Testing Carbon- and Microbial-Based Strategies for Soil Stabilization and Dust Mitigation in Barren Lands of the Sonoran Desert

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PIMA COUNTY

USDA United States Department of Agriculture
Natural Resources Conservation Service

COLLEGE OF AGRICULTURE & LIFE SCIENCES
Soil, Water and Environmental Science

Arizona State Land Department

Urgent Need for Dust Mitigation Solutions That Are:

- **Based on improving soil health first**
- **Long lasting**
- **Self-perpetuating using natural processes**
- **Sustainable and environmentally friendly**
- **Economical and scalable**

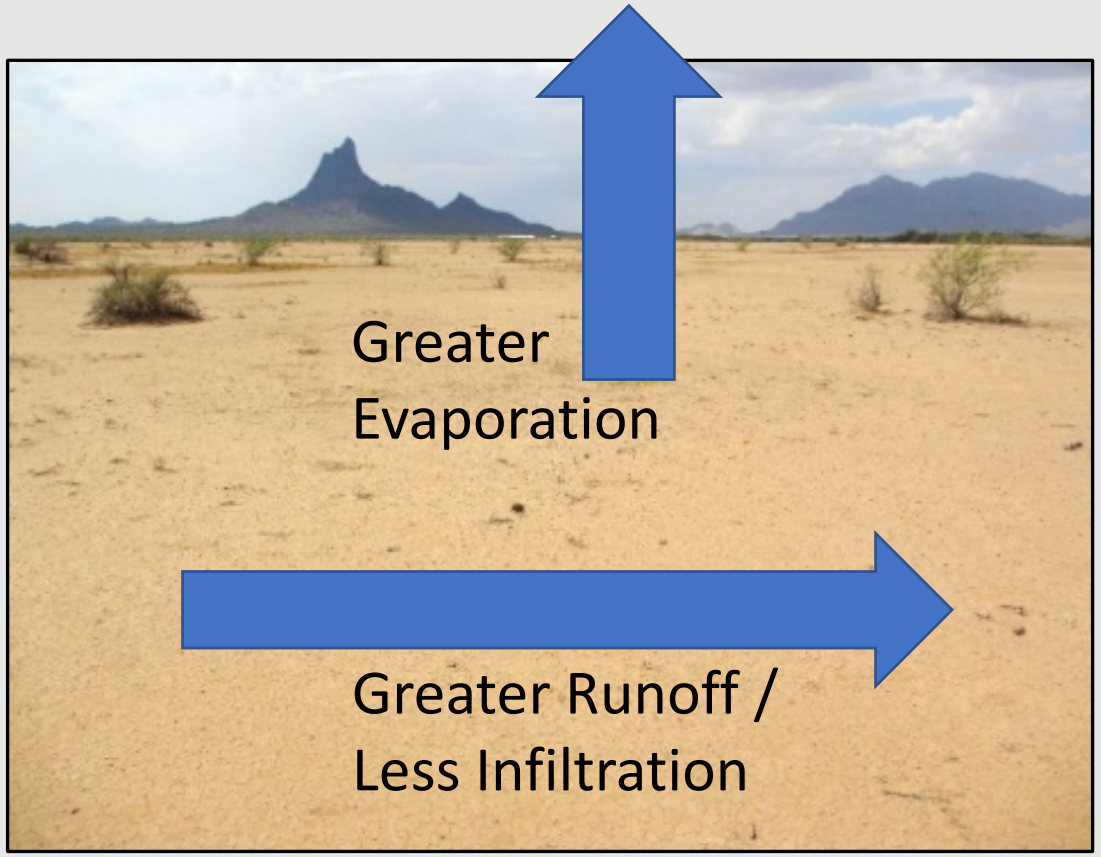
SOIL HEALTH

The continued capacity of a soil to **function** as a vital, **living** ecosystem that sustains plants, animals, and humans.

