Soil Health

National Science Teachers Association

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Sidney W. Davis
Assistant State Soil Scientist - California

Zahangir Kabir
Soil Health Regional Specialist- CA, NV & Pac Is.

USDA NRCS Natural Resources Conservation Service

Dominant farming systems: poor soil health…?

Photos: Bianca Moebius-Clune

Poor Soil Health Practices

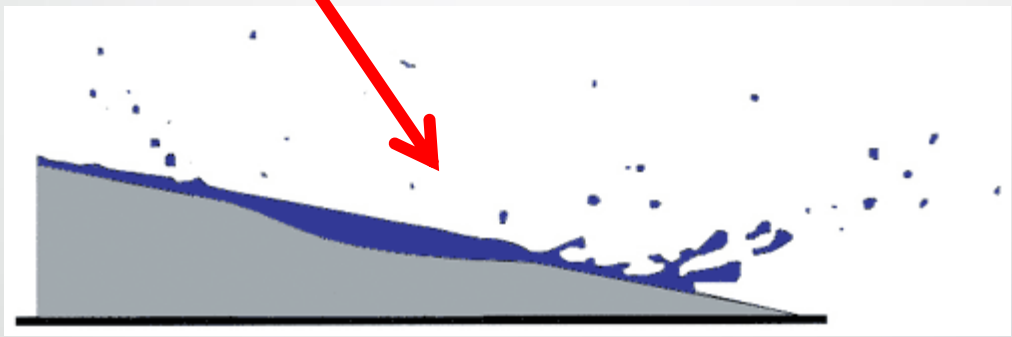
Fallow

No residue cover

Intensive Tillage practices

Raindrops Impact on Bare Soil

Dislodging soil particles and splashing them 3 to 7 ft away



Raindrop splash pattern from a slope landscape, (Envr. Soil Physics, Hillel, 2005)

Splash → Sheet → Rill → Gully → Channel erosion

Breakdown of Soil Structure by Habitual Tillage

From granular structure

To single grain (structureless) and loss of Soil Organic Matter

(Both soils are Columbia very fine sandy loam)

Downward Spiral of Soil Degradation
in annual systems

Platy structure indicative of Soil Compaction

1. Intensive tillage, residue oxidizes rapidly, low diversity, no surface cover

2. Soil organic matter decreases, plow pan forms at depth

3. Aggregates break down

4. Surface becomes compacted, crust forms

5. Infiltration decreases, runoff & wind erosion increases

6. Soil organic matter, nutrients, and top soil lost

7. Ponding & persistent wetness, but LESS soil water storage; less rooting; nutrient reservoir depletes; less diversity of soil organisms, more diseases

8. Crop yields decline

9. Environmental services lost

Modified from *Building Soils for Better Crops*

Lake Erie Becomes Eerie

Dramatic algal bloom resulting from eroded nutrients finding their way into waterways, streams and lakes.

