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

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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**

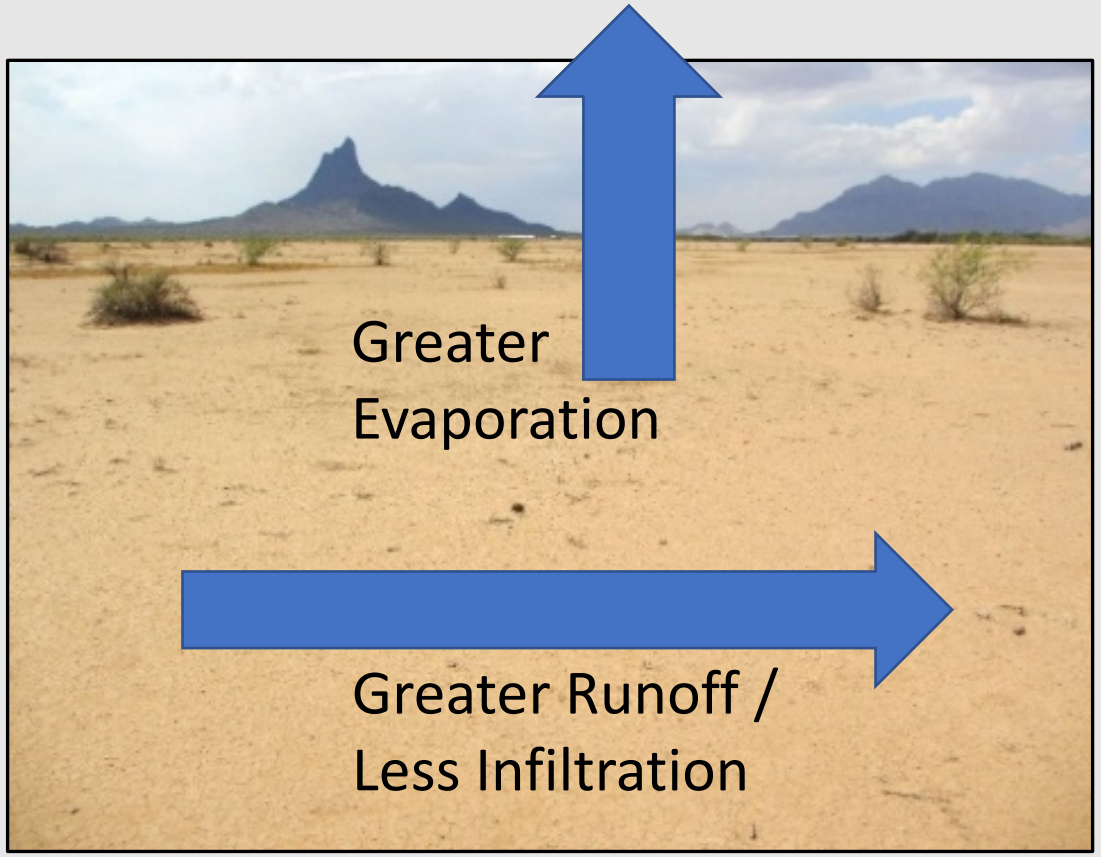
SOIL HEALTH

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

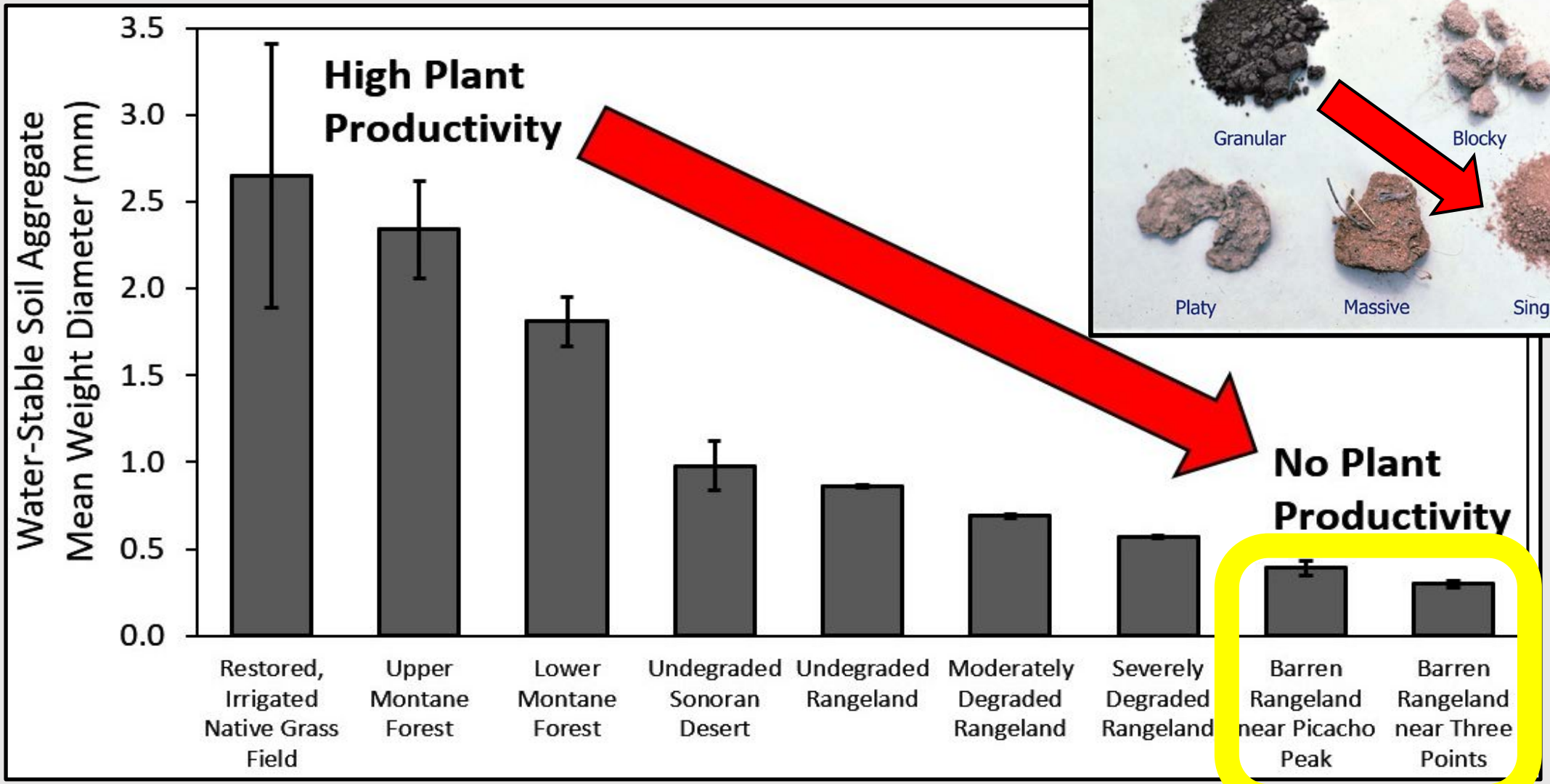
VS.