Symptom #1: Barren lands lack soil cover

Intact Functioning Ecosystem

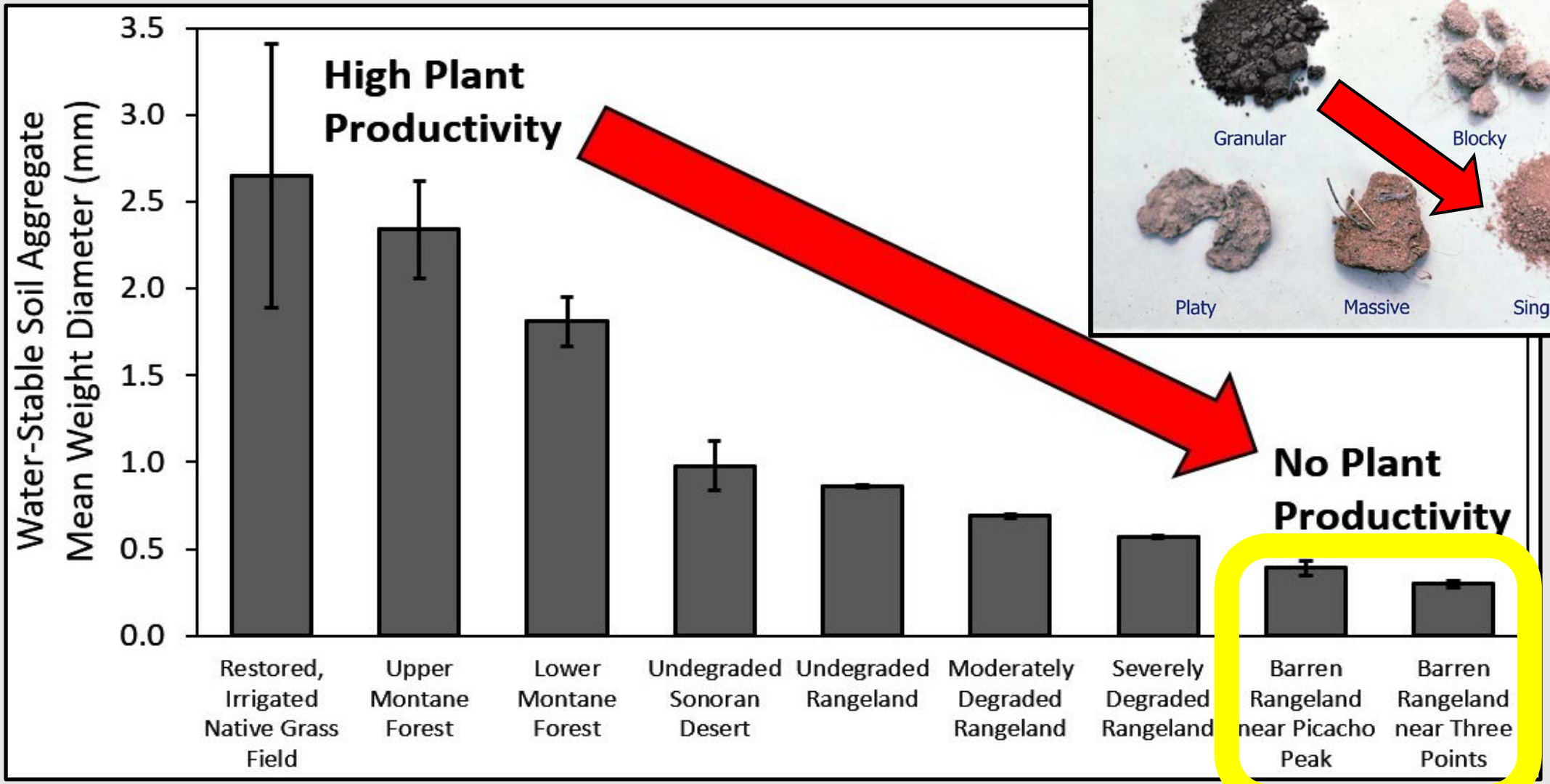
VS.