National Geographic, 2013

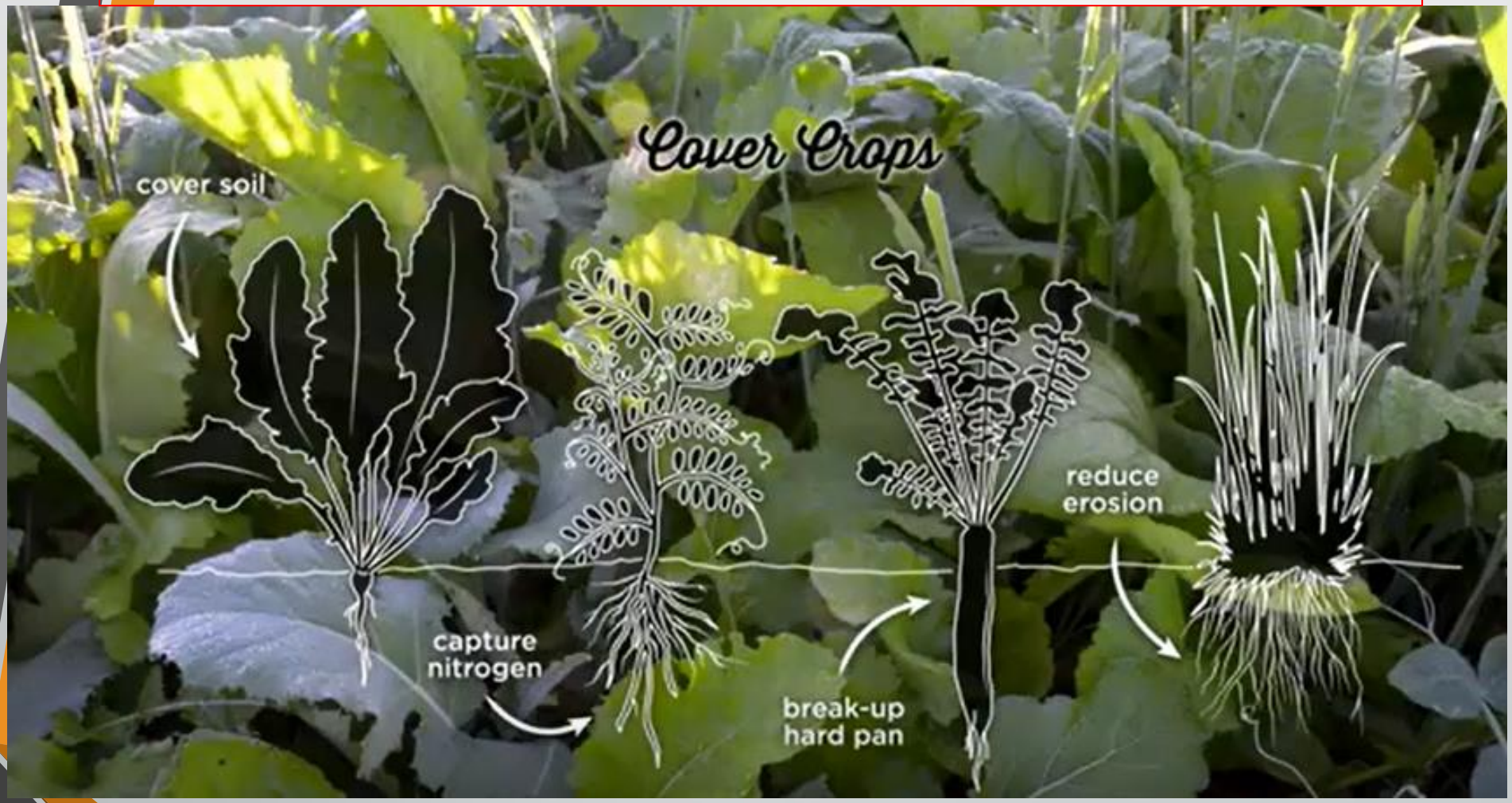
Conservation Practices

No-till/Strip-till

Crop rotation

Degradation of soil organic matter and structure can be reversed!

Conservation Practices



Idaho Soil and Water Conservation District

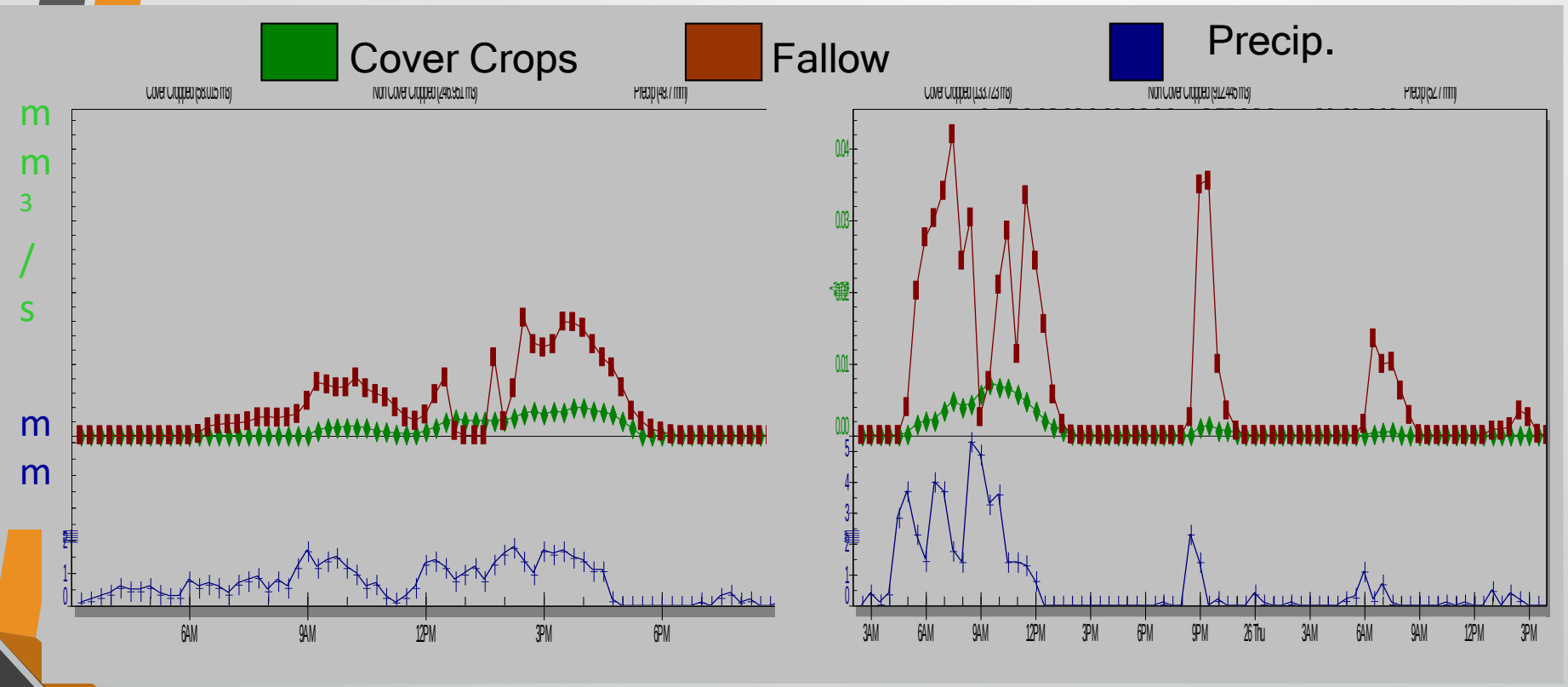
Grower-Collaborator Field Site

Winter Fallow (NCC)

