



Soil Health: Balancing Benefits and Challenges

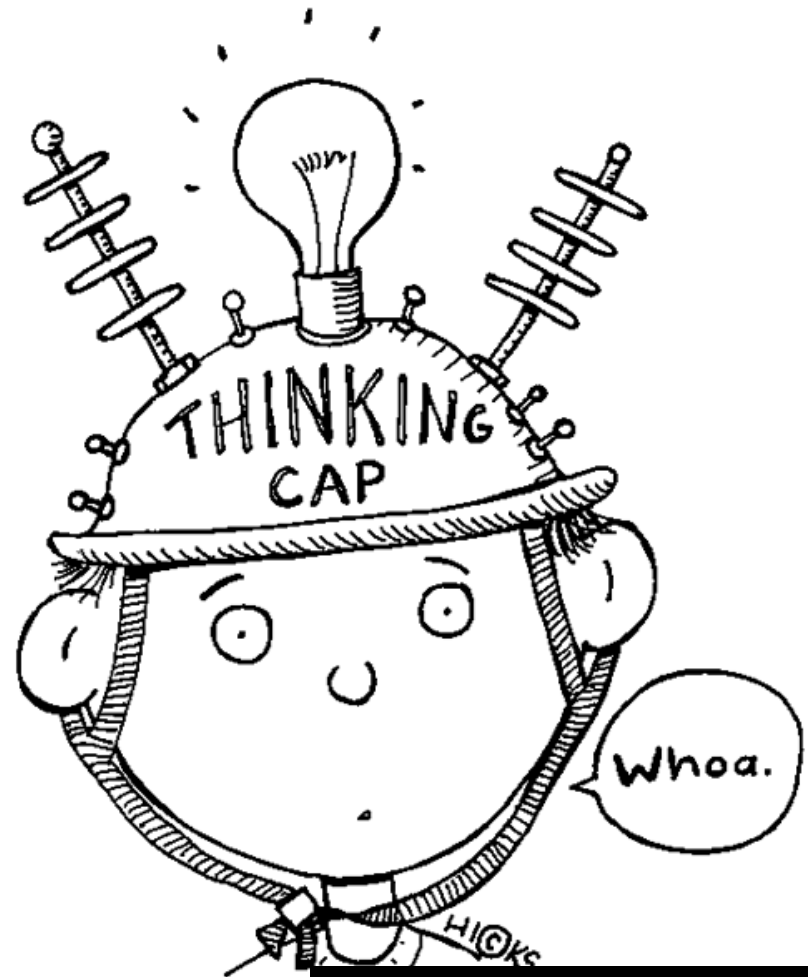
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POLL

How many producers have you worked with that have used these as arguments to not improve soil health?:

- It costs too much
- Yields will decrease
- Don't want any extra weeds in my field
- Uses too much water
- Mixes are too complicated

How do we
change the
way producers
think about
their soil?



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Source: hammer.org

Goals

At the end of this lesson you will be able to:

- Determine and evaluate benefits and challenges of improving soil health
 - Economic impacts
 - Reduced risk
 - Increased production efficiencies
 - More resilient soils
- Discuss these issues with your producers to encourage adoption of soil health practices

Soil Function & Soil Health Benefits

- Reduced Erosion
- Increased Soil Organic Matter
- Increased Nutrient Cycling
- Increased Drought Resilience
- Improved Filtering and Buffering
- Reduced Pest and Disease incidence



Benefits Of Healthy Soil

- Benefits of Healthy Soils
 - Higher Soil Organic Matter
 - Increased nutrient cycling
 - More available water
- Economic Results
 - Increased land values
 - Reduced risk
 - Higher profits





How
much is
soil
worth?