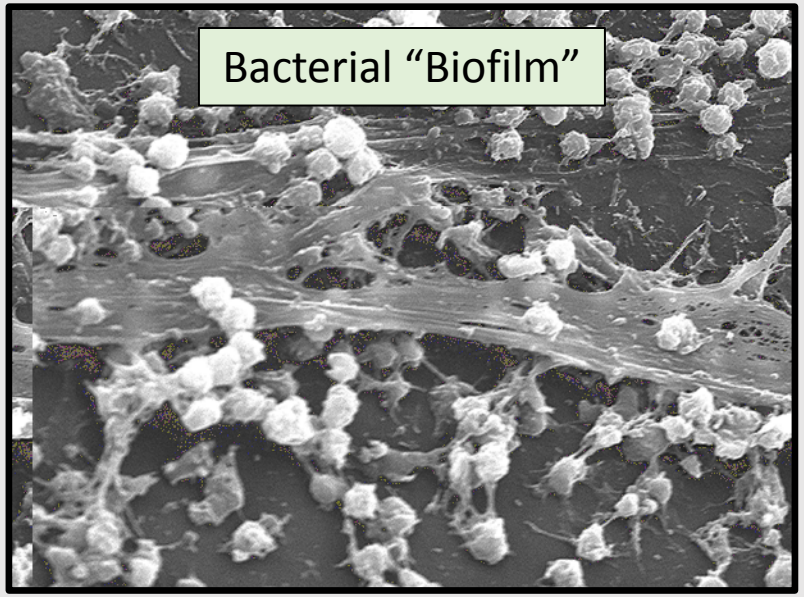
Barren Dysfunctional Land

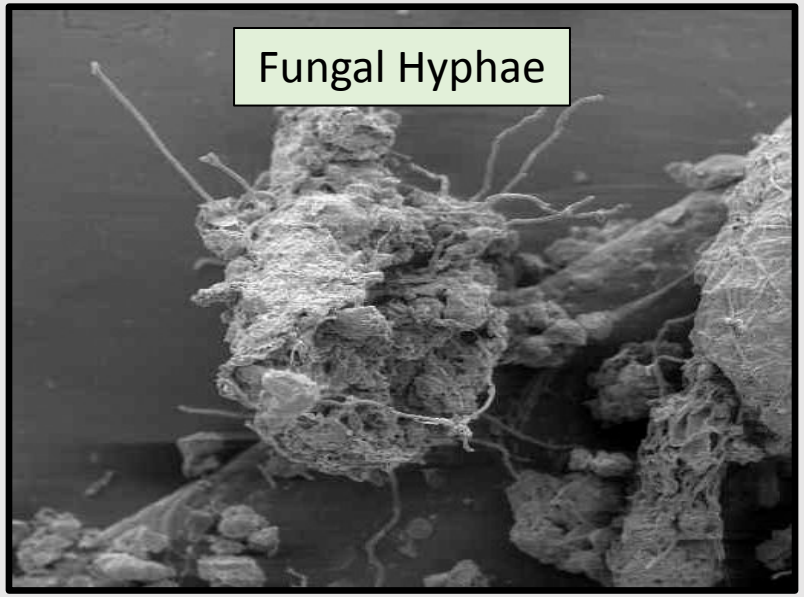
Symptom #2: Barren lands lack soil structure

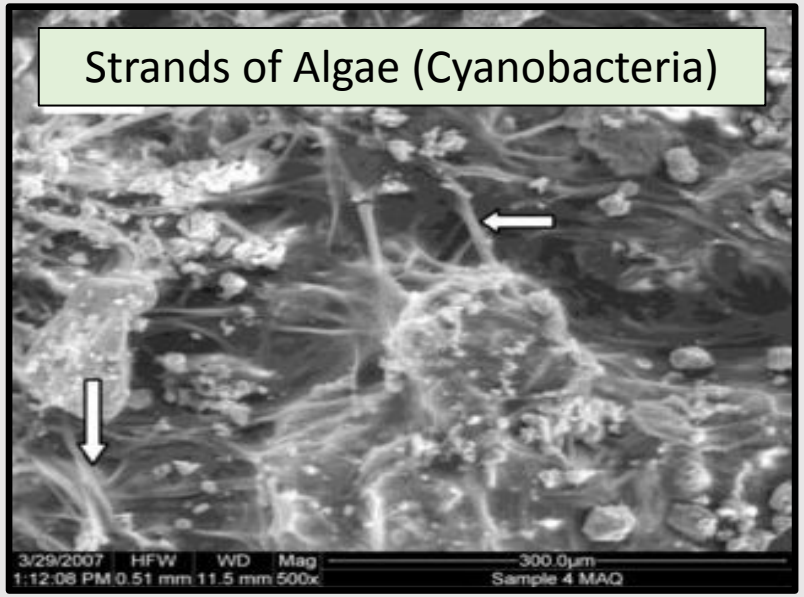
Blankinship et al. (Manuscript in preparation)

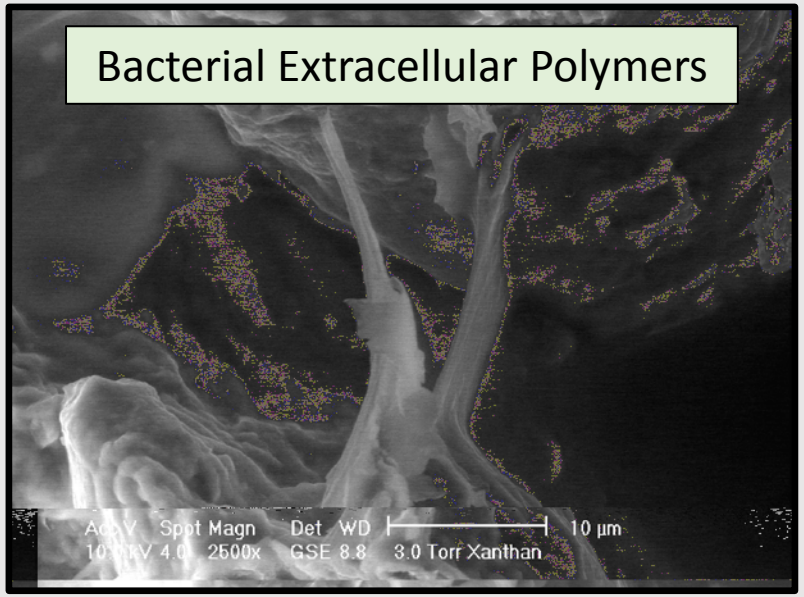


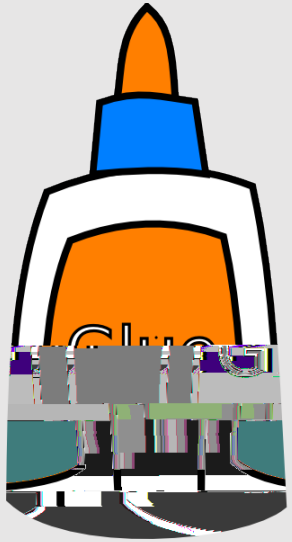
Symptom #3: Barren lands lack soil microbes

