# Soil Microbial Diversity and Abundance at Russell Ranch


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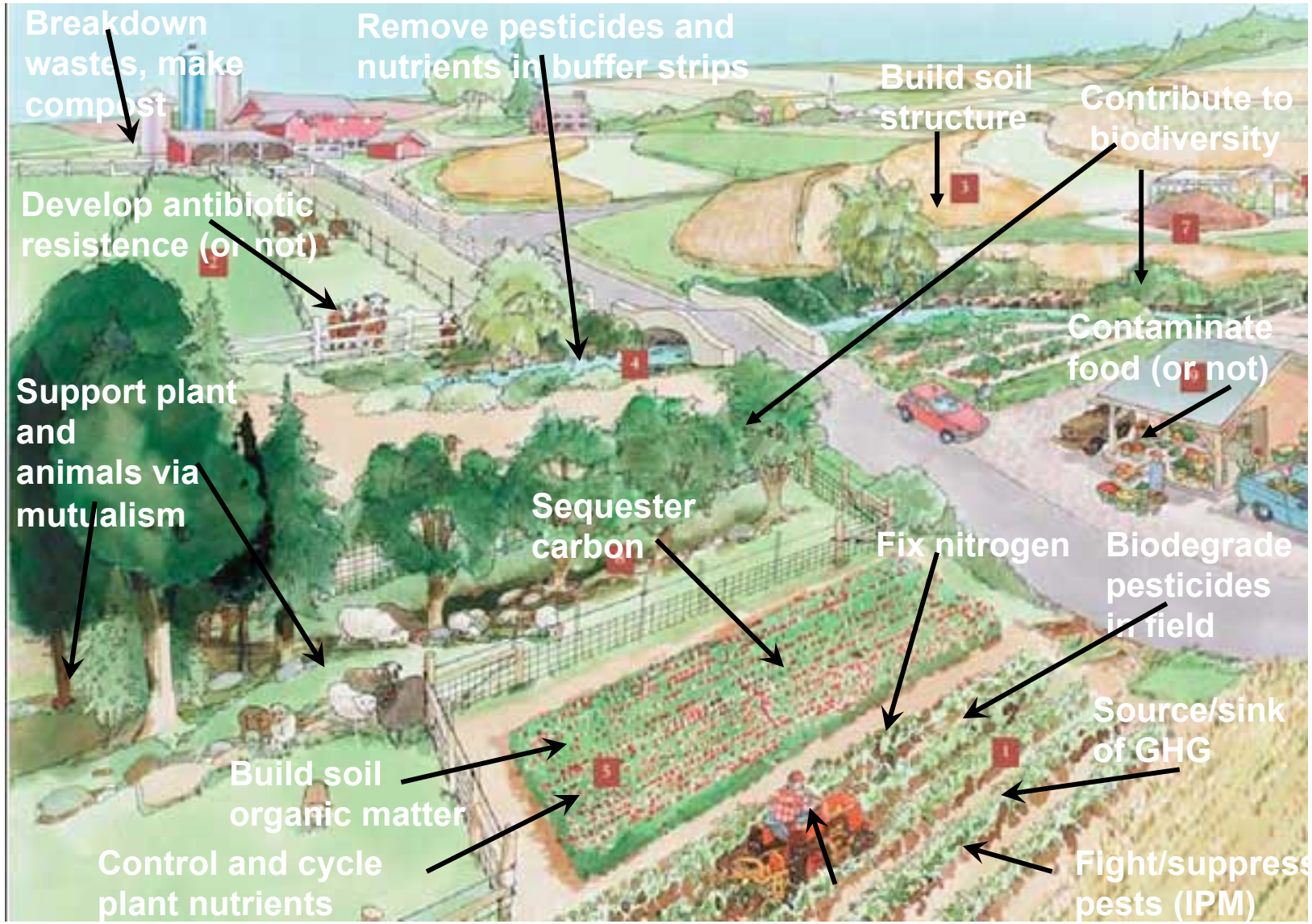


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**How microorganisms contribute to agriculture**

