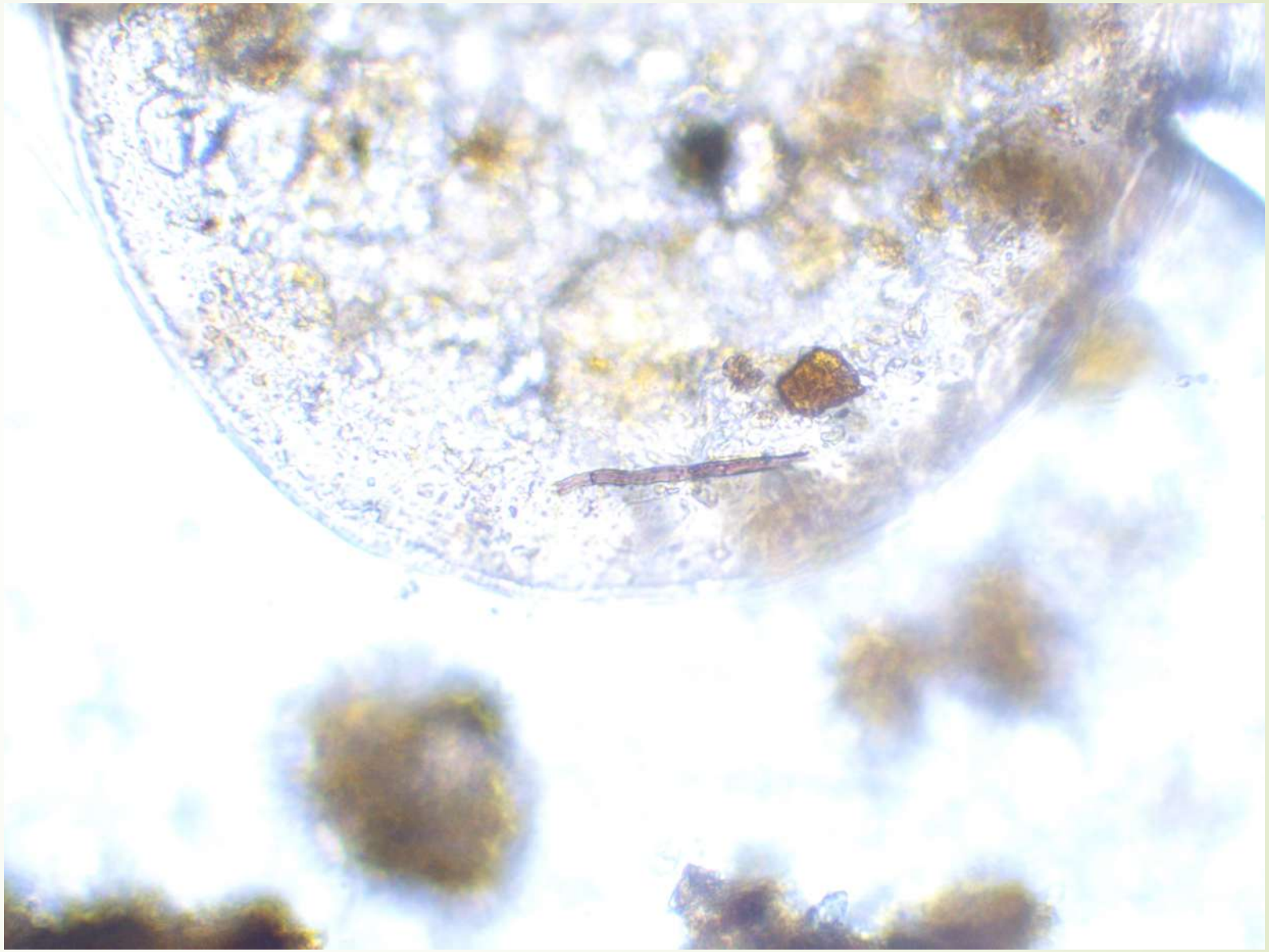


Microbial Monitoring

- Your nose knows
- Microscopy
- Microbiometer
- Genetic Sequencing
- Brix Meter
- Early detection and timely interventions
- Data-driven sustainable farming

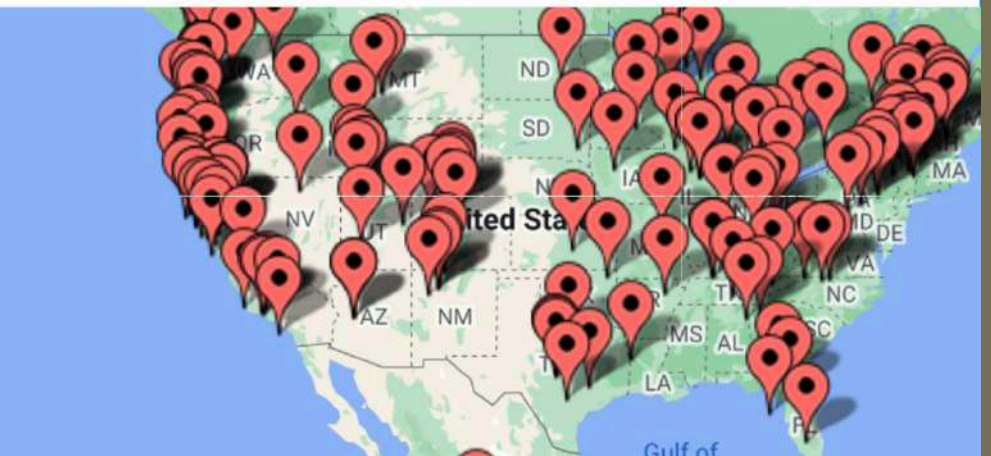
Soil-biology analysis of 40 year-old Henon

