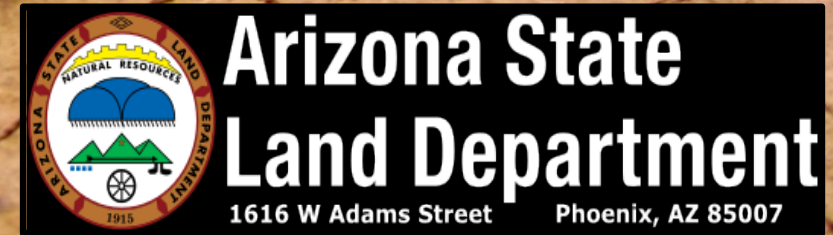


Testing Carbon- and Microbial-Based Strategies for Soil Stabilization and Dust Mitigation in Barren Lands of the Sonoran Desert

Dr. Joseph Blankinship

Assistant Professor
University of Arizona
jblankinship@email.arizona.edu



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.

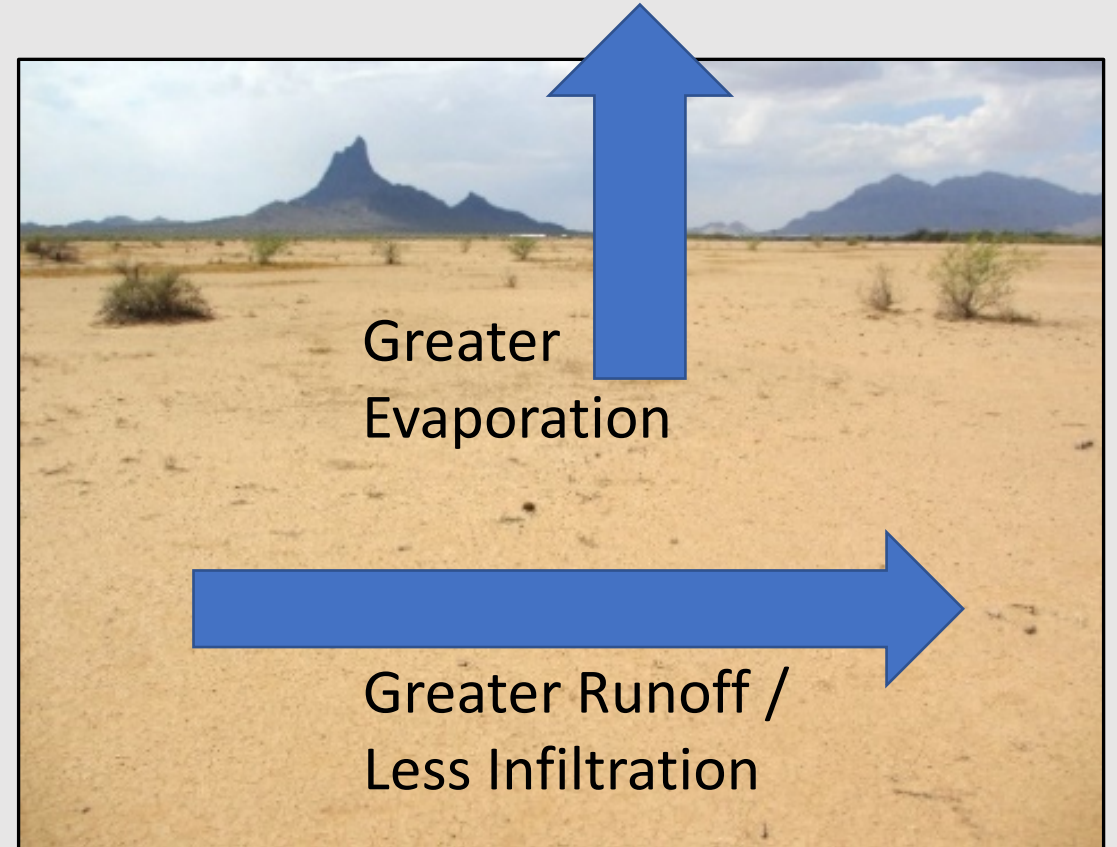


Symptom #1: Barren lands lack soil cover



Intact Functioning Ecosystem

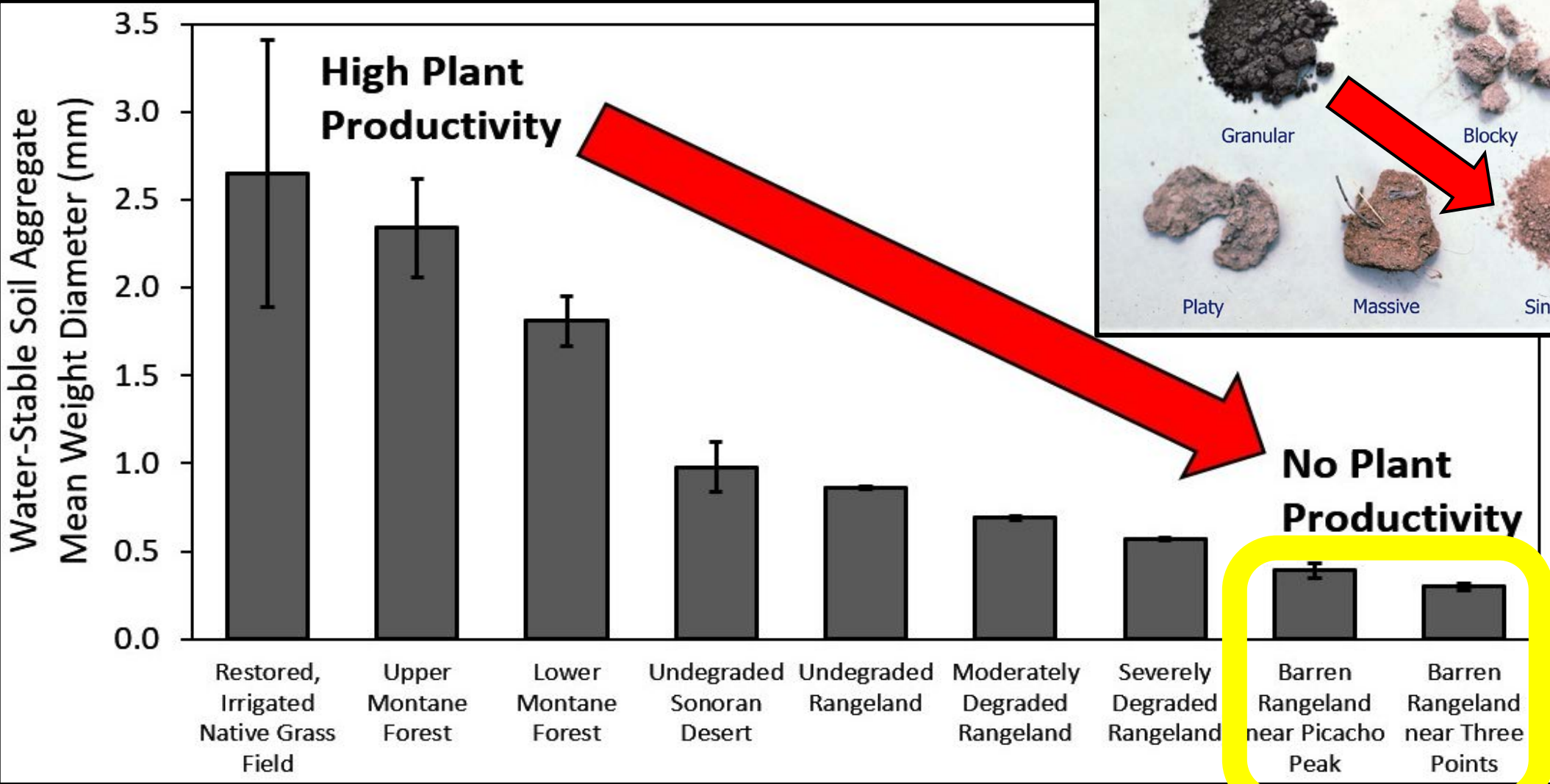
VS.