Winter Cover Crop (CC)

Same soil type, both fields, side-by-side comparison

Discharge Hydrograph Comparing Growers' Fields



Storm event 1

Storm event 2

Kabir & Horwath

Grower Field
Total Winter Discharge Comparisons

	Fallow (NCC)	Cover Crops
Precipitation Discharged as Runoff	16.3%	0.9%
Average Peak Runoff Velocity	0.52 m/s	0.24 m/s

Kabir & Horwath

Walnut Orchard: Fallow and Cover Crop in Solano County

Field with no cover crop

Field with cover crop

Identical Soil Types (Soil Hydrologic Group B)

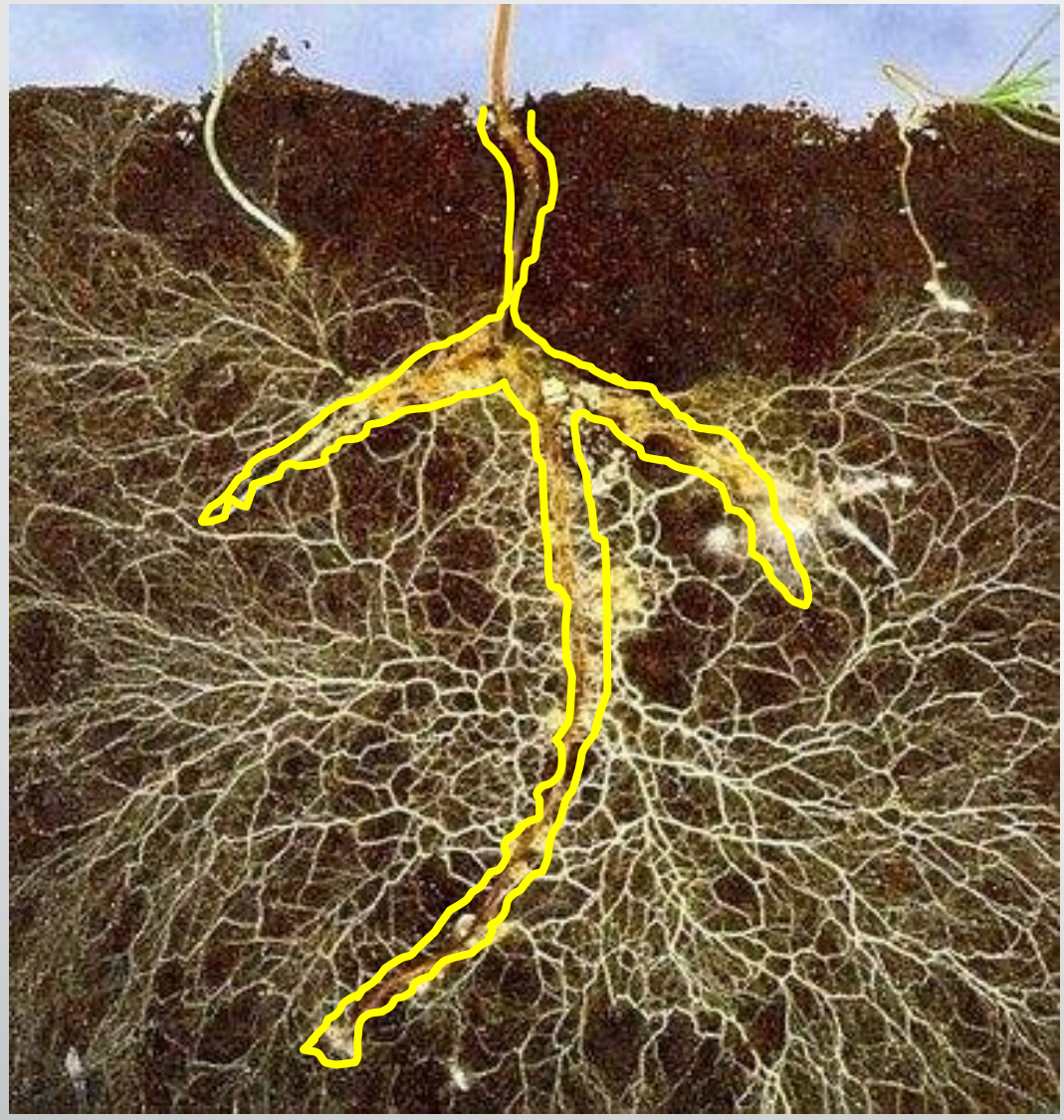
Photo taken on February 07, 2017

Almond Orchard: Fallow and Cover Crop in Yolo County

Photo taken on February 21, 2017

Fallow and Cover Crop Fields in Yolo County

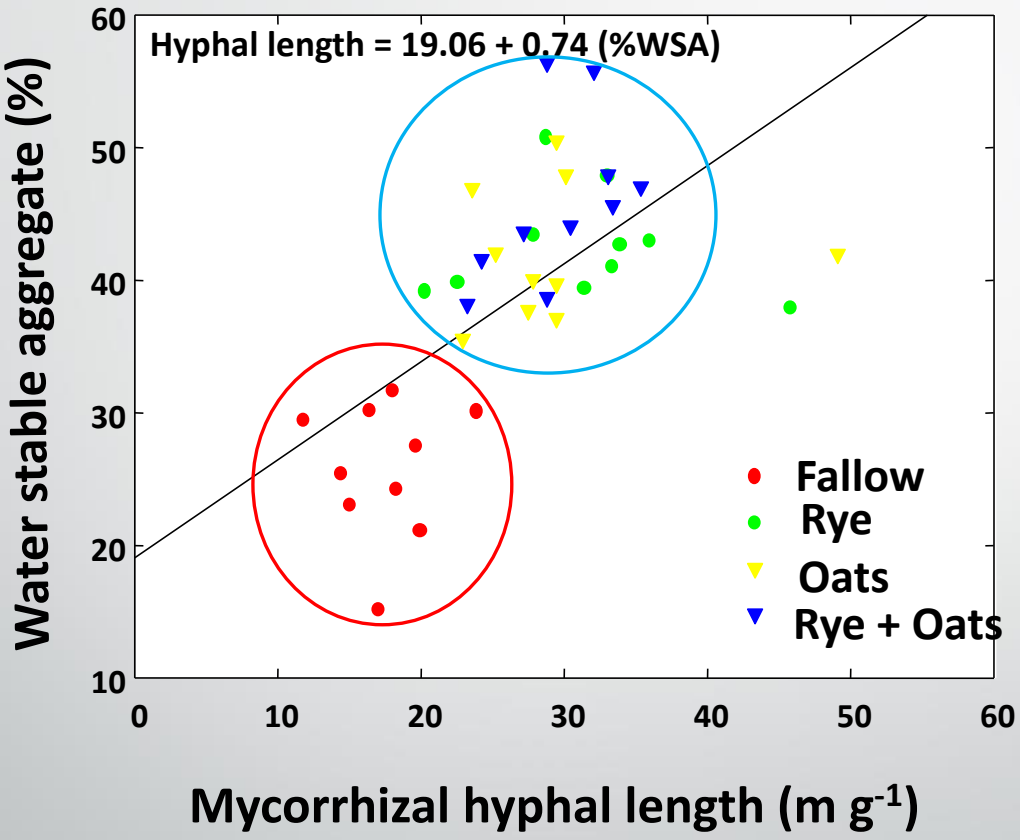
Photo taken (T. Rolfes) on January 8, 2017



Mycorrhizal hyphae network extending the root zone of a cover crop: the crop provides sugar energy from sun light; the hyphae mines water and minerals for the cover crop.

D. Read

Soil Aggregate Stability



Kabir and Koide, 2002

Management Challenges of Cover Crops Adoption in California

- May delay planting of the main crop
- Pest and disease may carry over to the main crop
- Water use and nutrient competition
- Economic loss
- May interfere harvesting of the main crop