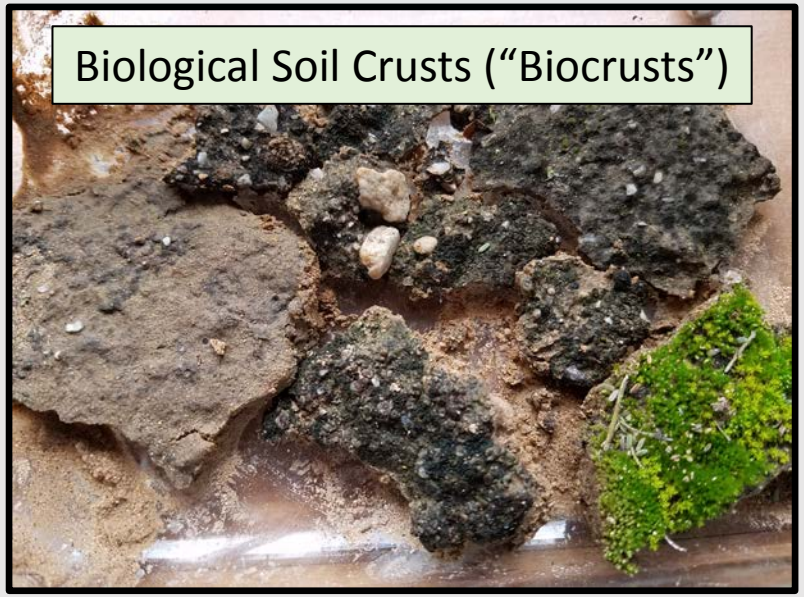








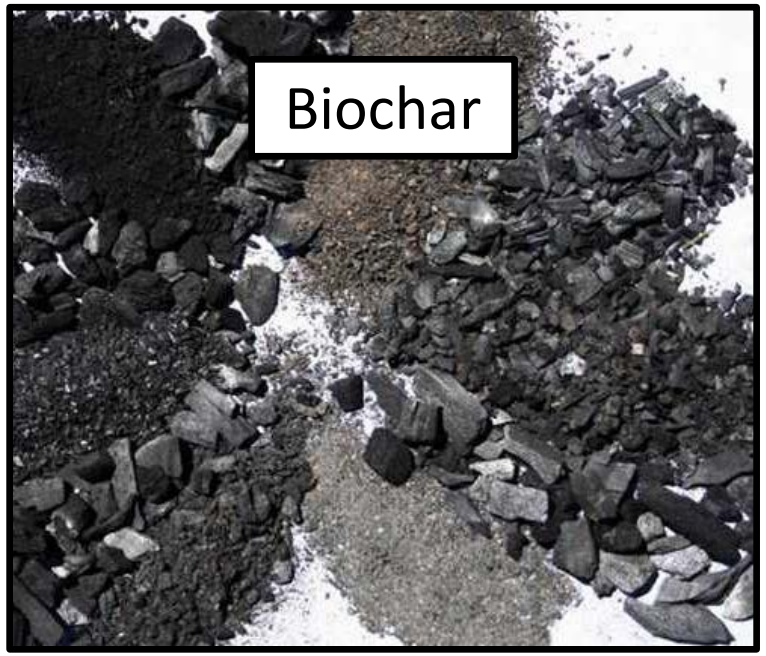




Research Objectives

1. What is the potential for recycled green waste to improve soil stability in the Sonoran Desert?

2. What is the potential for microbial inoculants to improve soil stability in the Sonoran Desert?



Recycled Green Waste Products

How can we best link carbon-rich cities with carbon-poor desert soils?




Case Study #1:
Abandoned cropland
North Altar Watershed Area (NAWA)