- High fungal biomass in the Henon rhizosphere
- Deeper soil penetration
- More diverse and active microbial community



Soil Food Web Laboratory Technicians

SFW Lab-Techs are certified by the Soil Food Web School annually, and are located around the world. You can rapidly have the biology in your soils tested, to find out what is missing from your soil food web.



Scientists to Follow

- Dr Elaine Ingham
  - Soil Food Web School
- Peter McCoy
  - Radical Mycology
- Dr. David Johnson
  - Johnson-Su Bioreactor
- Dr. James White Jr.
  - Plant biology & sustainable ag
- Dr. Pascal Avery
  - Applied Ecology & Entomopathogenic fungi
- Chany Paungfoo-Lonheinne & Suzanne Schmidt
  - Discovered Rhizophagy

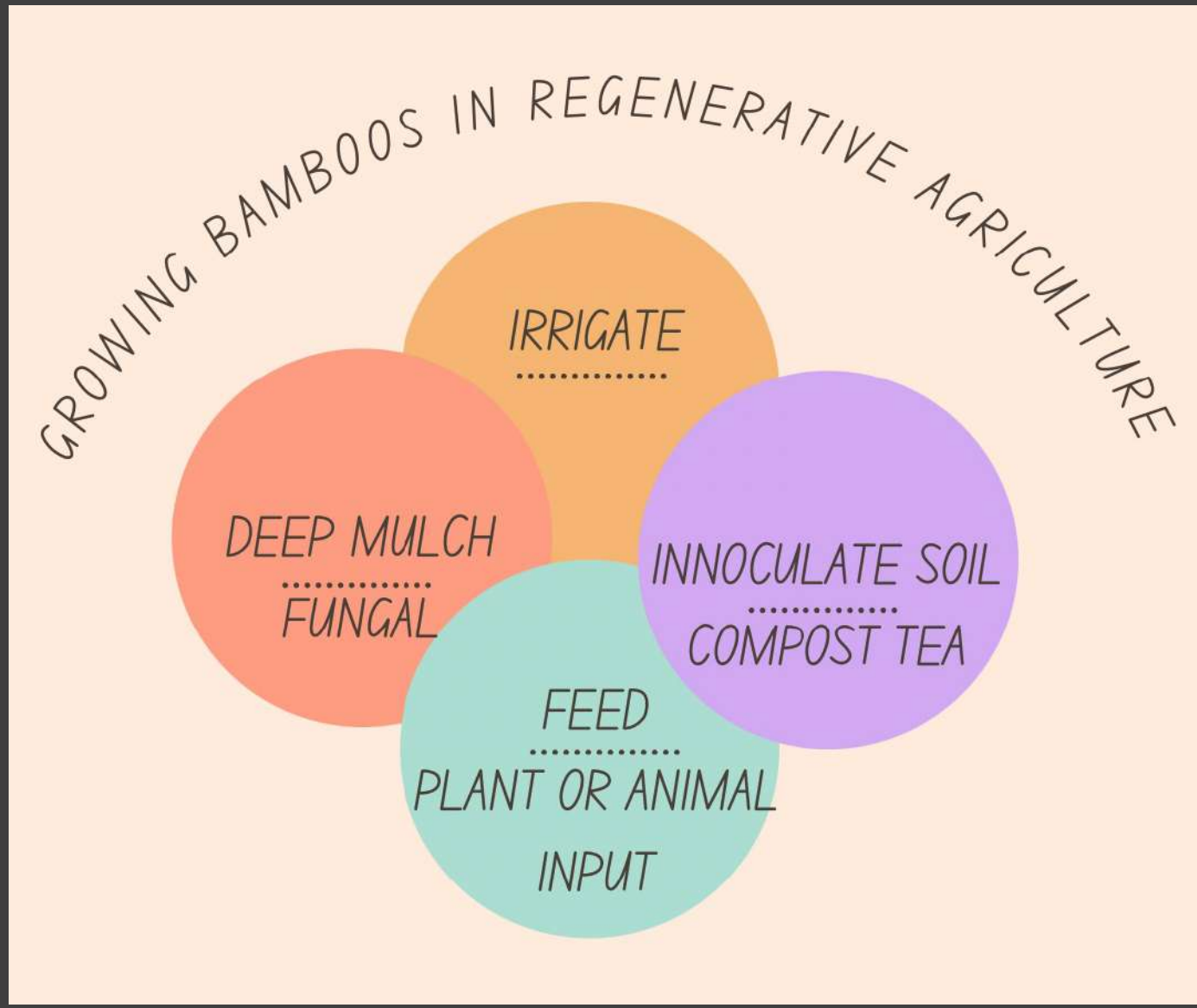
Case Studies

- Haiku Bamboo Nursery
  - Keji Oshima, Japanese-American, Hendersonville NC
- Hmong farmers of NC
- Wubu Bamboo Ecoretreat Center
  - Juan Pablo, Guatamala
- Dern Bamboo AU & Becky – Bigheart Bamboo