Economic impacts of NOT building Soil Health

Water & wind erosion at 7.6 t/ac/yr costs:

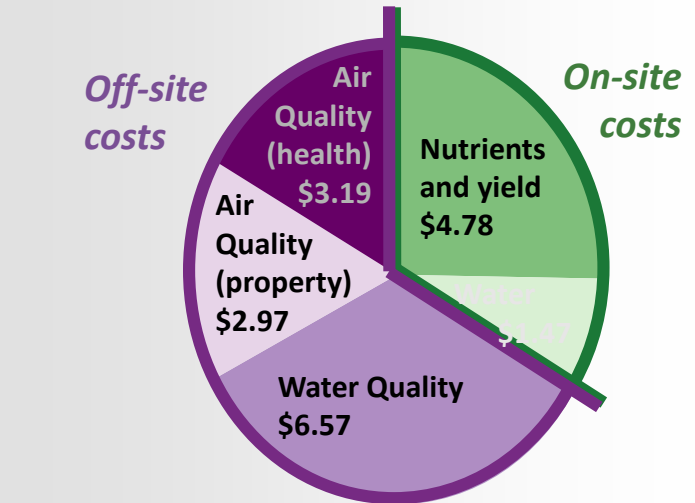
- \$40/acre/year to replace lost fertilizer nutrients
- ~ \$17/acre/year to pump well irrigation water to replace lost soil and soil water holding capacity
- Total cost of soil and water lost annually from U.S. cropland amounts to on-site productivity loss of **> \$27 billion/year**
- **World-wide costs are more than \$400 billion/year**

Erosion costs on one field

Degrades organic matter levels and other fines first



Affects soil, air & water quality *AND THE BOTTOM LINE \$\$\$*



\$19 per ton soil

Soil Quality Inst., 2003

Value of Ton of Topsoil

- Most Biological activity occurs in top 3 inches.
- One million pounds or 500 ton of topsoil in top 3 inches.
- Average Value of Cropland = \$10,000/Acre
- Soil Productivity Value: $\$5,000/500 = \$10/\text{Ton}$
- Soil Lost at T value = 4-5 ton/acre
- Lost value per acre = $\$10/\text{ton soil loss} * 4-5 \text{ tons}$
- Losing \$40 to \$50 per acre

Value of Soil Organic Matter

Assumptions: 2,000,000 pounds soil in top 6 inches

1% organic matter = 20,000#

Nutrients:

Nitrogen: $1000\# * \$0.50/\#N = \500

Phosphorous: $100\# * \$0.70/\#P = \70

Potassium: $100\# * \$0.50/\#K = \50

Sulfur: $100\# * \$0.50/\#S = \50

Carbon: $10,000\# \text{ or } 5 \text{ ton} * \$?/\text{Ton} = \$0$

Value of 1% SOM Nutrients/Acre = \$670

Original Jim Kinsella/Terry Taylor(2006)/revised Jim Hoorman (2011)



What does it take to convince a farmer?

- Reduce inputs
- Increase Production
- Combination of both

Three Questions:

- ? Soil Organic Matter: what's it worth?
- ? Improve nutrient cycling: is it believable?
- ? Increase water efficiency: can it be done?





Question

When discussing the benefits of improving soil, should it all be in monetary terms?

- a. Yes
- b. No



Soil Health Increases N Efficiency

Nitrogen Efficiency:

- Conventional: 30-50%
- Cover Crop & No-till: Goal is to Increase to 80%+

Phosphorus Efficiency:

- Conventional: 10-50%
- Cover Crop & No-till: Goal is to Increase to 80%+

Healthy Soils are FERITILE Soils

healthy soil is bio-powered...

✿ Natural biological processes in the soil are responsible for about **60%** of the available nitrogen and **50%** of the available phosphorus in soil.