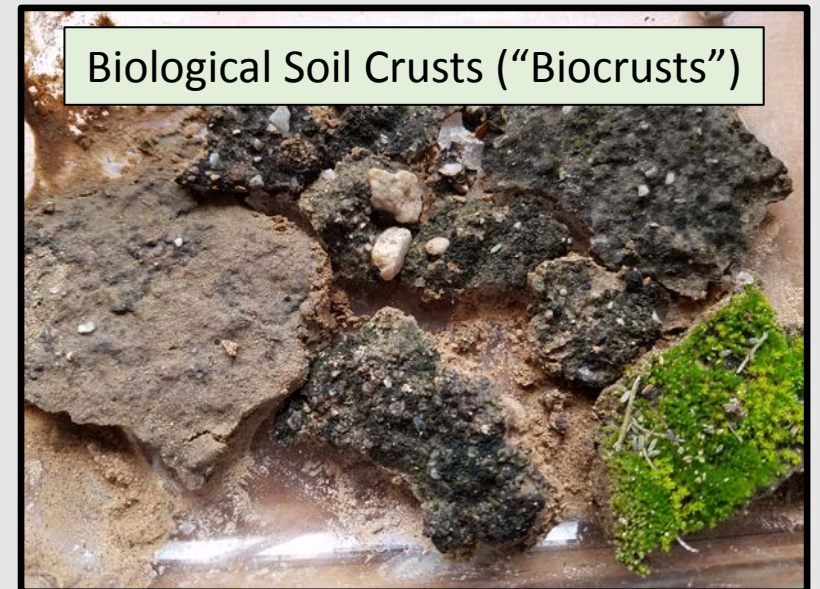
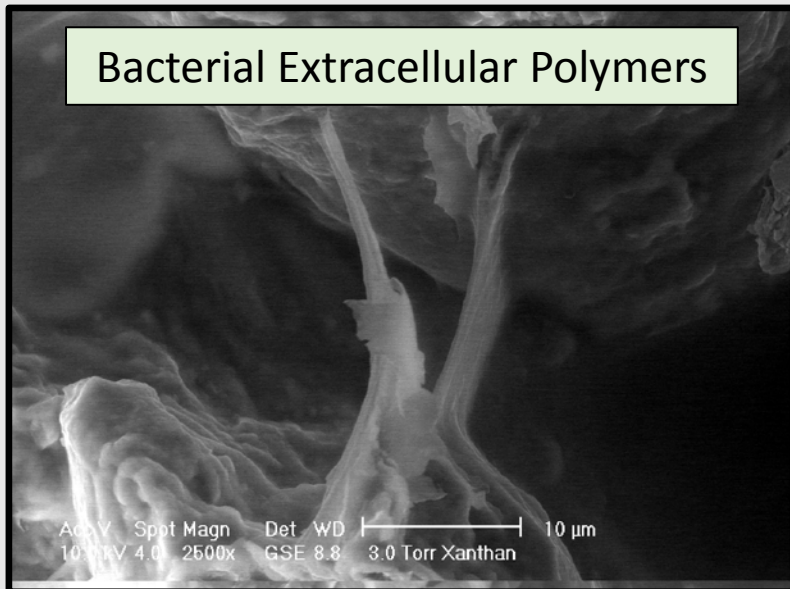
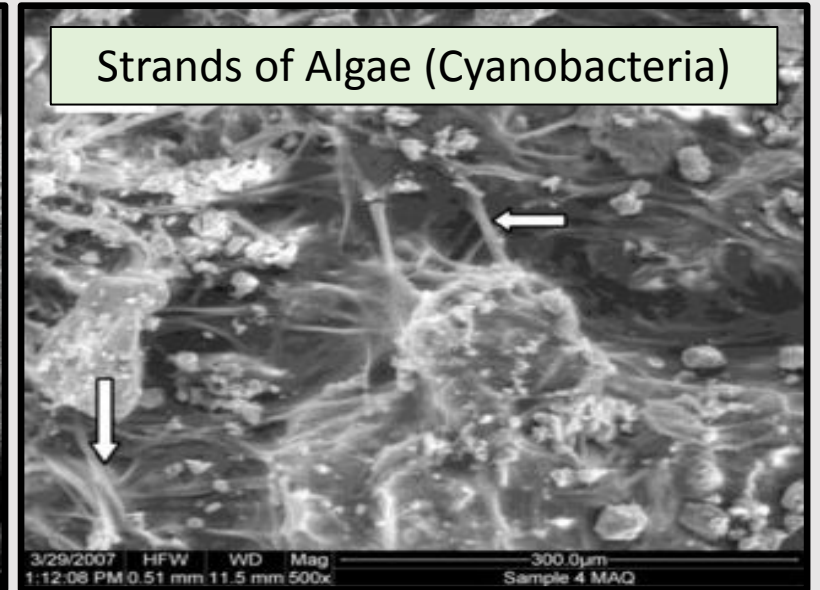
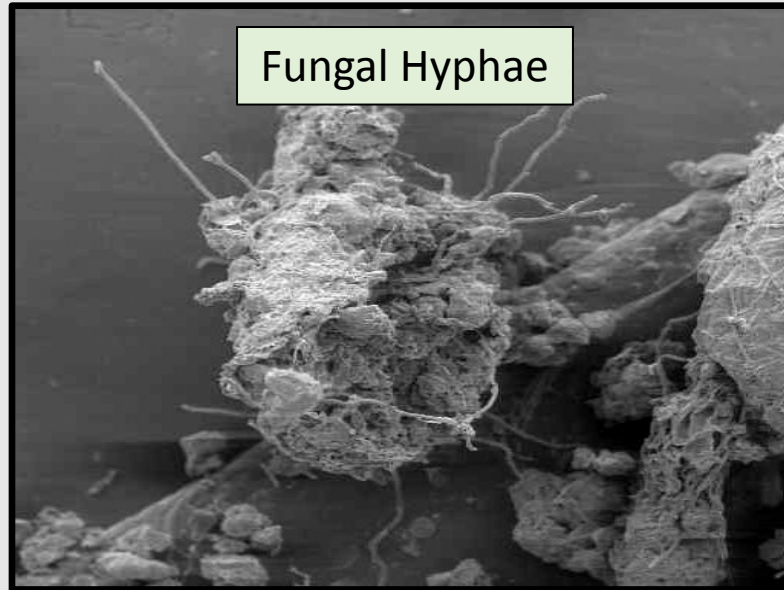
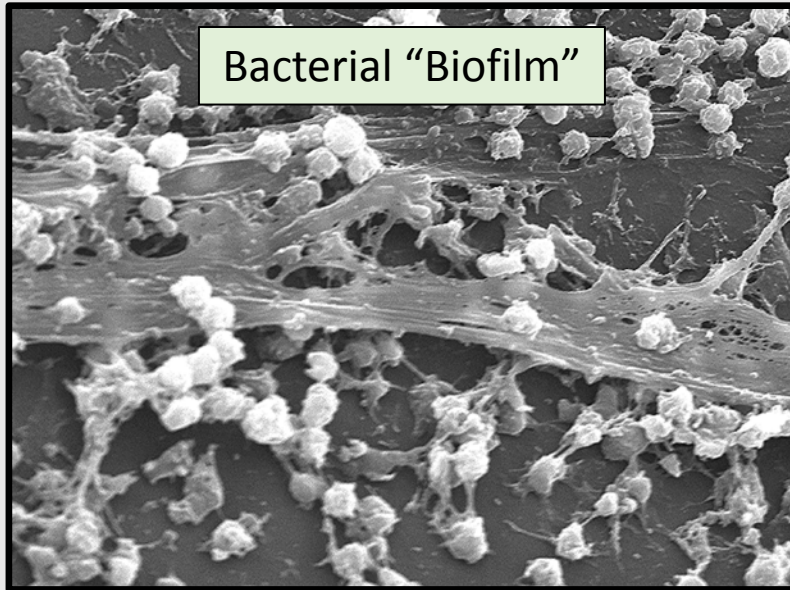
Barren Dysfunctional Land