Compost only

Biochar only

Compost + Biochar

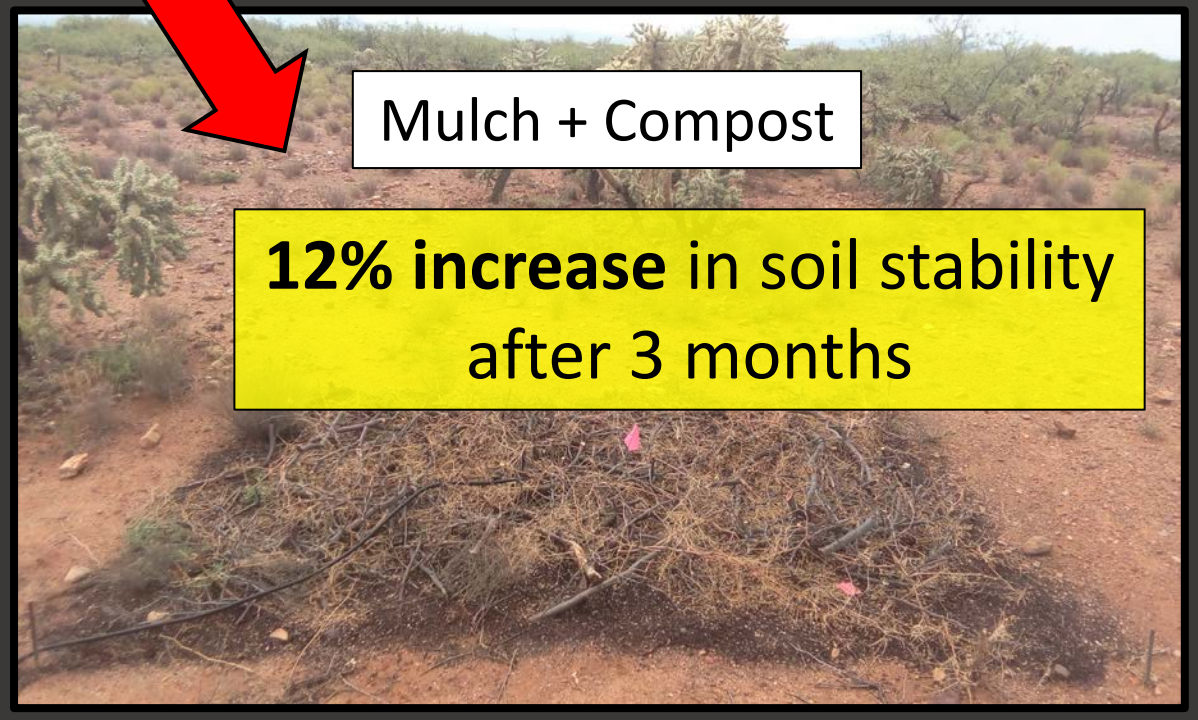


Case Study #2:
Degraded grazing land

Altar Valley, Santa Margarita Ranch


Mulch source


Mulch from
Mesquite Branches
31% increase after 3 months


Mulch + Compost
12% increase in soil stability
after 3 months

Case Study #3:

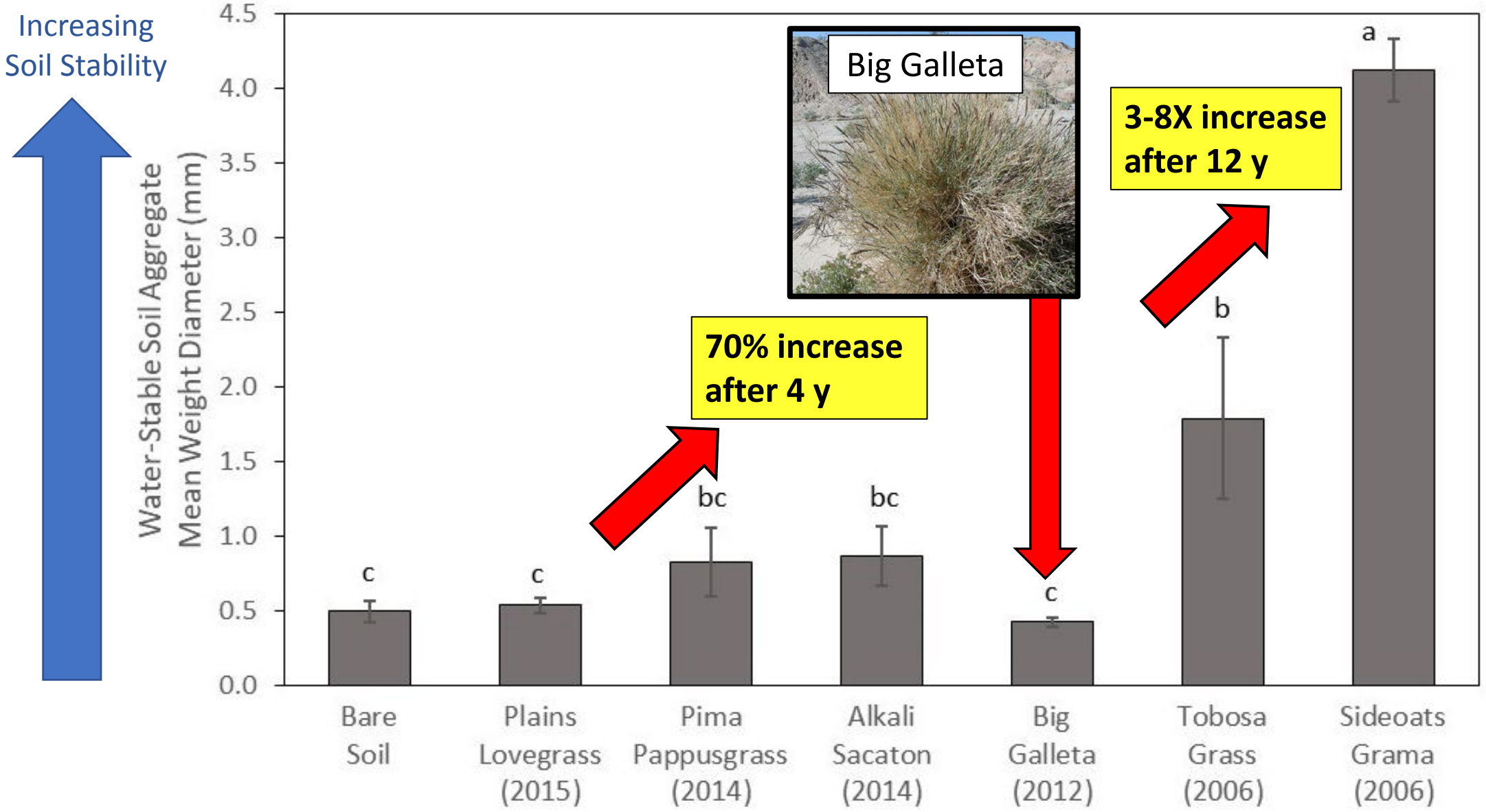
Monocultures of native perennial grasses