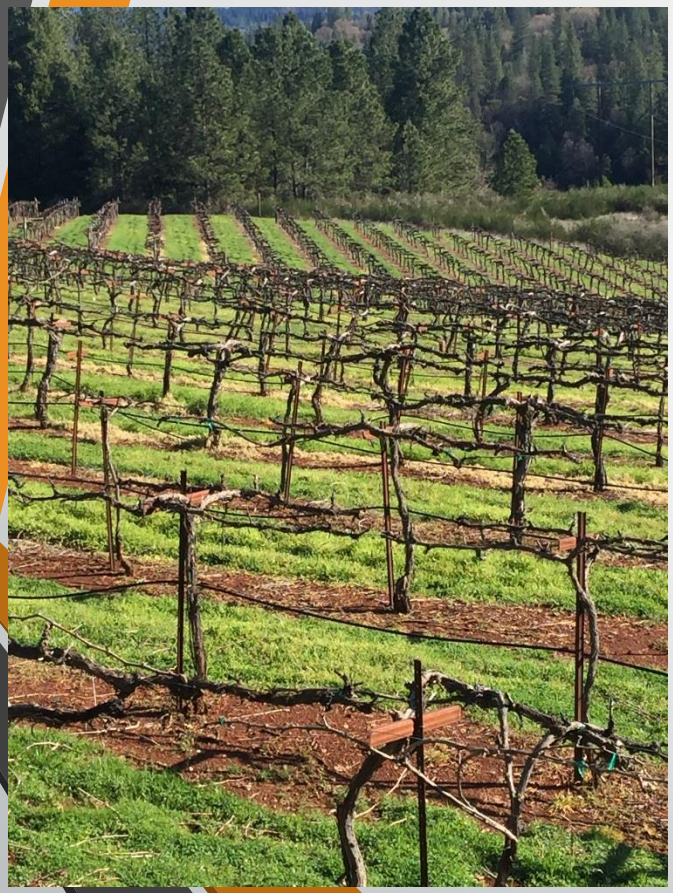
Cover Cropping in Furrows

Runoff Quantity and Quality Monitoring

R. Smith, UCCE

Growing Cover Crops in Vineyards

Mountain terrane



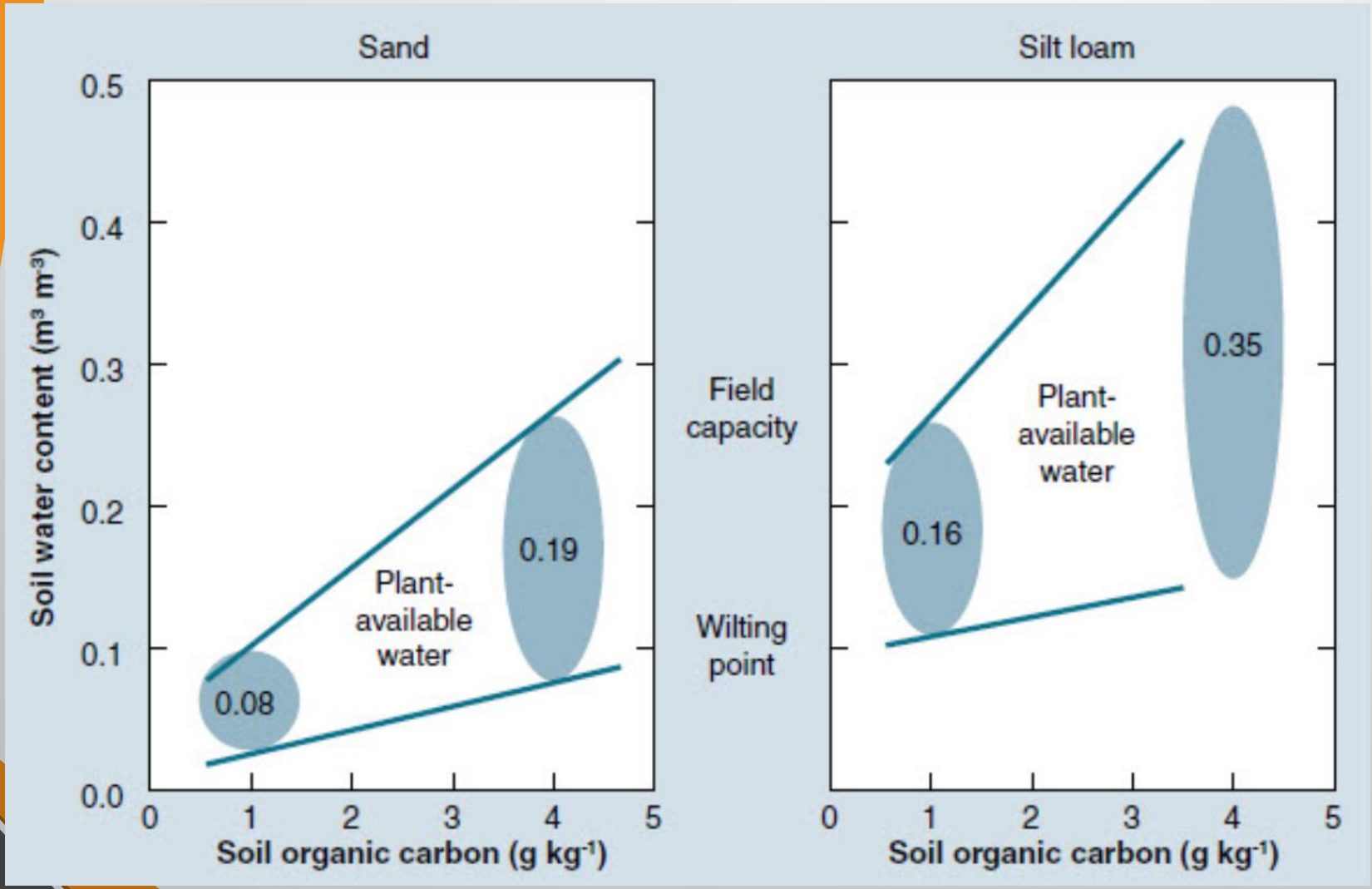
S.W. Davis, NRCS

Alternate rows

Chuck Ingels, UCCE

May interfere in Almond Harvesting

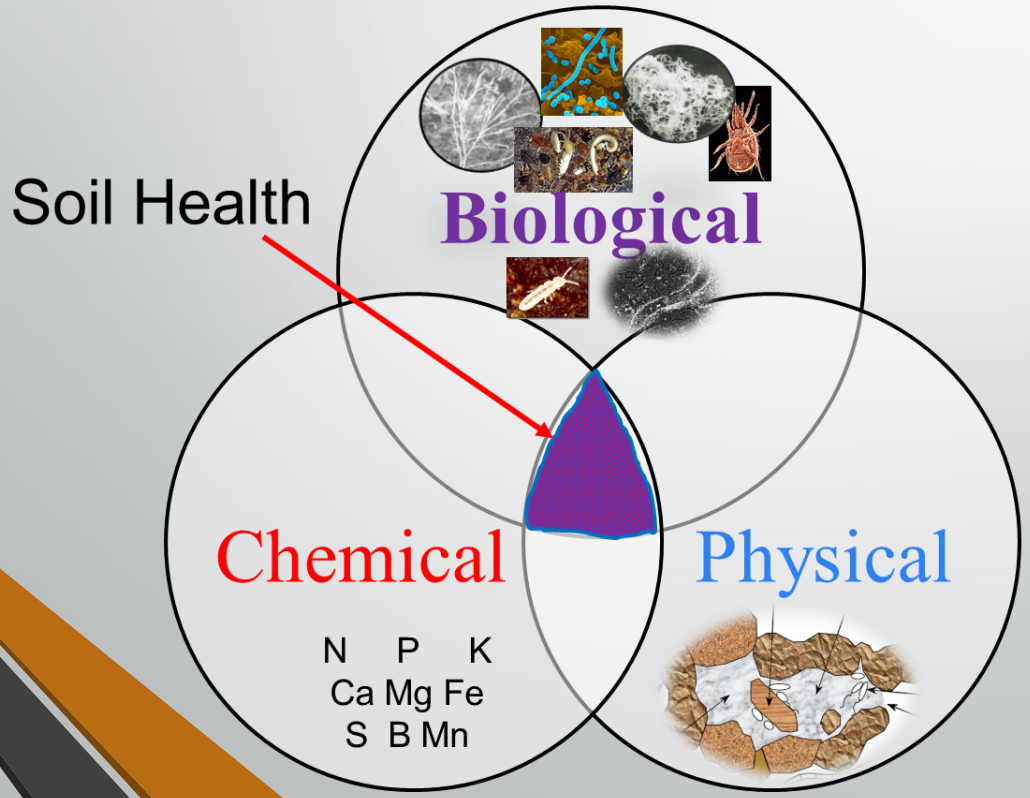
Organic Matter boosts Water Holding Capacity

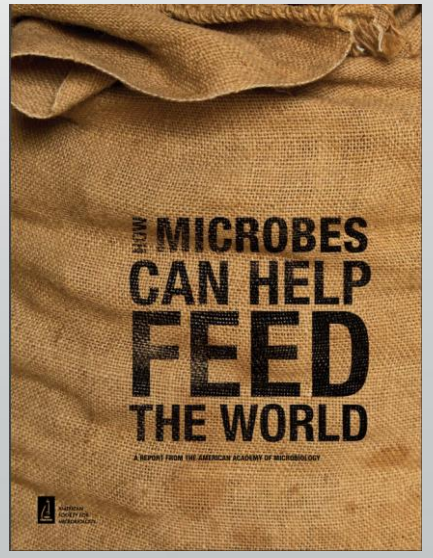