Symptom #2: Barren lands lack soil structure

Blankinship et al. (Manuscript in preparation)



Symptom #3: Barren lands lack soil microbes



Research Objectives

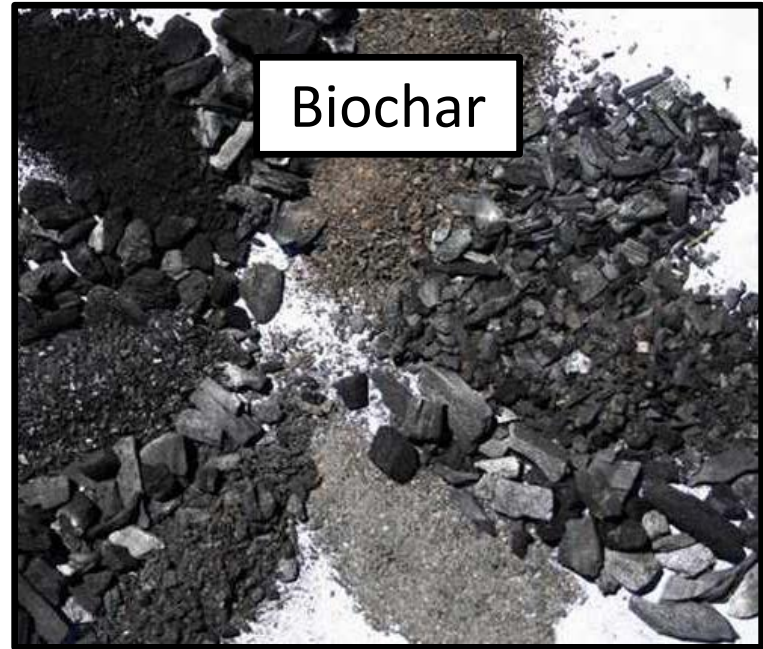
1. What is the potential for recycled green waste to improve soil stability in the Sonoran Desert?
2. What is the potential for microbial inoculants to improve soil stability in the Sonoran Desert?