NRCS Plant Materials Center, Tucson, AZ

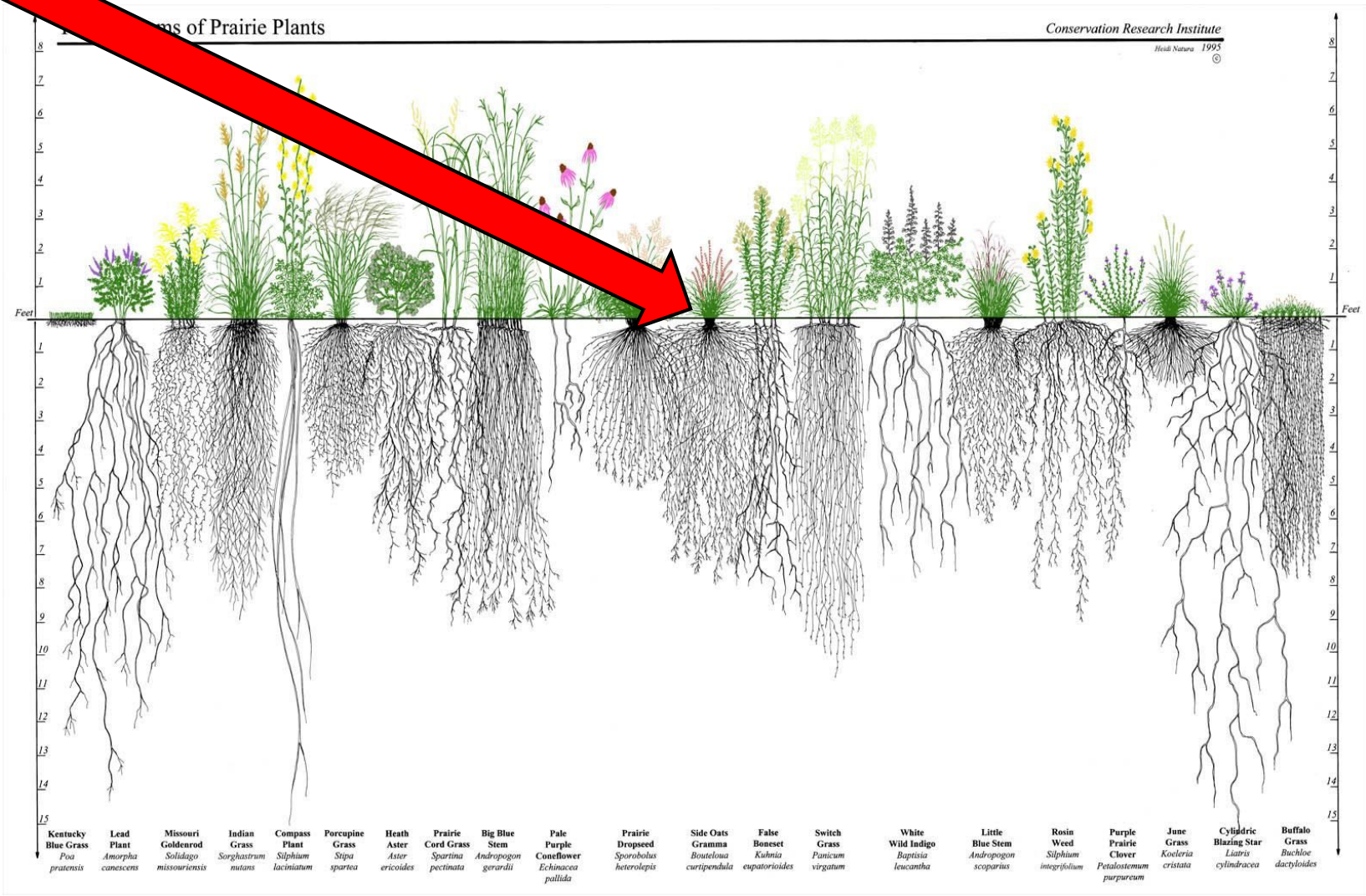
USDA United States Department of Agriculture

Natural Resources Conservation Service
Plant Materials Program

Not all plants are soil stabilizers



Role of fibrous root architecture?



Research Objectives

1. What is the potential for **recycled green waste <u>and plants</u>** to improve soil stability in the Sonoran Desert?

2. What is the potential for **microbial inoculants** to improve soil stability in the Sonoran Desert?

“Biocrust” Restoration in Rangelands

Collaborators include Matt Bowker and Anita Antoninka at Northern Arizona University

It is possible to “farm” biocrusts and then transplant established mats or crumbles