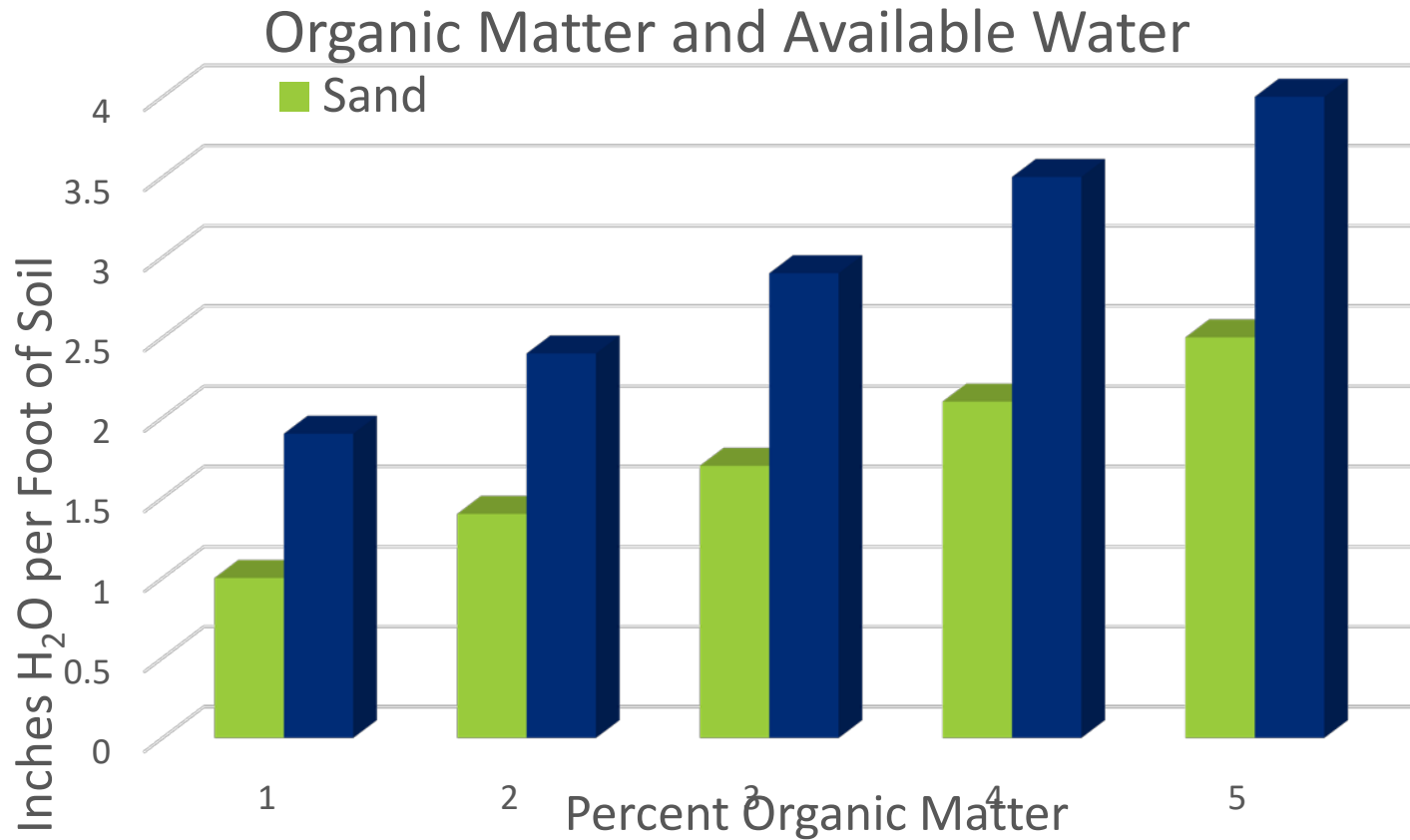
did you know ?

Many nutrients taken up by plant roots are first cycled through a soil organism before becoming available to the plant.

We're learning that the soil/plant interchange of nutrients and water is far more dynamic and elegant than we had ever imagined.

unlock the
SECRETS
IN THE
SOIL

SOM & Available H₂O Capacity/Foot Soil



Hudson,
1994

Soil Health Impact on Reducing Weeds

- Farmers promote weed seed production by tilling the soil and burying the seed.
- Ways to fight weed
 - Hoe or pull them out
 - Kill with herbicides
 - **Compete for sunlight and nutrients by growing cover crops to reduce weed seed production.**
- Mycorrhizae fungi reduce weed pressure in healthy soils by keeping plants healthy and growing faster.