Woody Mulch



Compost



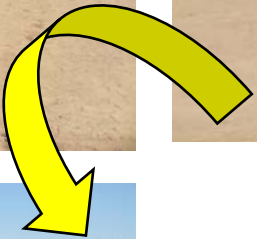
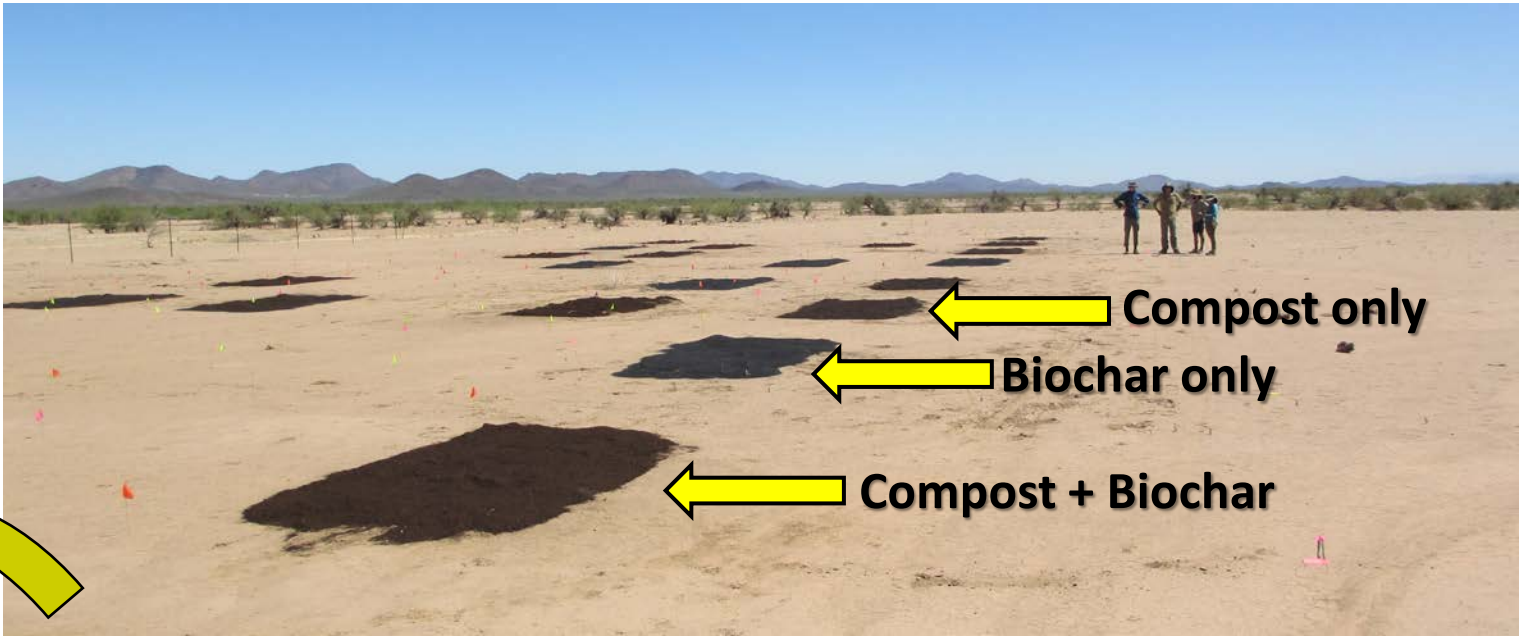
Biochar



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)