Besides stabilizing soil, biocrusts can promote plant growth

Cyanobacteria (aka “Algae”) as Soil Stabilizers

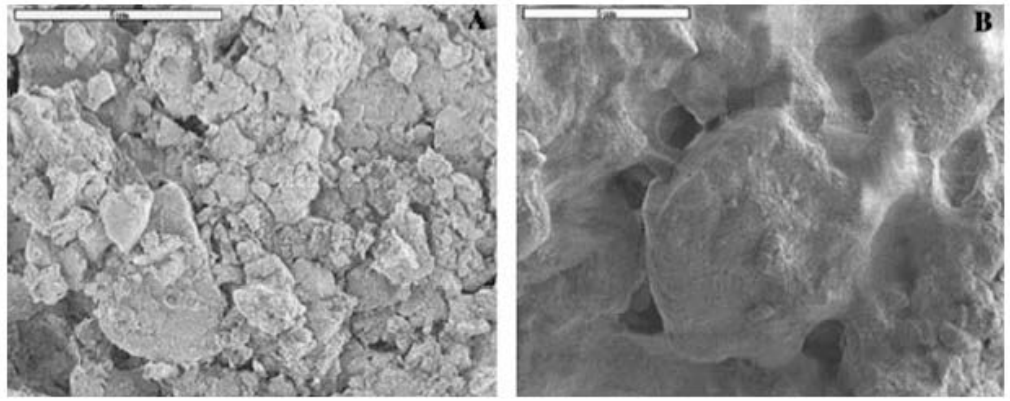
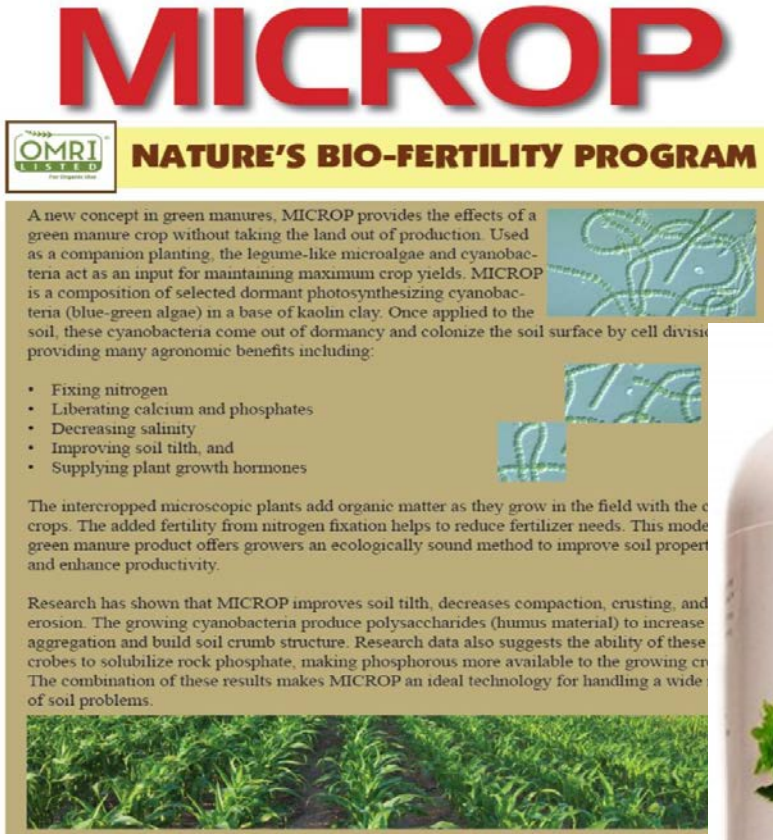
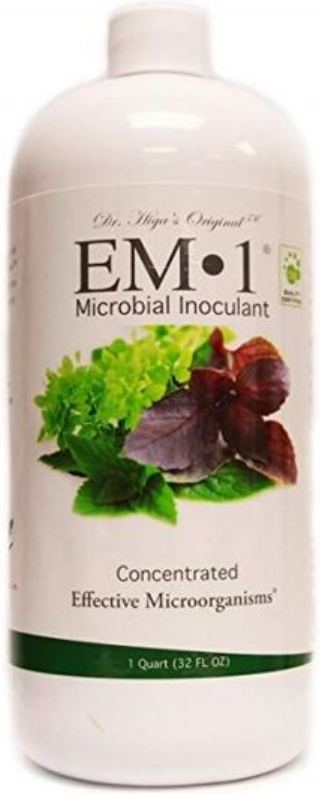
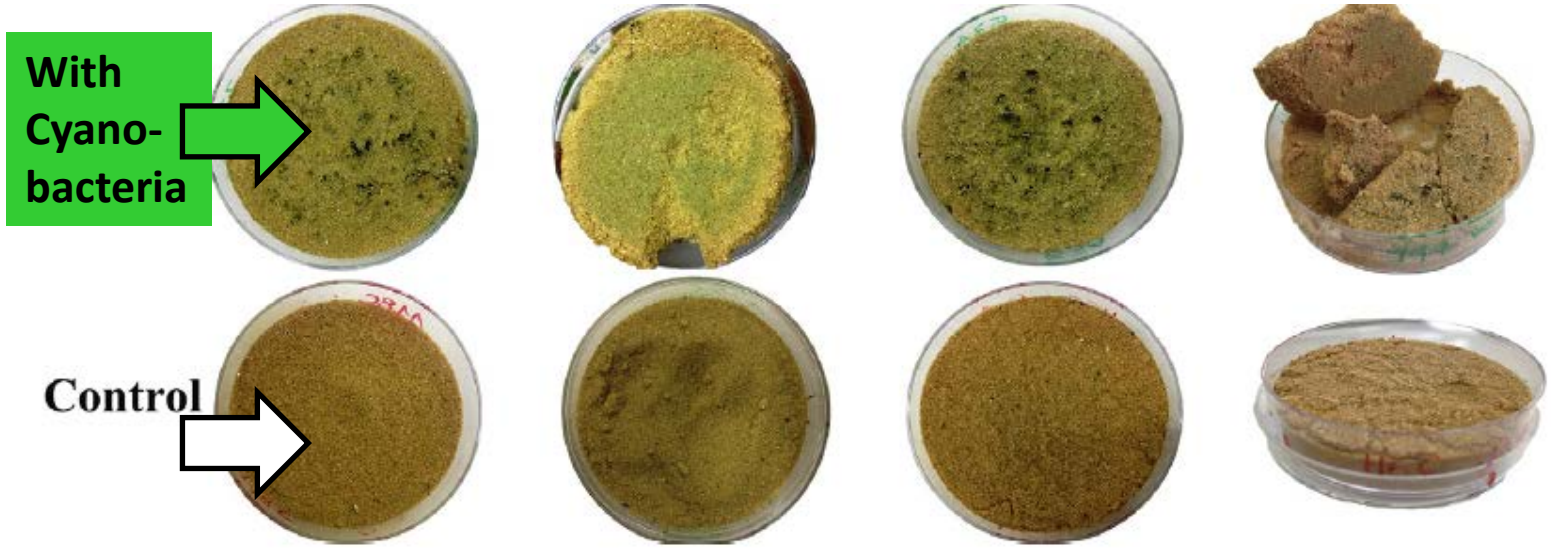