Rinaudo, 2010; Vatover et al. 2005; Atierie et al, 2005; Jordan and Heuerd, 2001

the green mile...

separate strands
of mycorrhizal fungi
can total more than

1 mile

in just a handful
of healthy soil.

did you know ?

Arbuscular mycorrhizal fungi (abundant in healthy soils) have a symbiotic relationship with many plants.

They attach themselves either on or inside plant roots to tap into the carbohydrates transported from the plant leaves. In turn, the fungal hyphae (filaments) grow out from the roots and bring water and soil nutrients back to the plant.

unlock the
SECRETS
IN THE
SOIL

Spring 2008 Weed Suppression

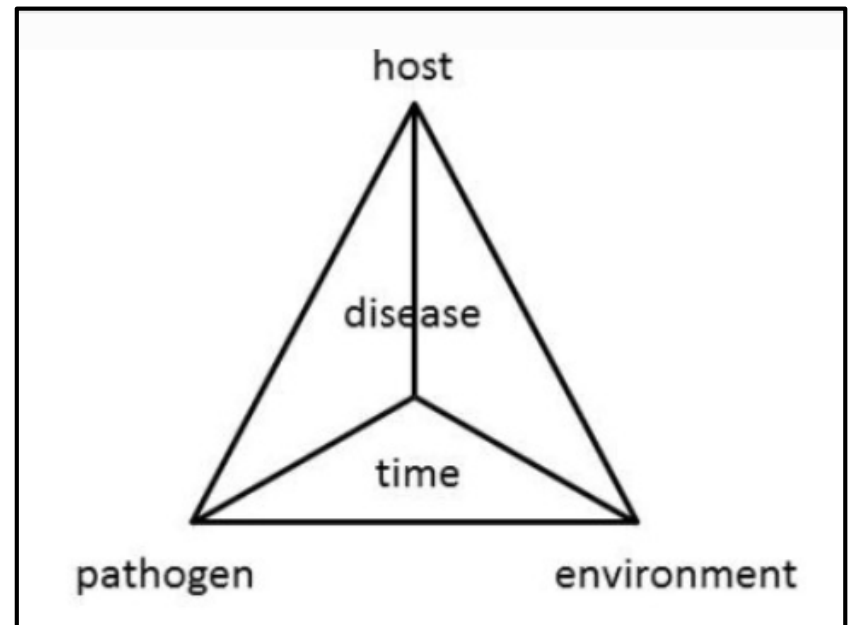


Long term no-tillers who use cover crops report cutting herbicide costs **by 33%**

Effects of cover crops on Disease

- Improved water infiltration
- Reduced compaction
- Improved soil structure

Lead to better drainage: which improves the soil environment for less disease incidence and higher number of predators of disease carrying insects.



Soil Health Mechanisms for increased resistance/tolerance to soil born diseases

- Increased nutrient uptake → More vigorous plants
- Competitive exclusion of pathogens
- Changes in root exudation
- Enhanced P uptake may inhibit spore germination/infection
- Microbial shifts that enhance soil health
- Lignification of root cells that limit pathogen penetration.

E. Barrios, 2007. Soil biota, ecosystem services, and land productivity. *Ecological Economics* 64. Science Direct.com

Disease Soil Ecology Research

Conclusions:

“Soil borne diseases are most damaging when soil conditions are poor as a result of inadequate drainage, poor soil structure, low SOM, low soil fertility, and high soil compaction.”

G.S. Abawi, T.L. Widmer, 2000. Impact of soil health management practices on soil borne pathogens, nematodes, and root diseases of vegetable crops. *Applied Soil Ecology*.