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

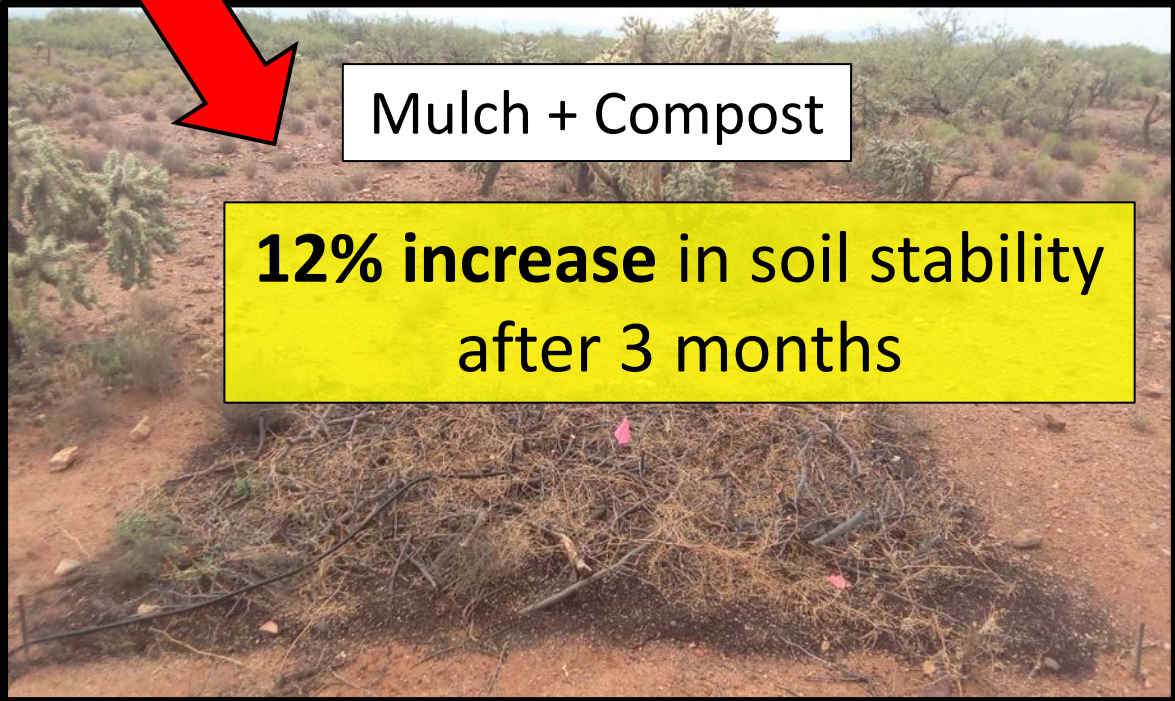


Mulch source



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

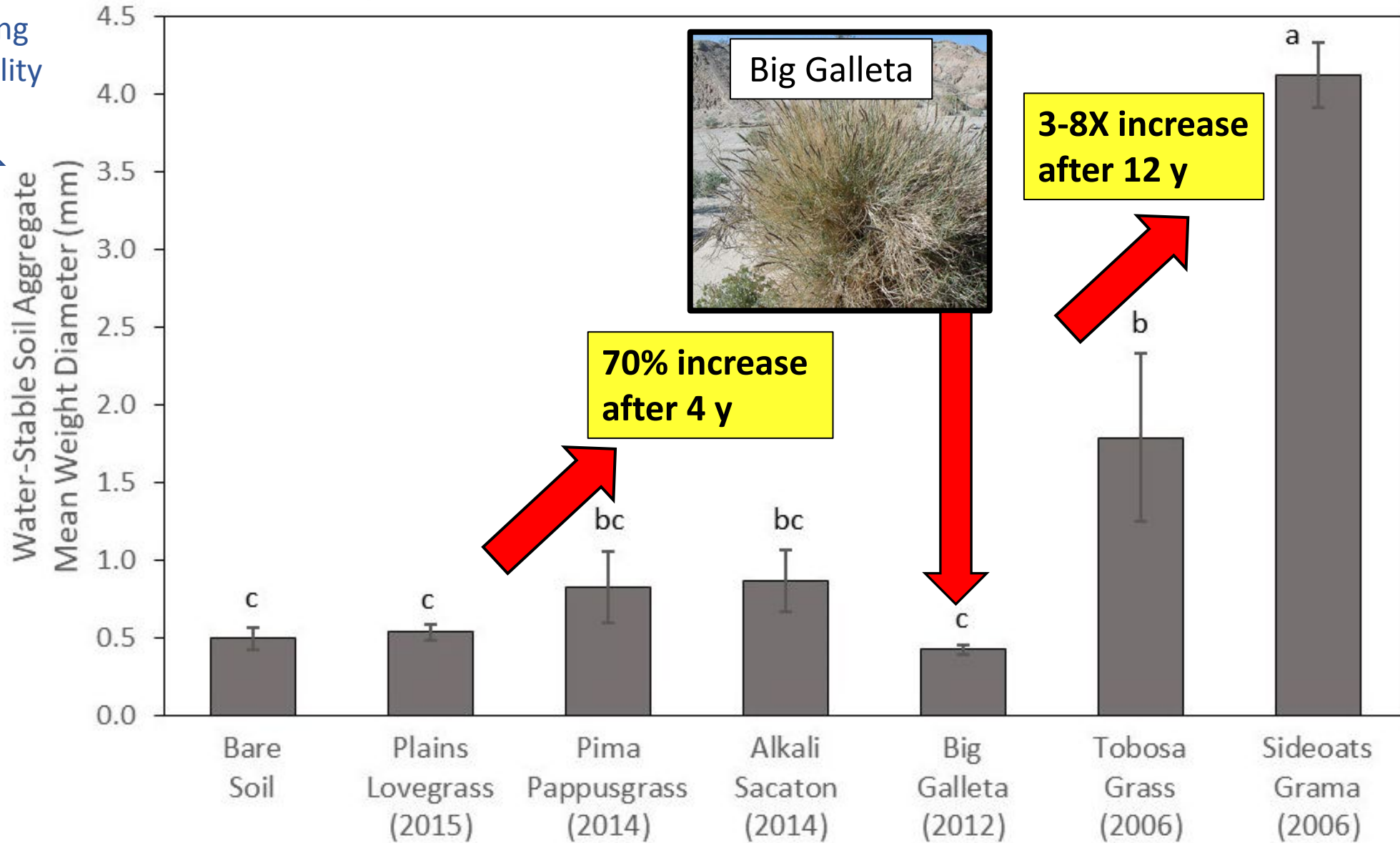
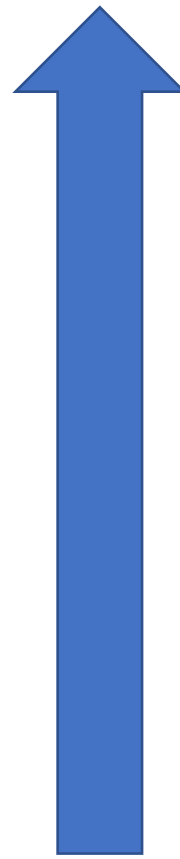