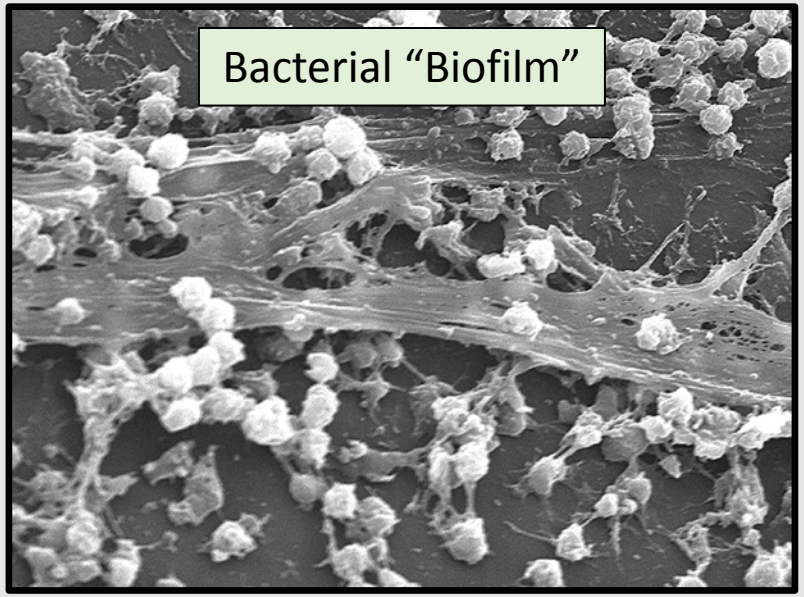
Barren Dysfunctional Land

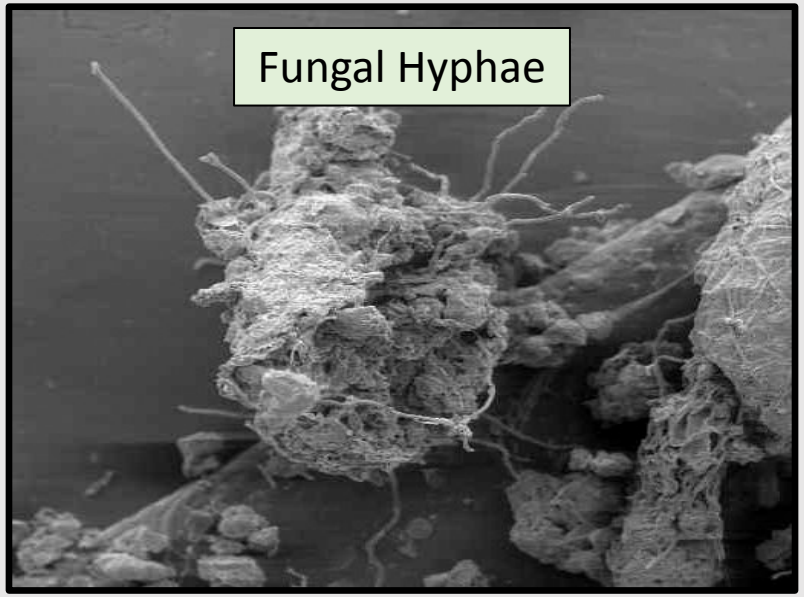
Symptom #2: Barren lands lack soil structure

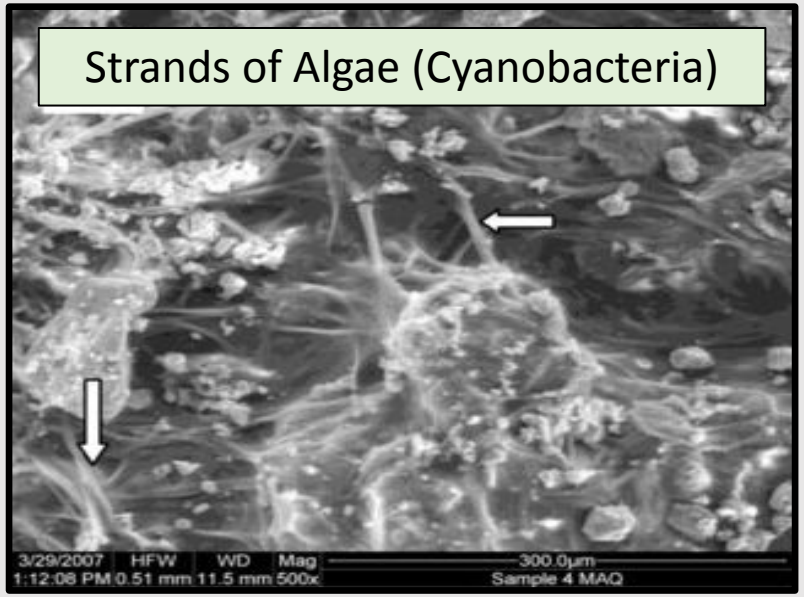
Blankinship et al. (Manuscript in preparation)