Fig. 12.7 SEM images. Microstructure and soil aggregate stability of Guquka soil aggregates inoculated by *Nostoc* 9v; (**a**) surface of non-inoculated sample; (**b**) surface of an inoculated sample. *Scale bar*, 5 µm (Source: Malam Issa et al. 2007)





D’Acqui (2016) Bioformulations for Sustainable Agriculture

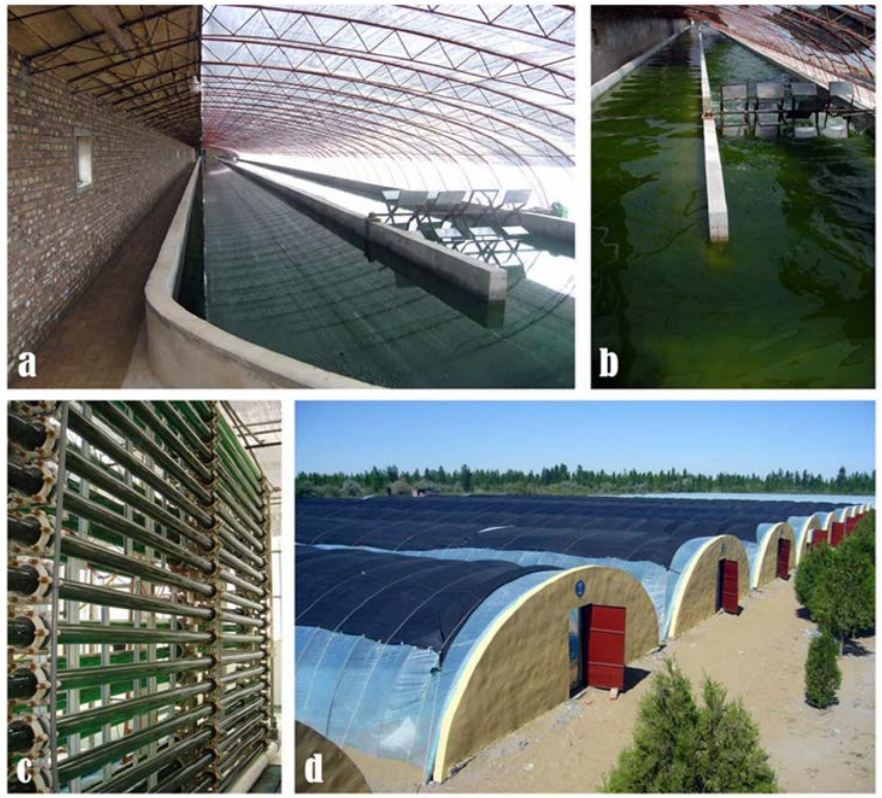


Mugnai et al (2018) Soil Biology & Biochemistry

No Cyanobacteria → **Lots of Cyanobacteria**

D'Acqui (2016) Bioformulations for Sustainable Agriculture

It is possible to cultivate cyano-bacteria much faster and in larger quantities than natural biocrusts



Rossi et al (2017) Earth Science Reviews

Soil “Bio-Stabilization” Experiment

University of Arizona

Campus Agricultural Center

Conclusions & Future Directions

SOIL HEALTH

Dust Mitigation

Mulch = Soil protector and slow-release carbon

Cyanobacteria = Soil stabilizer and fertilizer