United States
Department of
Agriculture

Natural Resources Conservation Service
Plant Materials Program

Not all plants are soil stabilizers

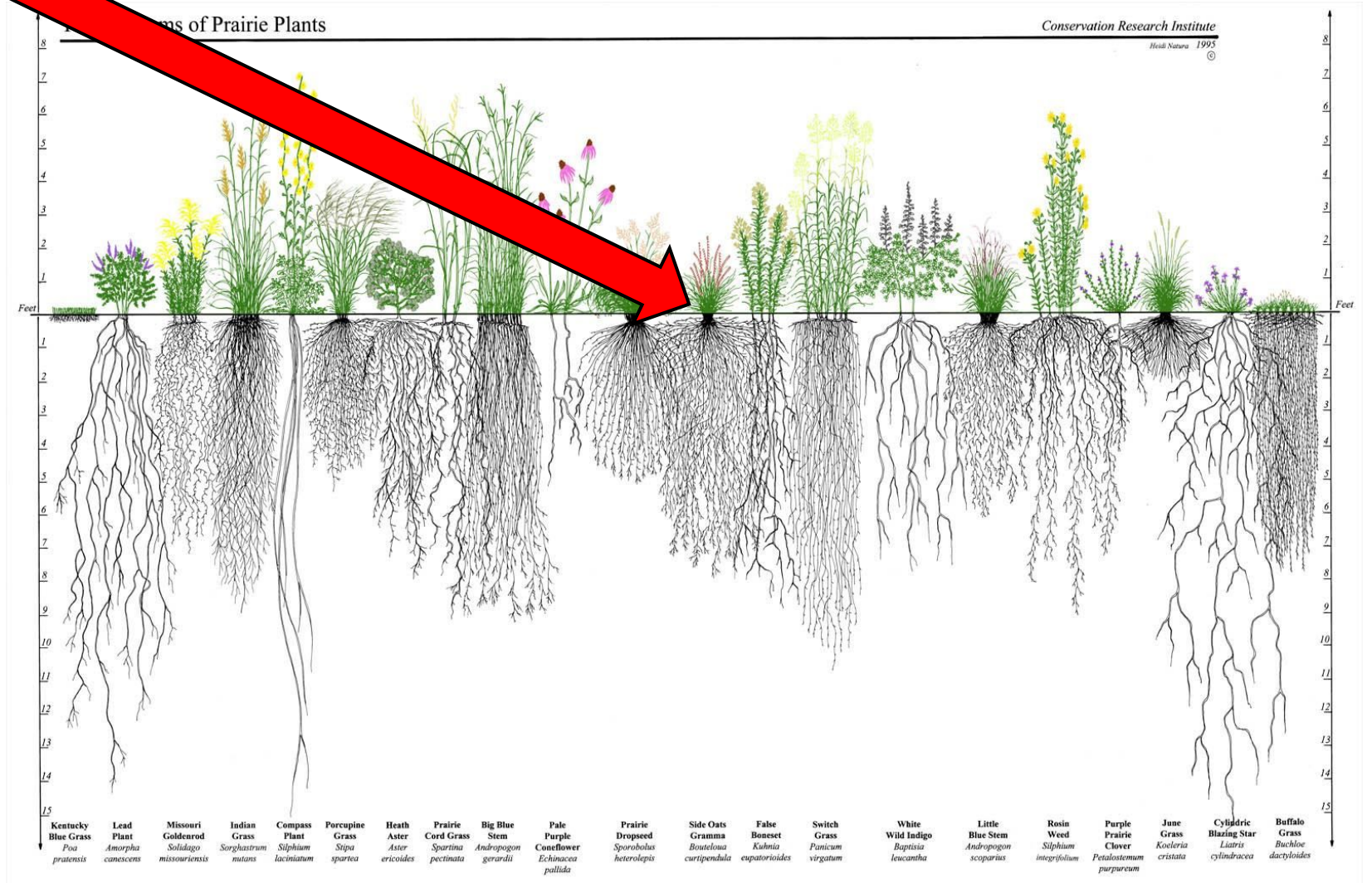
Increasing
Soil Stability



Sideoats Grama



Role of fibrous root architecture?



Research Objectives

1. What is the potential for **recycled green waste** and **plants** 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

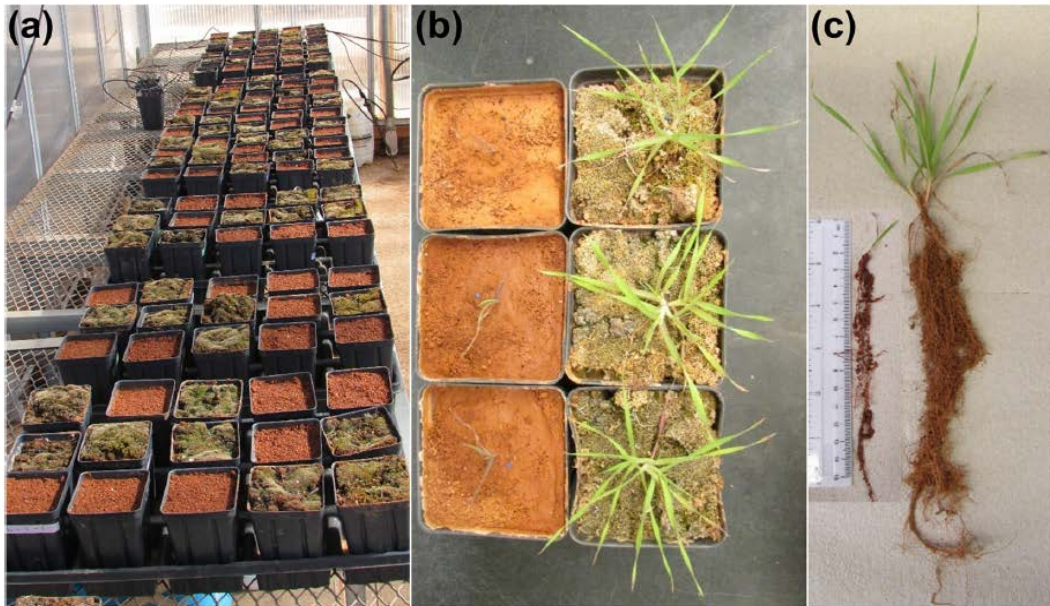


Fig. 2 Mesocosms constructed with a maintained in a greenhouse... Bio-crusted bare soil mesocosms grown in bare soil

Besides stabilizing soil, biocrusts can promote plant growth

(c) All mesocosms characterized of... as, as well as leaf... had significantly lowered root:shoot mesocosms (right)



Cyanobacteria (aka “Algae”) as Soil Stabilizers

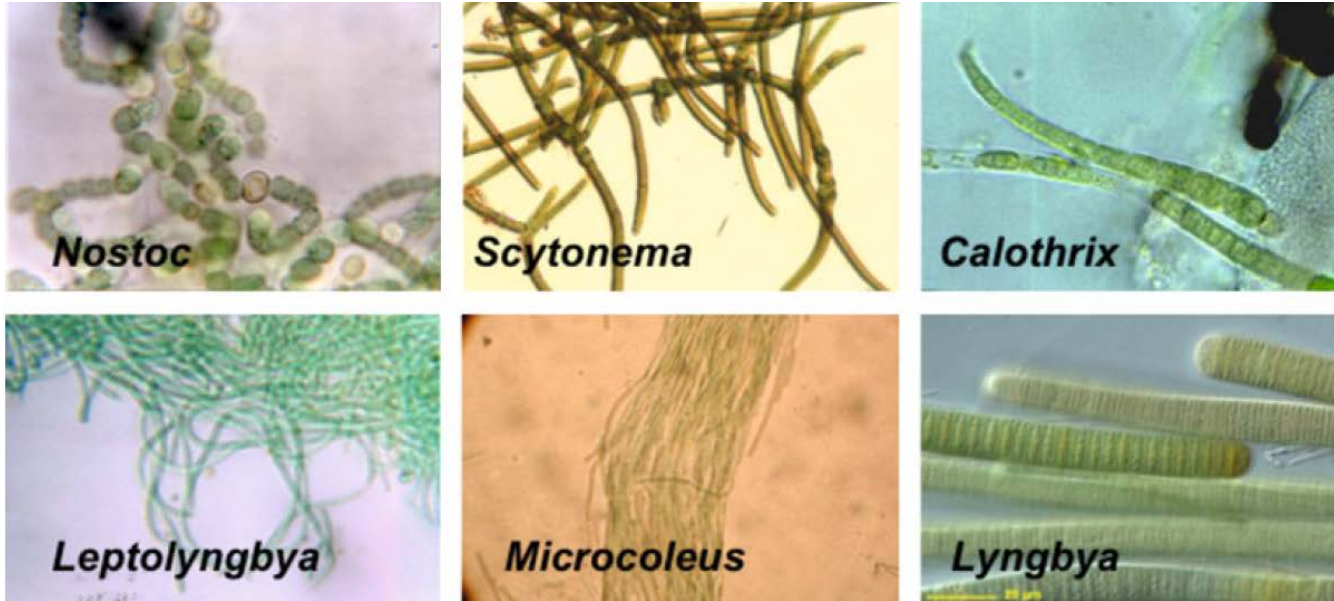
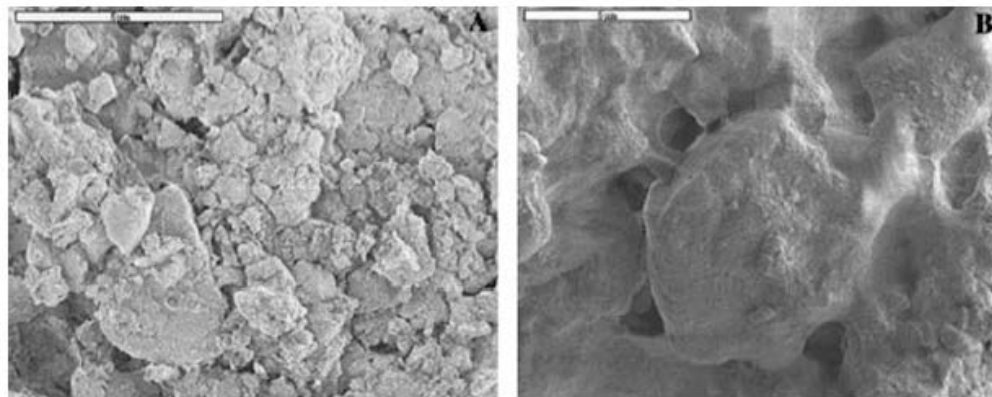