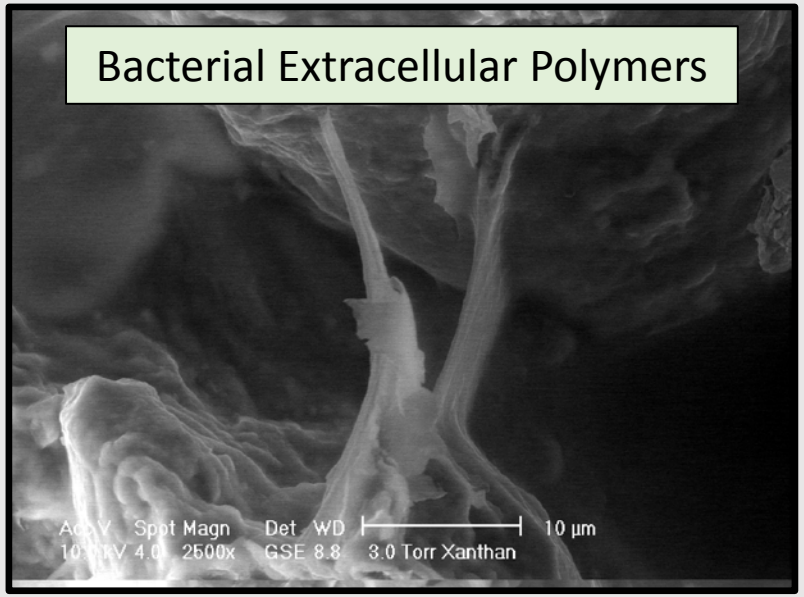


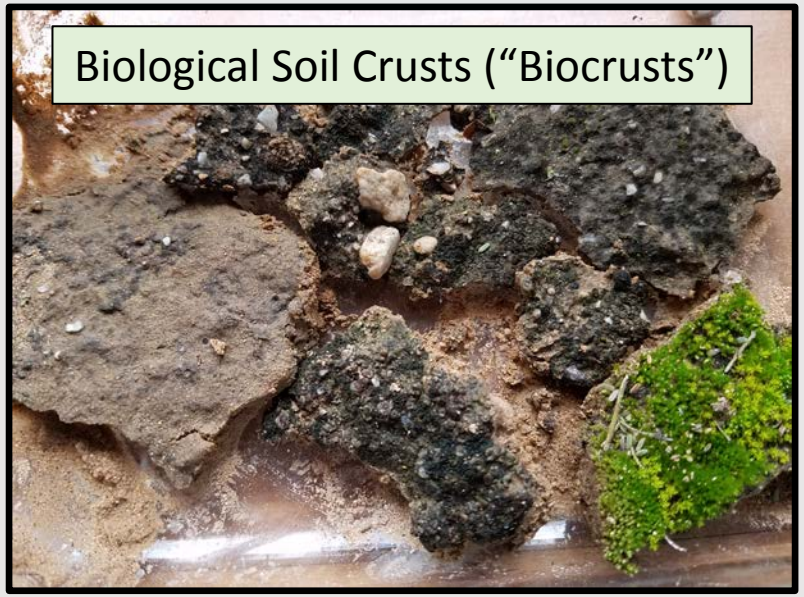
Symptom #3: Barren lands lack soil microbes







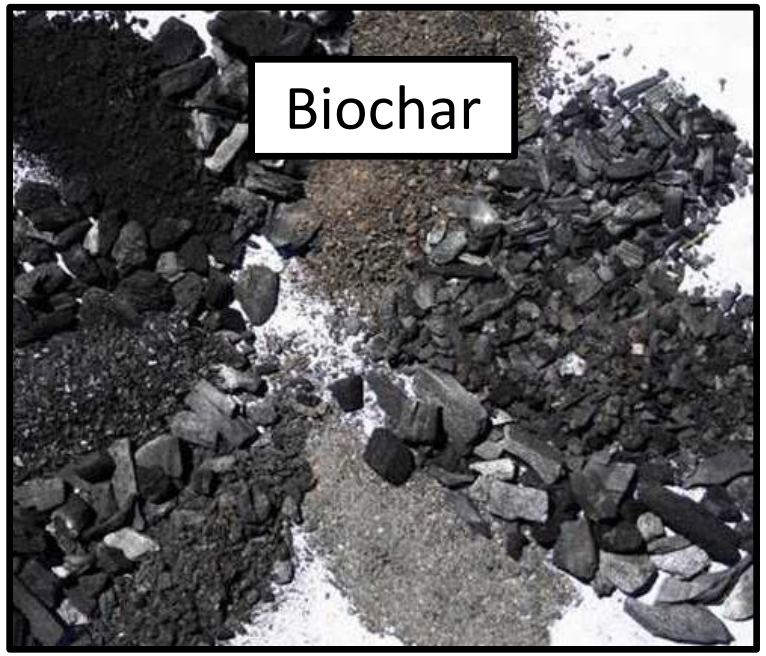




Research Objectives

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?