Reduce Compaction

- Deep ripping may cost \$30+/ac
- Deep rooted and/or fibrous rooted cover crops break up compaction
 - Annual Ryegrass \$17/ac.
 - Rapeseed \$8/ac.
 - Sunn Hemp \$26.80
- Advantage of deep roots vs tillage??? Increase SOM



Cover Crop Water Quality Benefits

- Reduces nutrient and pesticide runoff by 50% or more.
- Decreases Soil Erosion by 90%
- Reduces Sediment Loading by 75%
- Reduces Pathogen Loading by 60%
- May decrease flooding potential by increasing water infiltration



Cover Crop Benefits: Climate



- Soil temperature is *cooler* under cover!
 - Increase pest resistance
 - Increase crop resiliency to extreme climate shifts
 - Drought
 - Heavy rainfall events
 - Hotter temperatures
 - Increase soil moisture
 - Protect soil organisms

when temperatures rise...

to **100°** cover crops and their residues can help keep soil more than **20°** cooler than on cropland without cover crops.



did you know?

On days when the temperature reaches 100 degrees, cover crops and their residue can help keep soil more than 20 degrees cooler than on cropland without cover crops.

The blanket of mulch provided by the cover crop residue not only lowers soil temperatures, which protects soil microorganisms, but it also reduces the amount of water lost through evaporation, and protects the soil from erosion.

The combination of lower temperatures and more moisture in the soil profile helps reduce plant stress and increases yields—making farms more resilient during periods of drought.

unlock the
SECRETS
IN THE
SOIL

Summary

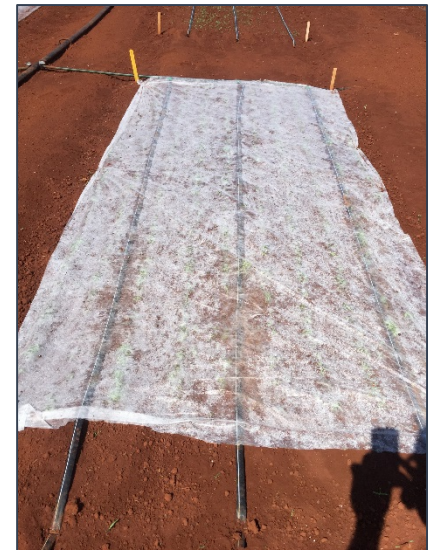
- Soil health practices are essential
 - Reduced/No-till
 - Cover crops or live plants/roots
 - Conservation cover
- Farmers can reduce their input costs by planting cover crops.
- How we manage the soil impacts soil temperature, water storage, & crop yields.
- Soil health also impacts weeds, insects, diseases, weather and climate.



What's next for PIA?

Soil Health in PIA: Challenges

- BUT... “PIA is different”
 - Year round growing season
 - Unique tropical and volcanic soils
 - Limitations on seed sources
 - Limited to approved varieties
 - Pest pressure
 - Cost of equipment
 - Others?

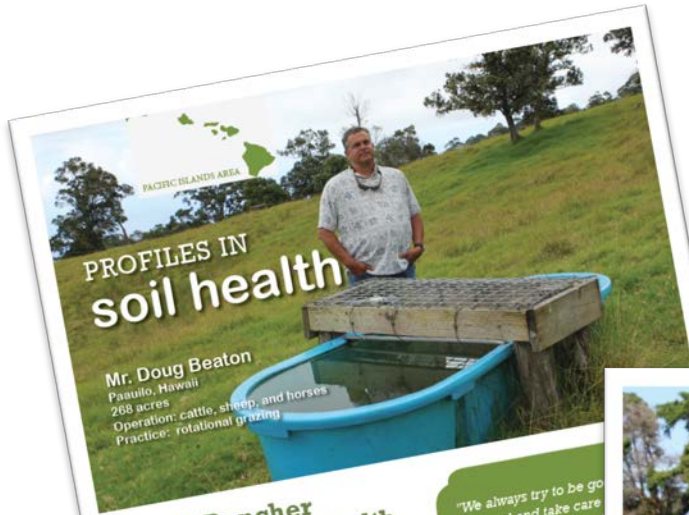


Soil Health in PIA: Accomplishments

- **Soil Health training for NRCS and partners**
- **PMC cover crop trials**
- **Revive PIA Soil Health Team**
- **Collaborate with partners to conduct soil health workshops and field days**
- **Work directly with farmers and ranchers to promote soil health practices**



unlock the SECRETS IN THE SOIL



PROFILES IN soil health

Mr. Doug Beaton
Paaulo, Hawaii
268 acres
Operation: cattle, sheep, and horses
Practice: rotational grazing