Fig. 12.7 SEM images. Microstructure and soil aggregate stability of Guquka soil aggregates inoculated by *Nostoc* 9v; (a) surface of non-inoculated sample; (b) surface of an inoculated sample. Scale bar, 5 μ m (Source: Malam Issa et al. 2007)



MICROP

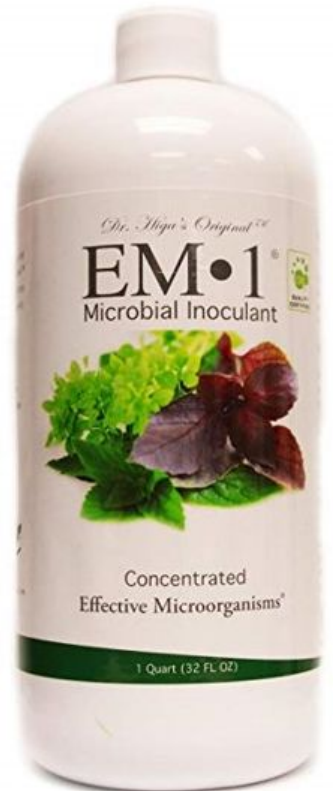
OMRI LISTED NATURE'S BIO-FERTILITY PROGRAM

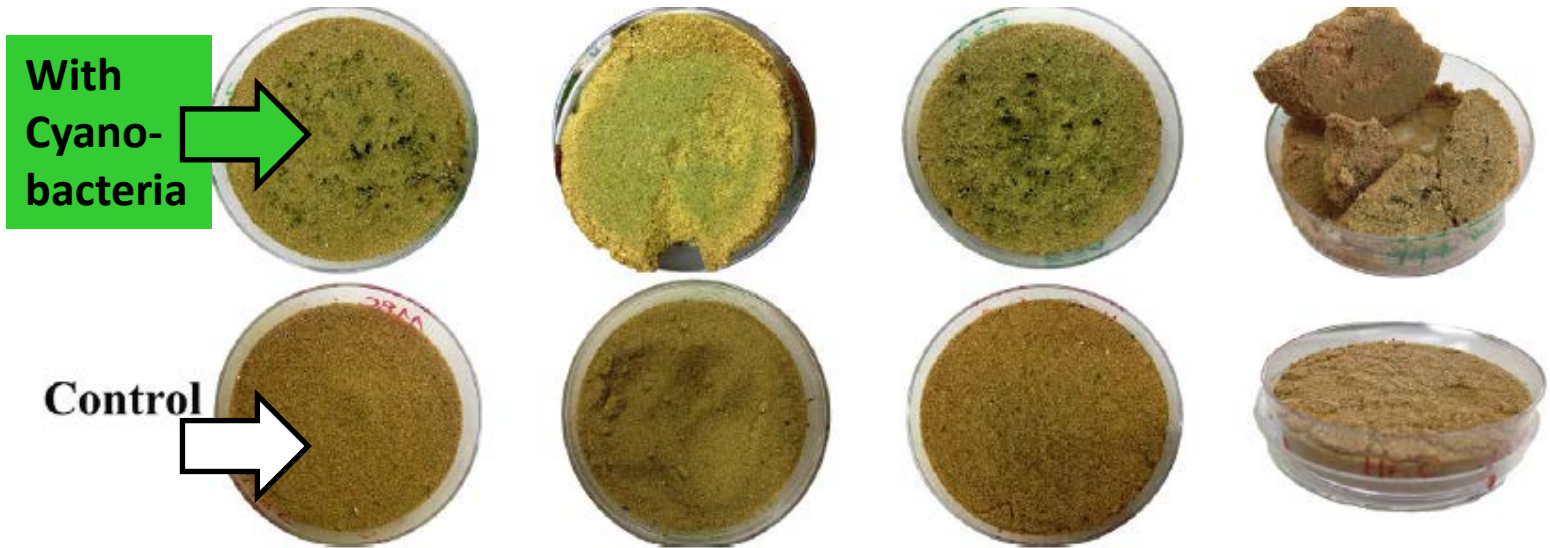
A new concept in green manures, MICROP provides the effects of a green manure crop without taking the land out of production. Used as a companion planting, the legume-like microalgae and cyanobacteria act as an input for maintaining maximum crop yields. MICROP is a composition of selected dormant photosynthesizing cyanobacteria (blue-green algae) in a base of kaolin clay. Once applied to the soil, these cyanobacteria come out of dormancy and colonize the soil surface by cell division, providing many agronomic benefits including:

- Fixing nitrogen
- Liberating calcium and phosphates
- Decreasing salinity
- Improving soil tilth, and
- Supplying plant growth hormones

The intercropped microscopic plants add organic matter as they grow in the field with the crops. The added fertility from nitrogen fixation helps to reduce fertilizer needs. This modern green manure product offers growers an ecologically sound method to improve soil properties and enhance productivity.