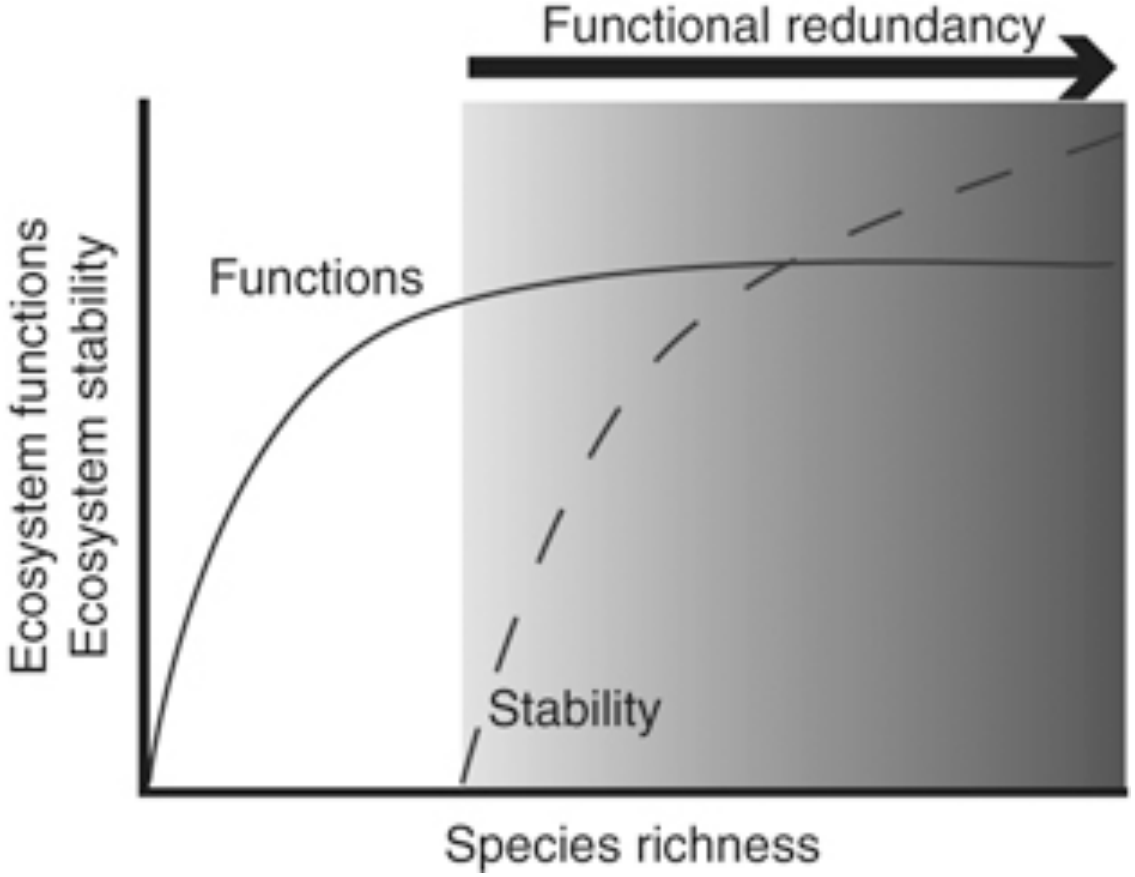
# Indicators, metrics for soil biodiversity

| Indicator | How measure | Why useful |
|---|---|---|
| Identity<br><br>Community composition | DNA or RNA: clone libraries, pyrosequencing, DNA fingerprinting, metagenomics | Determines WHO is there, what relationships are there, what is "potential" of these organisms |
| Quantity<br>•Numbers<br>•Biomass | Fumigation-extraction, phospholipids, DNA, microscope counts, | How many or how much? How fast? |
| Functional traits<br>•Degrades chemicals, produces chemicals<br>•Associates with a symbiont<br>•Kills someone<br>•Competes with someone<br>•Helps build structure | Substrate utilization, formation of products (e.g. CO2)<br><br>Presence/quantity of functional genes (Geochip);<br>RNA expression of functional genes | What are IMPACTS of microbes? What do they eat, excrete, who do they partner with<br><br>What is activity of genes responsible for specific microbial processes |

# Background: Microbial biodiversity

- Diversity – degree of variation of life forms in an environment
- **Species diversity** refers to number of species in an environment and their relative abundance.
- Why do we care?
  - To achieve functional redundancy

# Functional Redundancy = Stability




**Functional redundancy comes from diversity**

Konopka 2009, What is microbial ecology? *ISME,* **3,** 1223–1230

# Research questions

- Are soil microbial communities in unfarmed (fallow) soils more diverse than in soils that are actively farmed?
- Does growing crops without any fertilizer reduce soil microbial diversity?
- Are soil microbial communities more diverse in organic than conventionally managed crops?

# Farming Systems Compared

*RECEIVING INPUTS* (rotation with wheat)

- **Organic** tomato: irrigated, no synthetic pesticides, fertility from compost and cover crops
- **Conventional** tomato: irrigated, pesticides, fertility from ammonium sulfate

*NO INPUTS*

- Wheat**: no inputs**--not irrigated or fertilized
- Fallow: **uncropped** systems with weeds

# Biomass

Total microbial biomass is ~2X higher in organic than other systems.