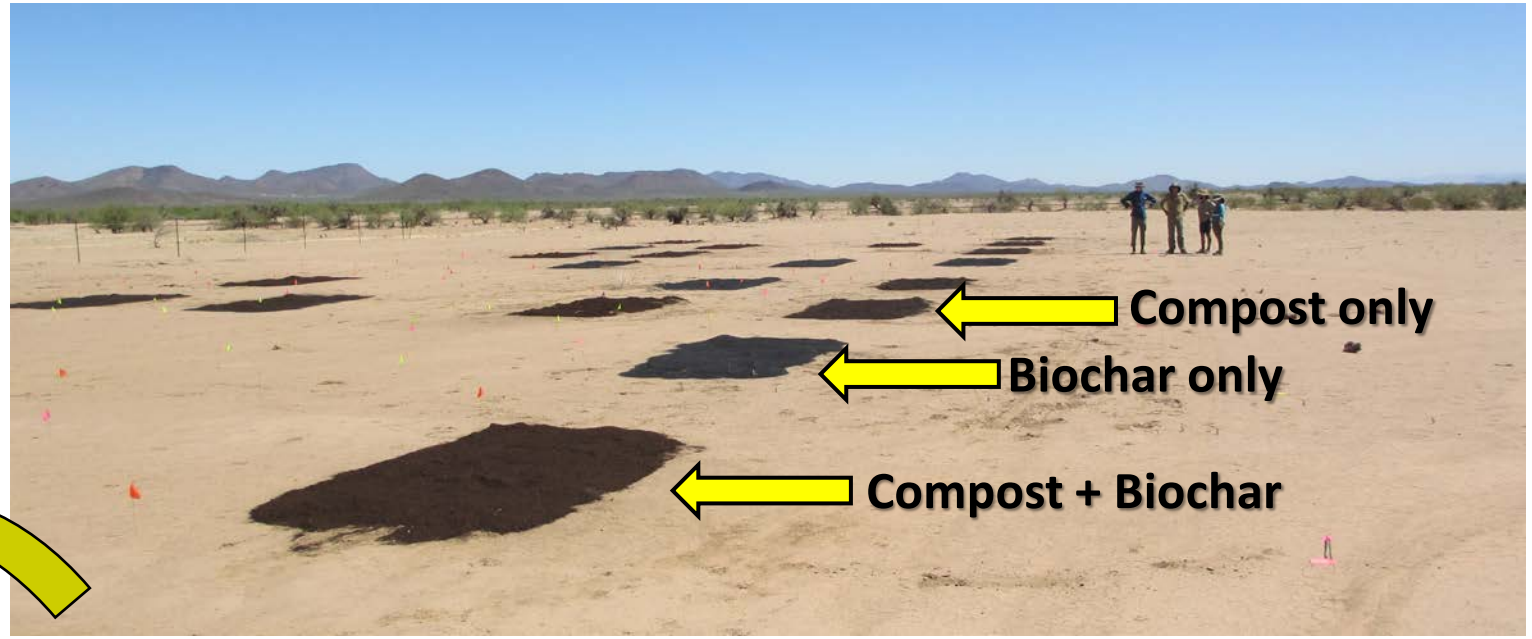


Recycled Green Waste Products

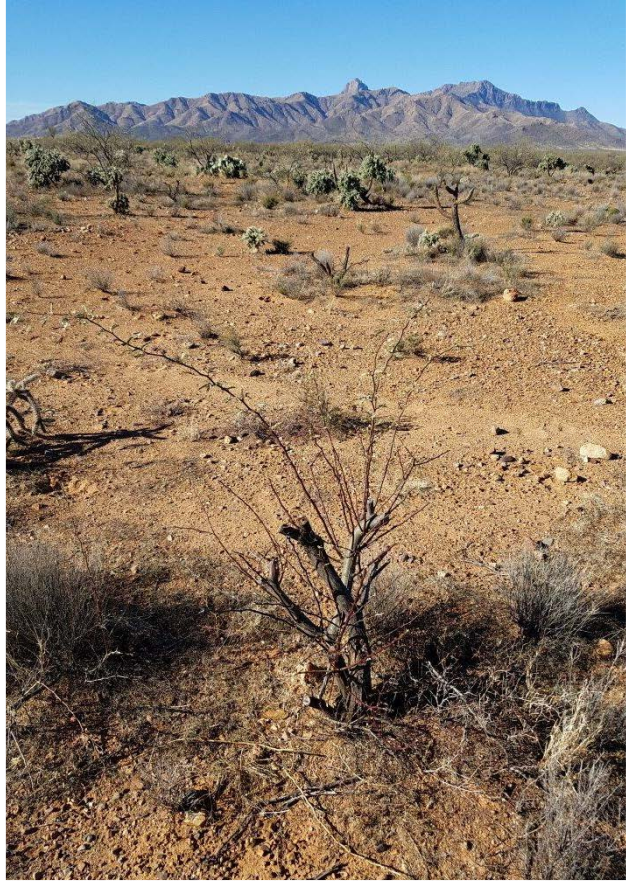
How can we best link carbon-rich cities with carbon-poor desert soils?




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


Compost only
Biochar only
Compost + Biochar

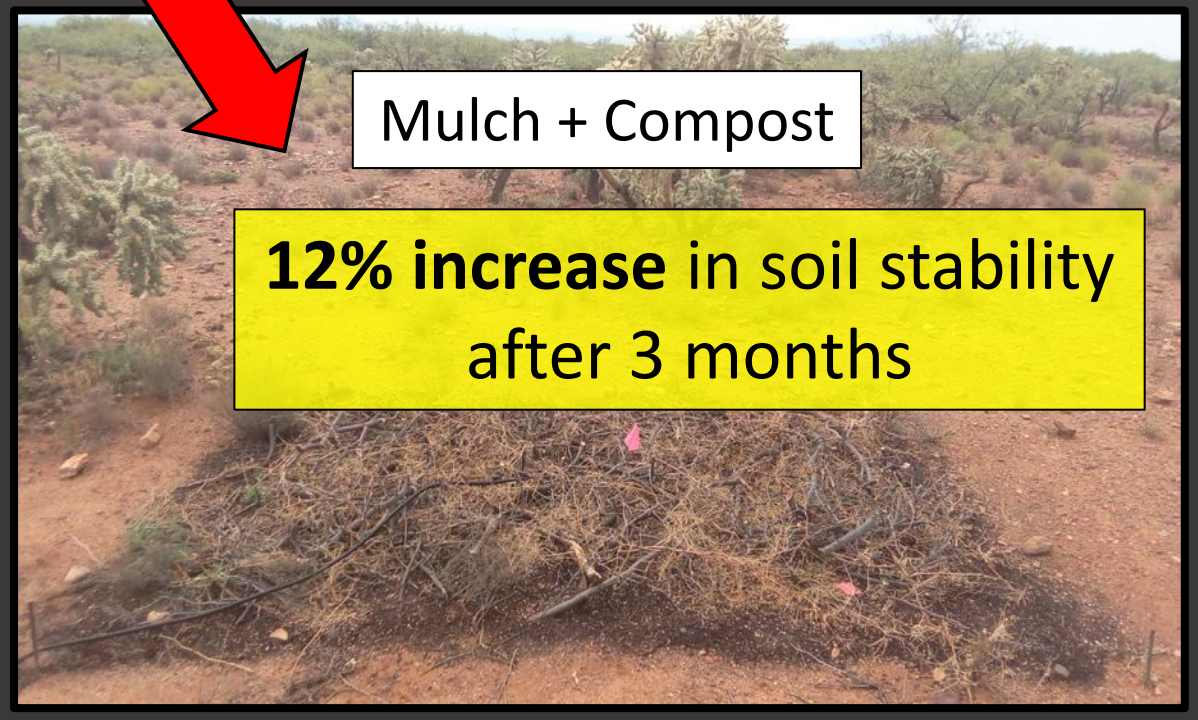





Case Study #2:
Degraded grazing land
Altar Valley, Santa Margarita Ranch


Mulch source


Mulch from
Mesquite Branches
31% increase after 3 months


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

Case Study #3:

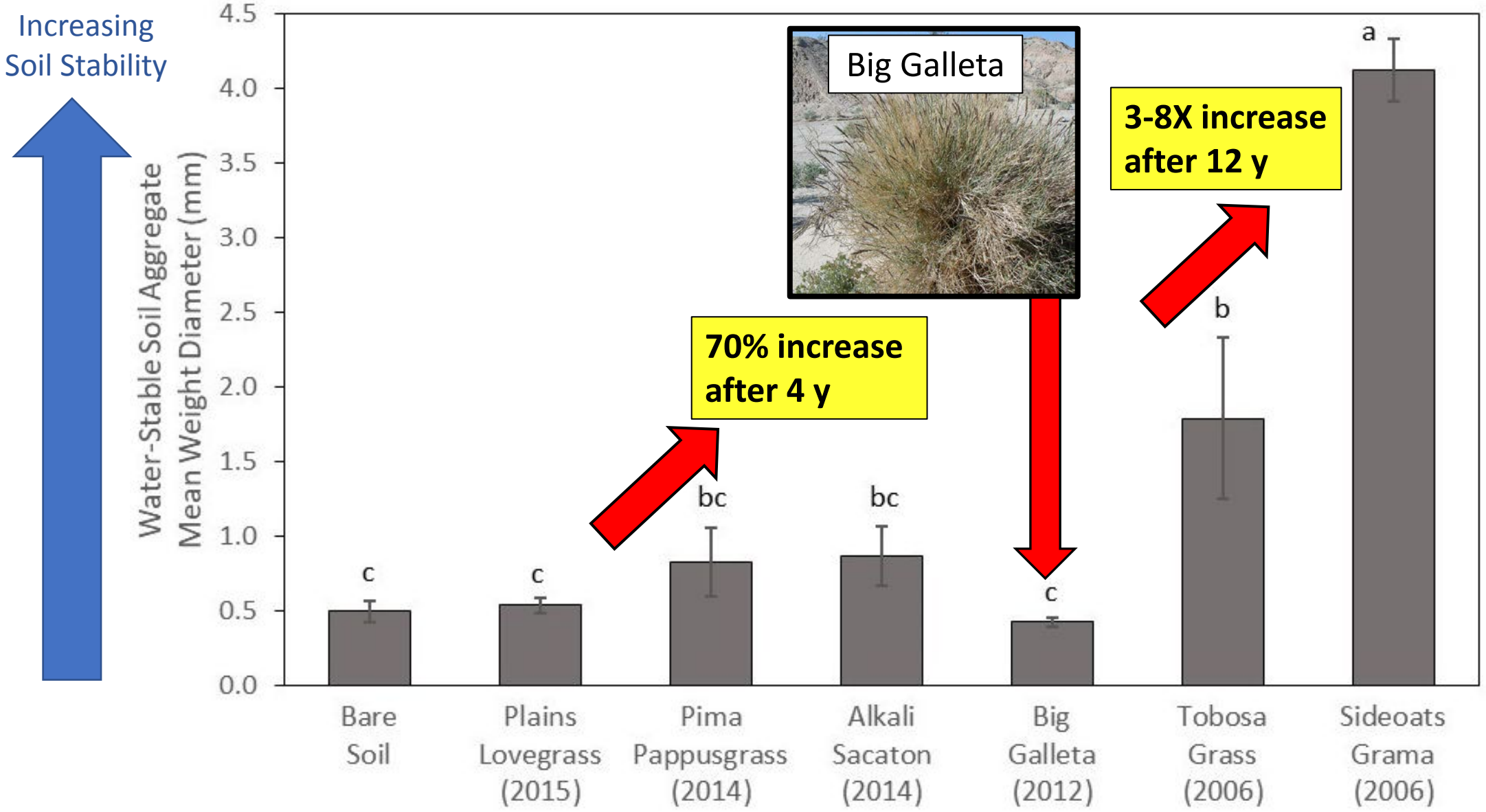
Monocultures of native perennial grasses

NRCS Plant Materials Center, Tucson, AZ

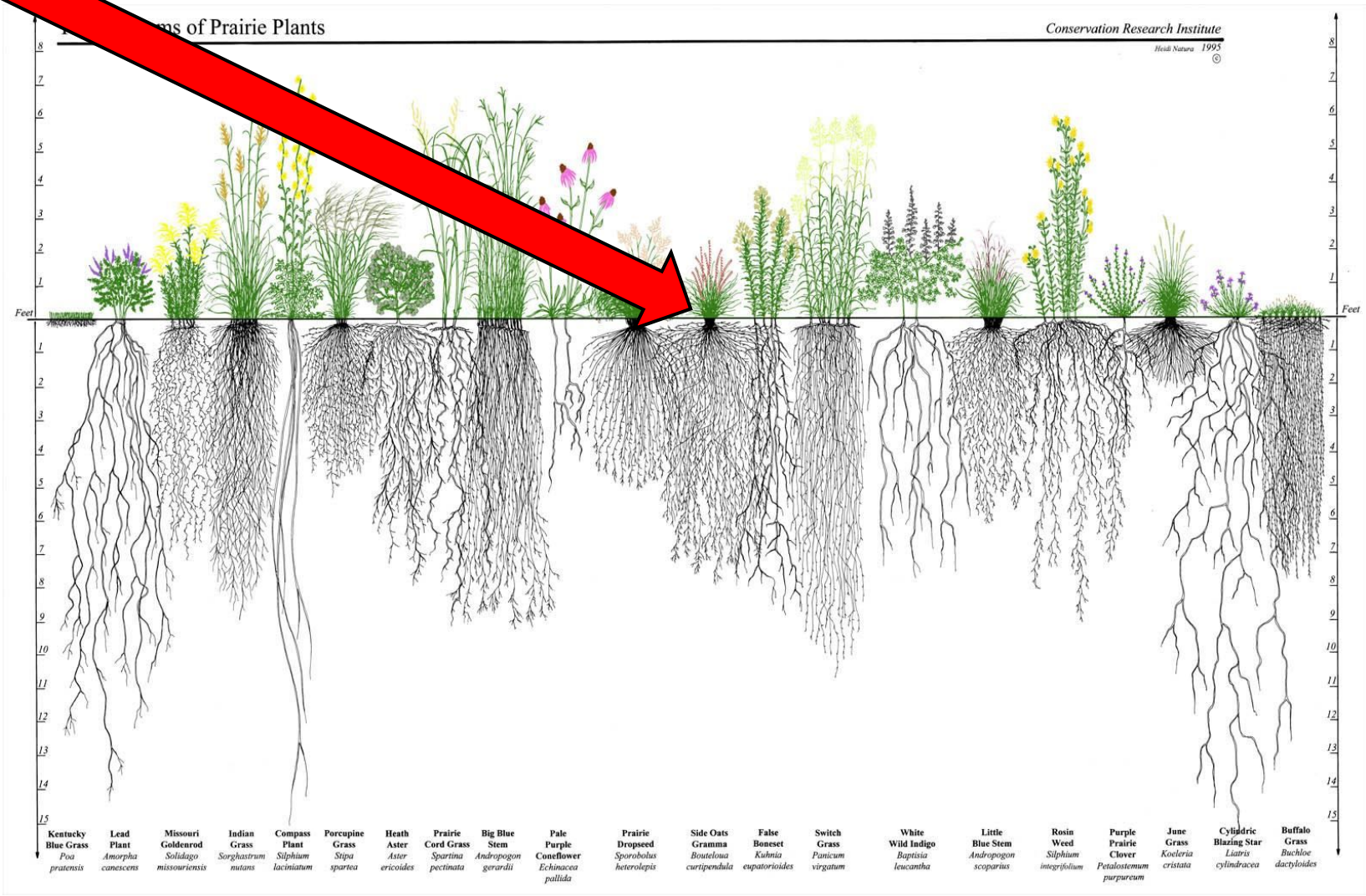
USDA United States Department of Agriculture