(Hudson, 1994, as redrawn in Franzluebbers, 2010)

What is Soil Health?

The continued capacity of a soil to function as a vital, living ecosystem that sustains plants, animals, and humans (NRCS, 2015).





Important Soil Functions

- Support productive plants and livestock
- Be stable and resist erosion
- Efficient at cycling nutrients internally
- Allow H_2O to enter quickly & store
- Drain well to avoid drowning plant roots
- Resist pests, pathogens, and disease
- Help plants grow during 'stressful' events

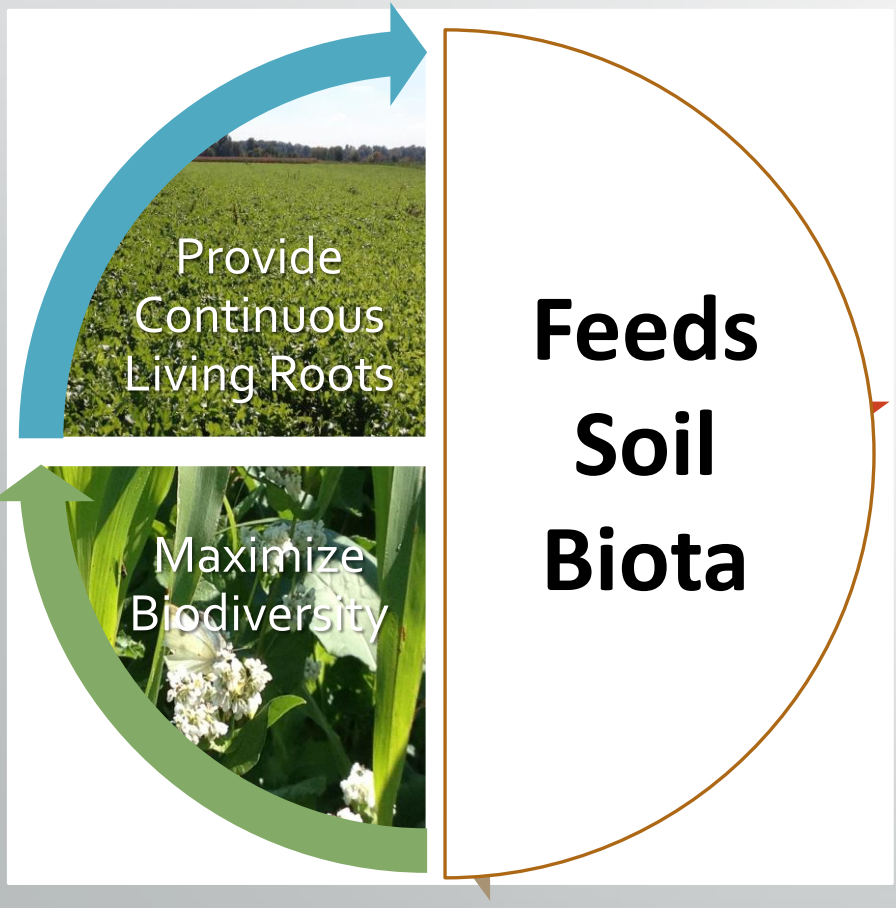
Soil Health Principles & Soil Function

Soil Health Principles & Soil Function

Minimize Disturbance & Maximize Soil Cover

- Maintain stable aggregates
- Reduce erosion and runoff risk
- Buffer temperature
- Reduce evaporation
- Maintain soil organic matter
  - Water-holding capacity, infiltration, storage
  - Nutrient-holding capacity
  - Habitat