Research has shown that MICROP improves soil tilth, decreases compaction, crusting, and erosion. The growing cyanobacteria produce polysaccharides (humus material) to increase aggregation and build soil crumb structure. Research data also suggests the ability of these microbes to solubilize rock phosphate, making phosphorus more available to the growing crop. The combination of these results makes MICROP an ideal technology for handling a wide range of soil problems.





Mugnai et al (2018) Soil Biology & Biochemistry

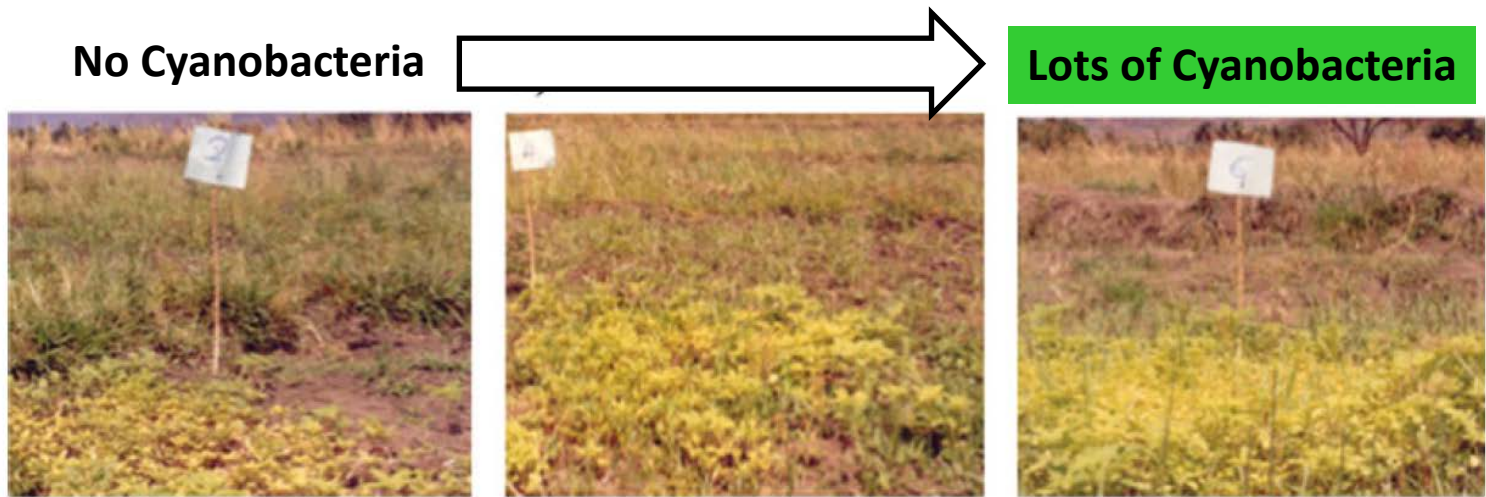
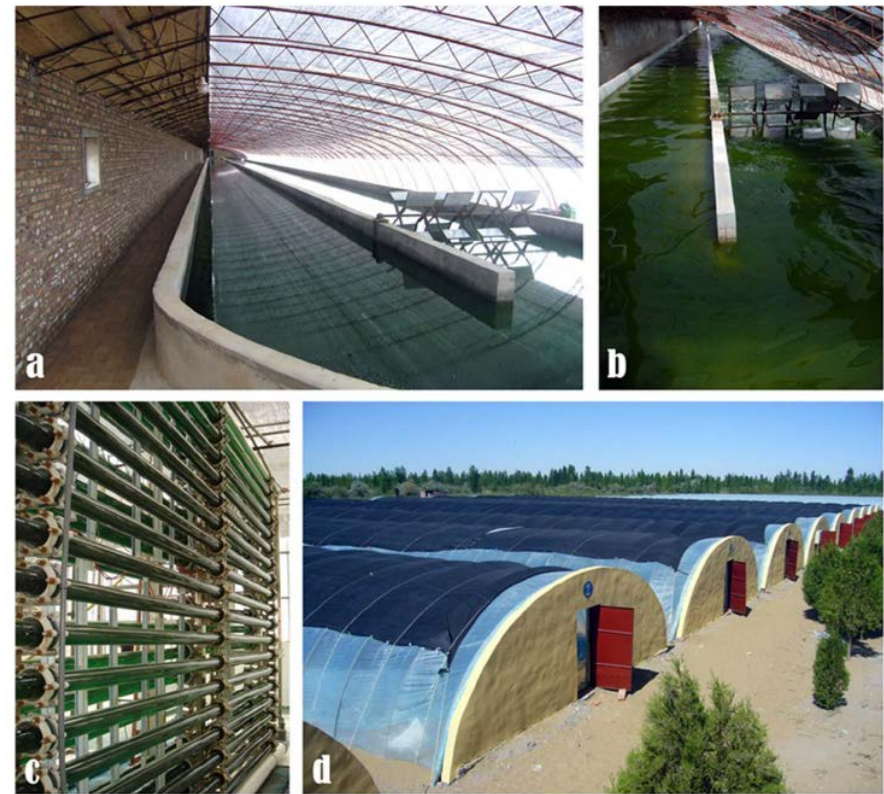


Fig. 12.11 Field experiment carried out on *Amaranthus* spp.: (a) cropped without inoculation, (b) cropped plus inoculation 3 g^{-2} cyanobacteria (c) cropped plus inoculation 6 g m^{-2} cyanobacteria (Photo S. Maliondo)

D'Acqui (2016) Bioformulations for Sustainable Agriculture

It is possible to cultivate cyanobacteria 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



Dust Mitigation

Mulch = Soil protector and slow-release carbon

Cyanobacteria = Soil stabilizer and fertilizer