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

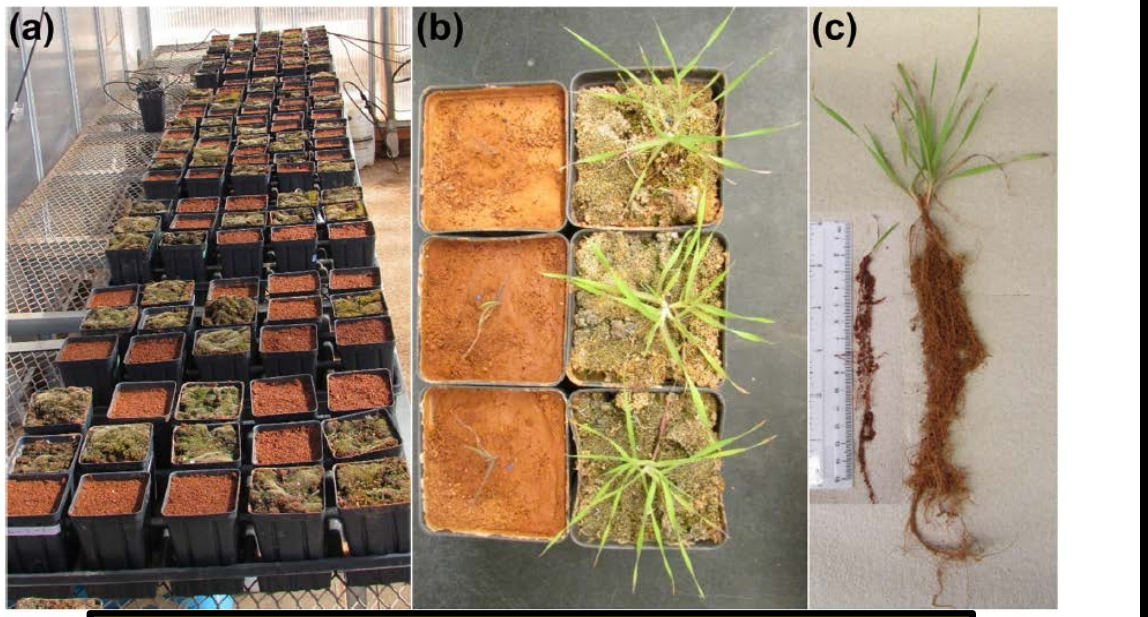
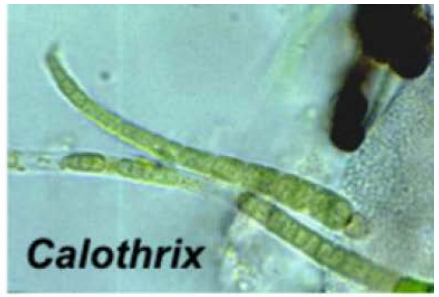
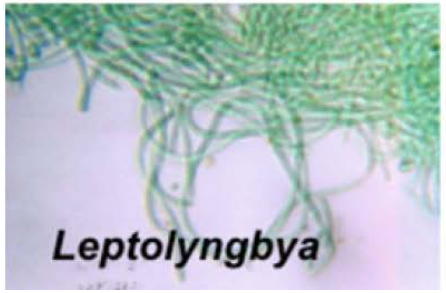


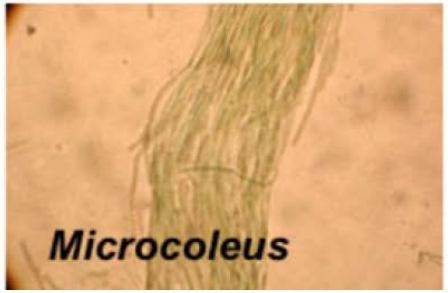
Fig. 2 Mesocosm
constructed with a
tained in a greenh
tion daily. Biocru
bare soil mesocon
grown in bare soil
c) All mesocosms
aracterization of
s, as well as leaf
) had significantly
owered root:shoot
mesocosms (right)