Soil Health Principles & Soil Function



Maximize Biodiversity &
Maximize Living Roots

- Break disease/pest cycles
- Stimulate/change belowground diversity
- Increase soil organic matter
- Increase nutrient cycling
- Enhance plant growth
- Increase predator & pollinator populations

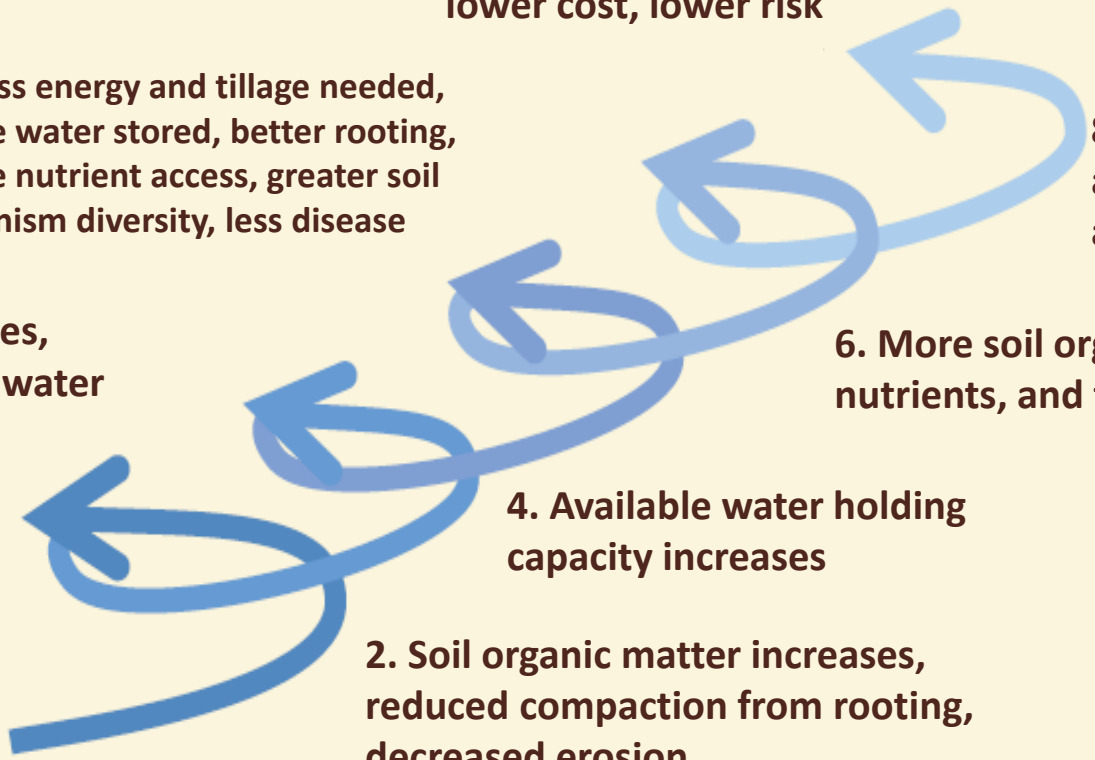
Agricultural Management Practices and Soil Health

Choose practices that feed the soil organisms and protect their habitat (soil aggregate)

Tend to Reduce Soil Health	Tend to Promote Soil Health
Aggressive tillage	No-till or conservation tillage
Annual/seasonal fallow	Cover crops; Relay crops
Mono-cropping	Diverse crop rotations
Annual crops	Perennial crops
Excessive inorganic fertilizer use	Organic fertilizer use (manures)
Excessive crop residue removal	Crop residue retention
Broad spectrum fumigants/pesticides	Integrated pest management
Broad spectrum herbicides	Weed control by mulching, cultivation