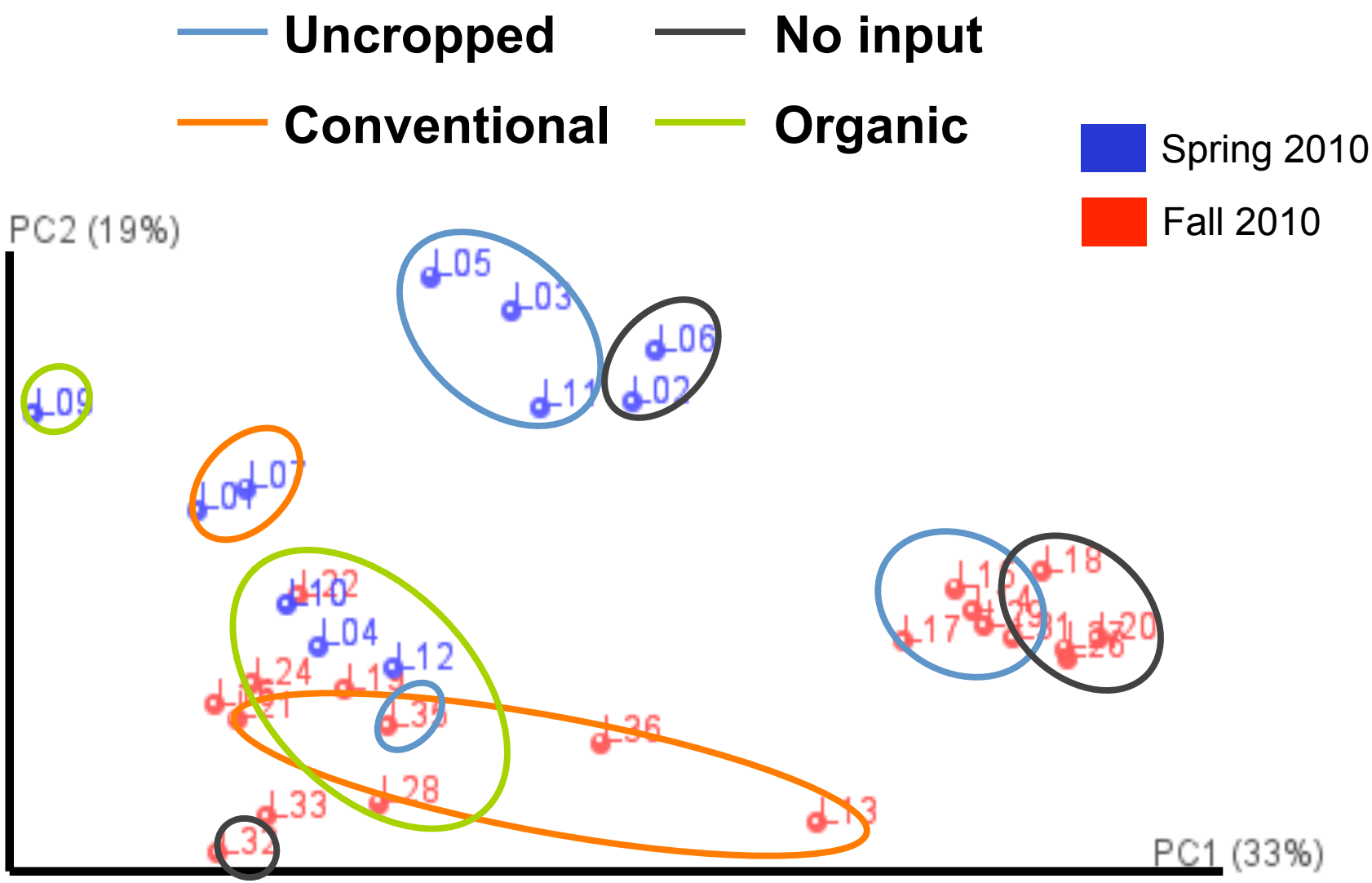
Conv, no input and uncropped not significantly different in biomass.

# Species Diversity

We frequently use **DNA sequencing** to measure microbial species diversity. Each “species” has unique DNA sequences that can be used to catalog numbers and relative abundance.

**Pyrosequencing** is recent technology for characterizing complex microbial communities.

# Community Composition by System and Season



# RESULTS

- All systems have same **number** of species
- Systems differ in **composition** of their communities.
  - Organic and conventional systems more similar to one another than to no input and uncropped systems
- Most systems showed strong changes in communities in Spring versus Fall.
  - Organic less so?

# Conclusions/discussion

- Organic and conventional not very different—why? How about commercial organic farms with greater crop diversity? How about commercial conventional farms with higher fertilizer/pesticide inputs?

- Seasonal variation is high in uncropped, no input systems and conventional but less so in organic. Organic has more resources to maintain and stabilize microbial communities?

- Do differences in community composition translate into
  - Differences in ability of these soils to perform key functions?
  - Differences in resistance and resilience to disturbances?

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