Besides stabilizing soil, biocrusts can promote plant growth

Cyanobacteria (aka “Algae”) as Soil Stabilizers







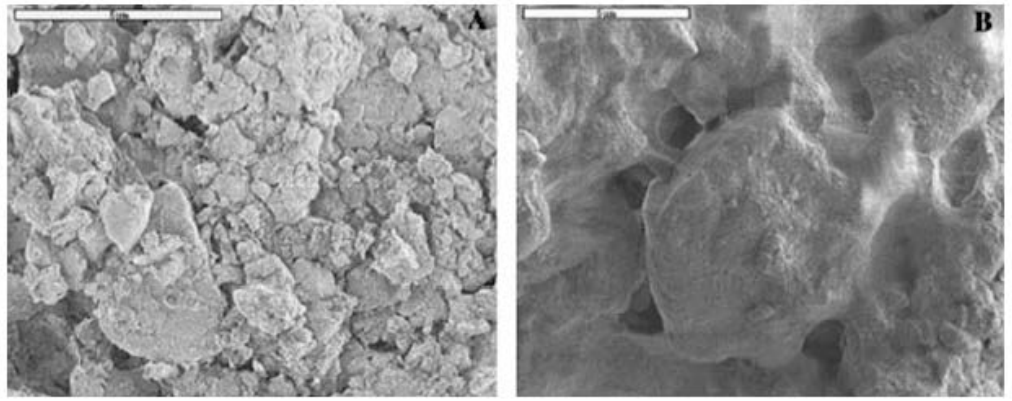
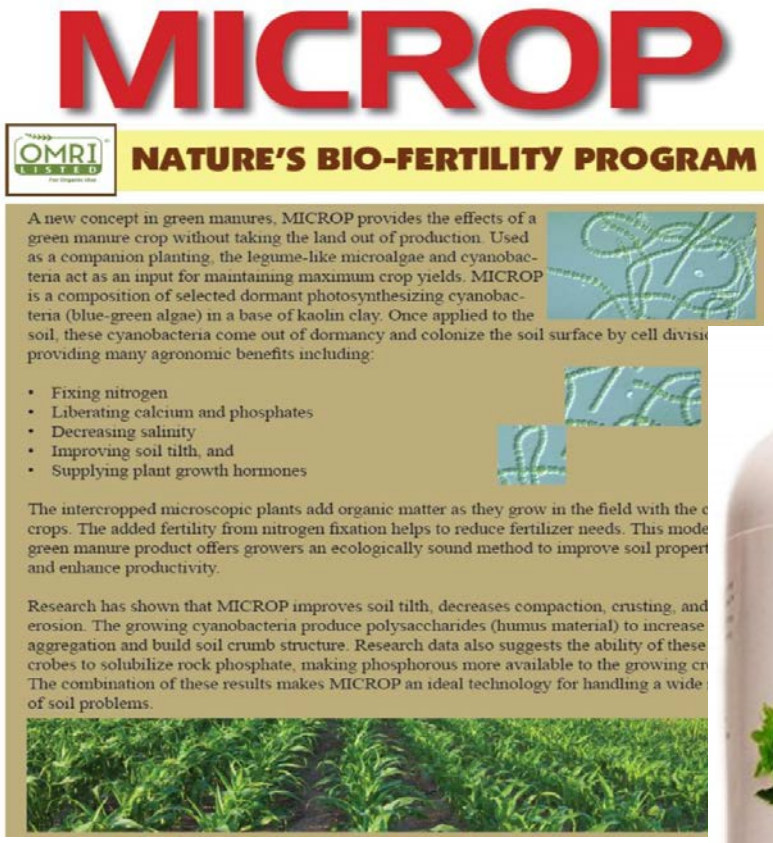
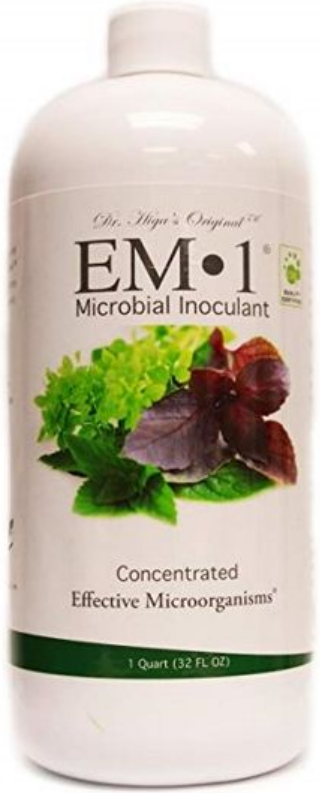
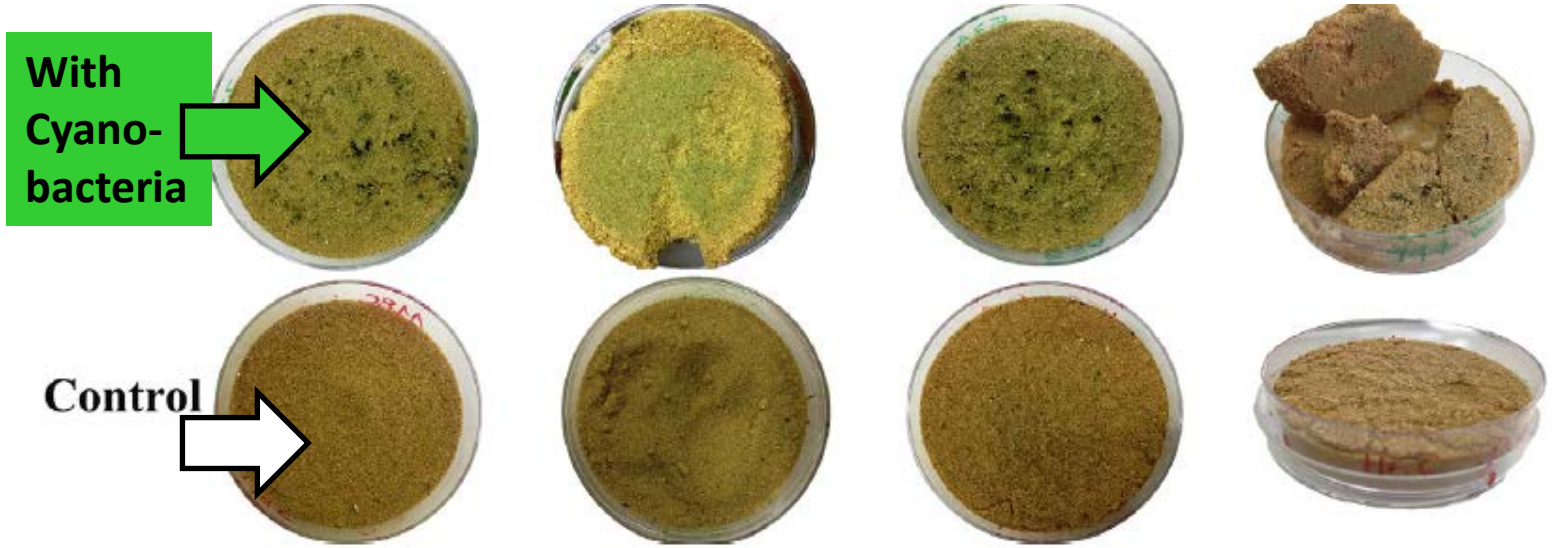