This Bamboo Life

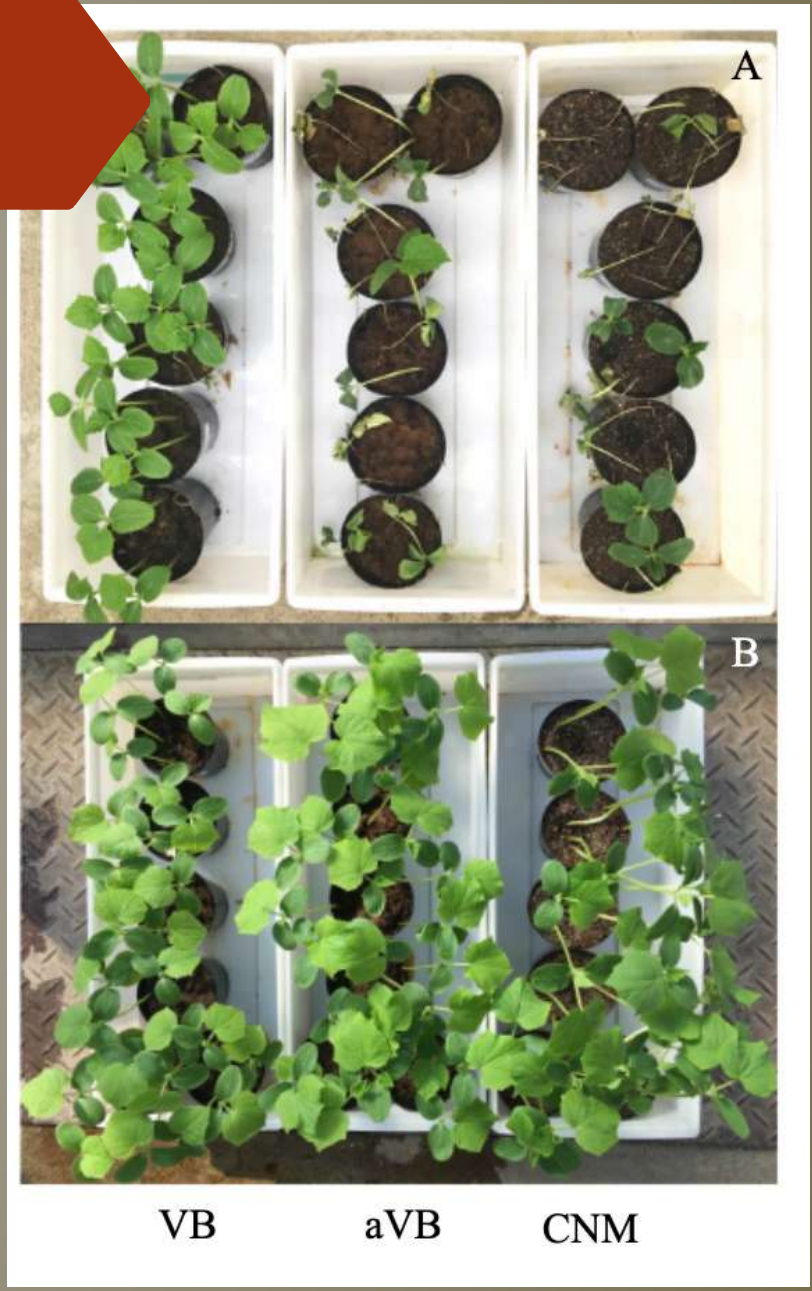
Using bamboos in regenerative agriculture to benefit people, plants, animals, & soil.

Shanti Pierce
Kissimmee, FL



Disease Suppressive Effects of Bamboo Vermicompost

- 2019 study - Japan Agricultural Research Quarterly
- Bamboo Shoot Powder – fed to worms
- Byproduct controlled damping off caused by Pythium and Rhizoctonia
- Rich microbial activity and diversity



Improved Sustainability

- Profitable
- Eliminate need for fertilizer
- Self-regulating system

- Life is Enhanced
  - Soil health
  - Plant health
  - Animal health
  - Human health
- Long term viability

Challenges and Future Directions

- Challenges In biological farming
  - Complexity
  - Changing climate
  - Chemical dependence
- Challenges in bamboo farming
  - Tissue culture
  - Diseases and Pests
  - Intensive management

Conclusion

- Regenerative
- Biological
- Chemical salts free
- Nature based
- Ecological diversity
- Test don’t guess
- Health and prosperity for all

Questions?

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