Local Rancher Steward of Soil Health

Doug Beaton and his family are ranching on 268 acres in Paaulo, Hawaii with 22 cattle, 60 sheep, and 8 horses. For the Beaton's, soil is the beginning to healthy grass. "As ranchers, we have to realize that we are grass farmers first," said Doug Beaton. He says that their grazing management considers the soil and grass first. Once they followed that, their animals were healthy because there was a lot of feed available. As a result, their grass-finished animals finished faster and the animals are younger when processed.

Making the Change

So what is soil health? This rancher says it's not difficult to achieve. It's pretty simple. The soil used to be healthy once before when we weren't impacting the environment. It's not a hard thing to grasp. "We tried to learn a little about soil health before we got involved."



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"We always try to be good to our land and take care of it. Thinking about our soil that just helped everything grow better."
- Doug Beaton

so there was no reluctance to go to it," said Doug Beaton. It's just a matter of the management practices.

The Practices

At Puuwal Ranch, the core practice was rotational grazing to rest and get re-established.



PROFILES IN soil health

Corinne Weller
Waimea, Hawaii
Operation: nursery
Practices: seasonal high tunnel

Local Farmer Blossoms with Soil Health

Corinne Weller is a nursery grower on Hawaiian Homelands in the Puukapu area of the Big Island of Hawaii. She has three acres in a variety of flowers. Corinne says that with the right leadership, guidance, and understanding, we can care for the soil so that it will continue to feed us. There is so much to be grateful for when you look at what is on your table, from the food you eat to the beautiful flowers that adorn it. It all depends on healthy soil.

Making the Change

Compared to traditional farming practices from before, Corinne Weller noticed an 80 percent increase.



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"To me, soil health means, if I put back what I take out, it's the only way to continue."
- Corinne Weller, farmer

Corinne's grandparents were taro growers in Waipi'o Valley. Her father also farmed the land for 50 years. He taught her that if she took care of the land, it will be productive in return. Her goal is to pass the nursery operation on to her children and grandchildren.



PROFILES IN soil health

Mr. Chris Robb
Waimea, Hawaii
Crop: Jacks, lettuce, and broccoli
Practice: cover crop and drip irrigation

Organic Farmer

Practices for Soil Health

Chris Robb is a farmer from the Big Island of Hawaii who started his farm in 1993.

He started his farm because it kept the soil healthy with his system of cover crops. Robb is experimenting with different mixes. A lot of research has shown that at lower elevations, but at higher elevations, temperatures are cooler, and the soil can be grown are quite well. Robb likes to grow bell beans, Austrian peas, and vetch very well. The vetch has a longer term with a longer

"Soil health and land stewardship are one in the same. You leave the land better than how you found it."
- Chris Robb, Waimea Farmer

The Practices

Chris Robb says that he could not have afforded to update his irrigation system alone. Re-doing the entire main line was a big undertaking, and budget. "Without the assistance from NRCS, there's no way I could have pulled it off."

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Soil Health in PIA: Partnerships

- UH-Manoa, CTAHR, HARC, Oahu RC&D, PREL
- Soil Health training for NRCS and partners
- PMC cover crop trials
- Revive PIA Soil Health Team
- Collaborate with partners to conduct soil health workshops and field days
- Work directly with farmers and ranchers to promote soil health practices



Soil Health in PIA: Future Directions

- Collaboration is KEY!
- Conduct soil workshops & outreach events
- Promote soil health practices
- Share success stories – and challenges
- TEAMWORK!



Questions?