Fig. 12.7 SEM images. Microstructure and soil aggregate stability of Guquka soil aggregates inoculated by *Nostoc* 9v; (**a**) surface of non-inoculated sample; (**b**) surface of an inoculated sample. *Scale bar*, 5 µm (Source: Malam Issa et al. 2007)





D’Acqui (2016) Bioformulations for Sustainable Agriculture



Mugnai et al (2018) Soil Biology & Biochemistry

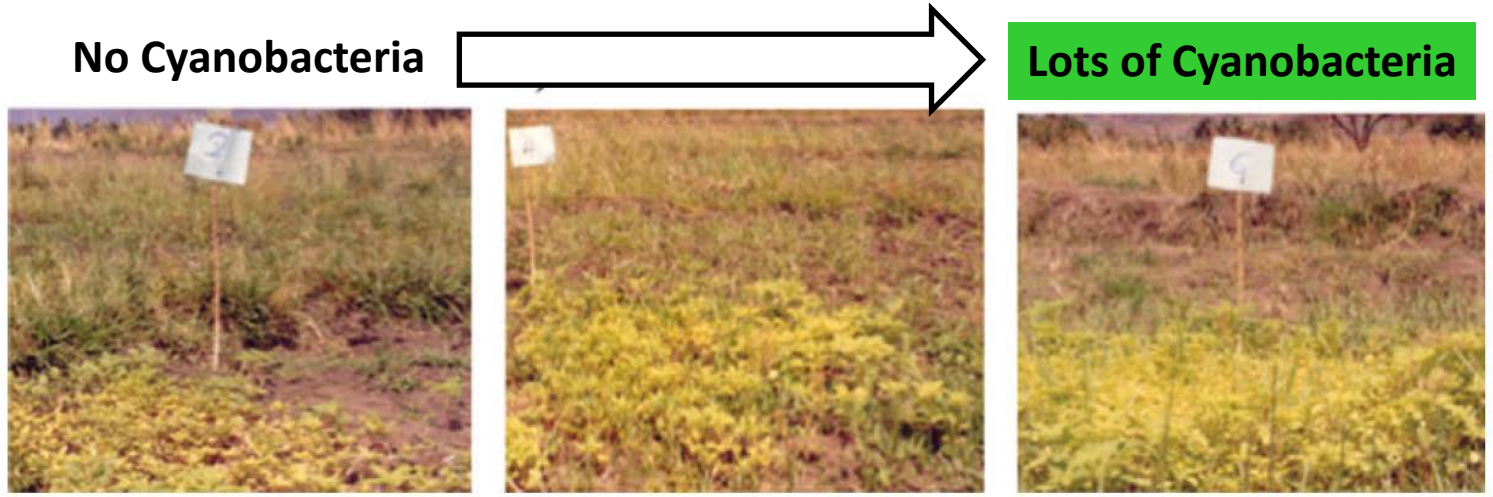
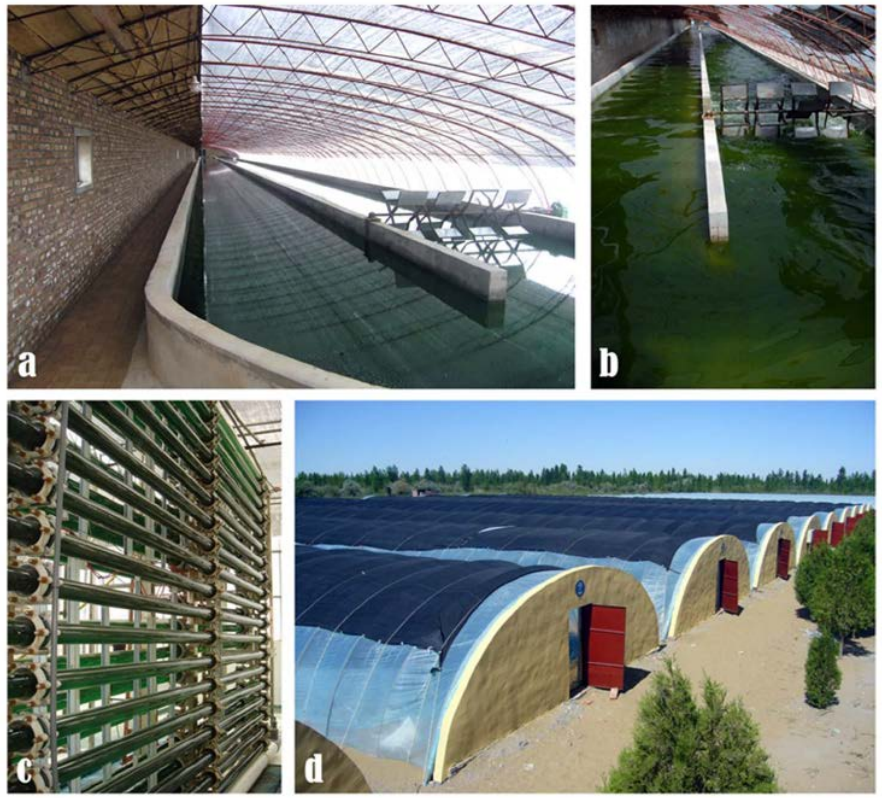


Fig. 12.11 Field experiment carried out on *Amaranthus* spp.: (**a**) cropped without inoculation, (**b**) cropped plus inoculation 3 g^{-2} cyanobacteria (**c**) cropped plus inoculation 6 g m^{-2} cyanobacteria (Photo S. Maliondo)

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