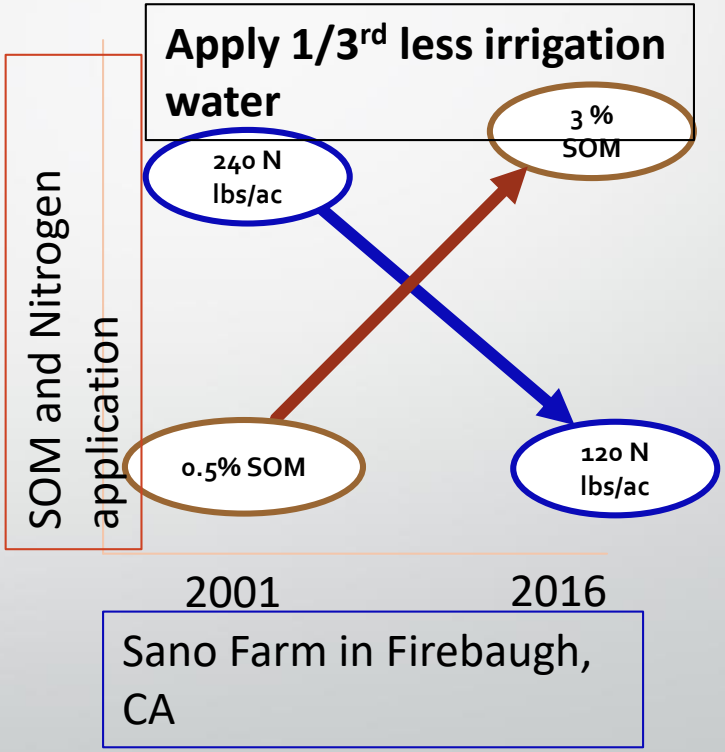
Lehman, R. M., et al. (2015). J. Soil Water Conserv. 70(1): 12a-18a.

Upward Spiral
Soil Health Management Systems for Healthy Soils



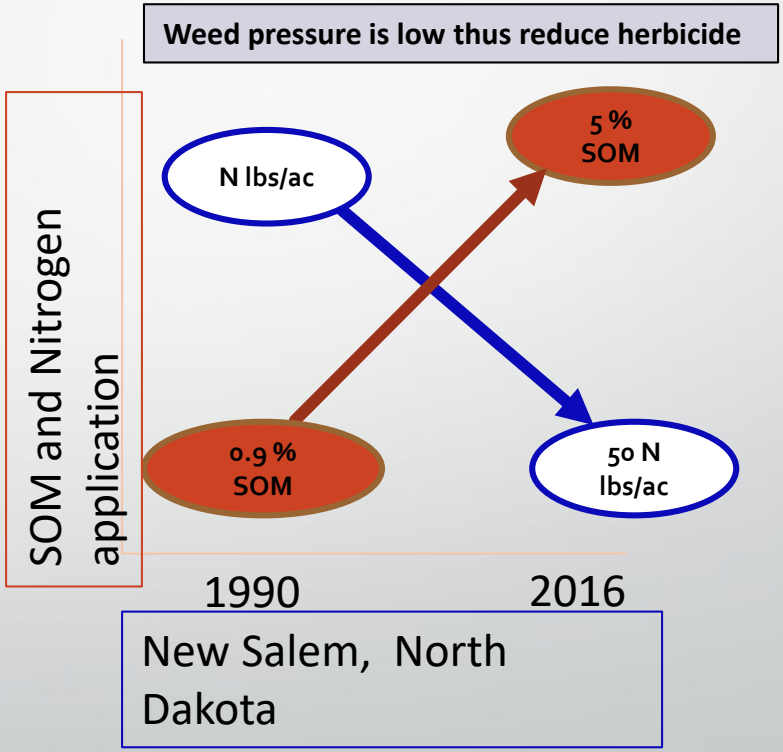
Regenerative Agriculture

Jesse Sanchez – San Joaquin Valley farmer



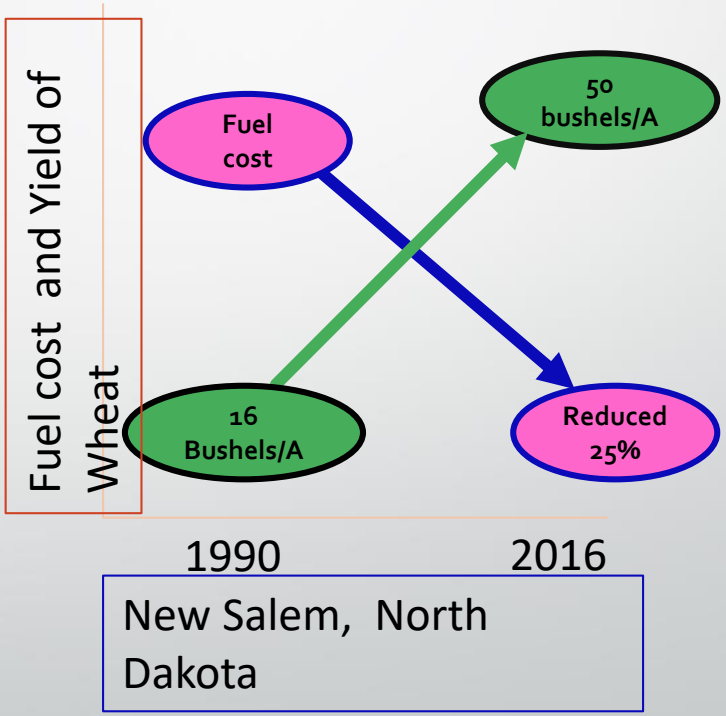
Sano Farm in Firebaugh, CA

Soil Health Practices rebuilds SOM, increases Soil Fertility and reduce Weed Pressure



Rocky Bateman – 5th generation farmer

Soil Health Practices reduce Fuel Cost and increase Crop Yield




Thank You!