

unlock the
SECRETS
IN THE SOIL



Soil Health

Managing our soil resources sustainably



United States Department of Agriculture
Natural Resources Conservation Service
Pacific Islands Area

USDA is an equal opportunity employer and provider.

Soil is a living resource

Soil supports life by:

- Growing plants & crops
- Feeding livestock
- Storing & filtering water

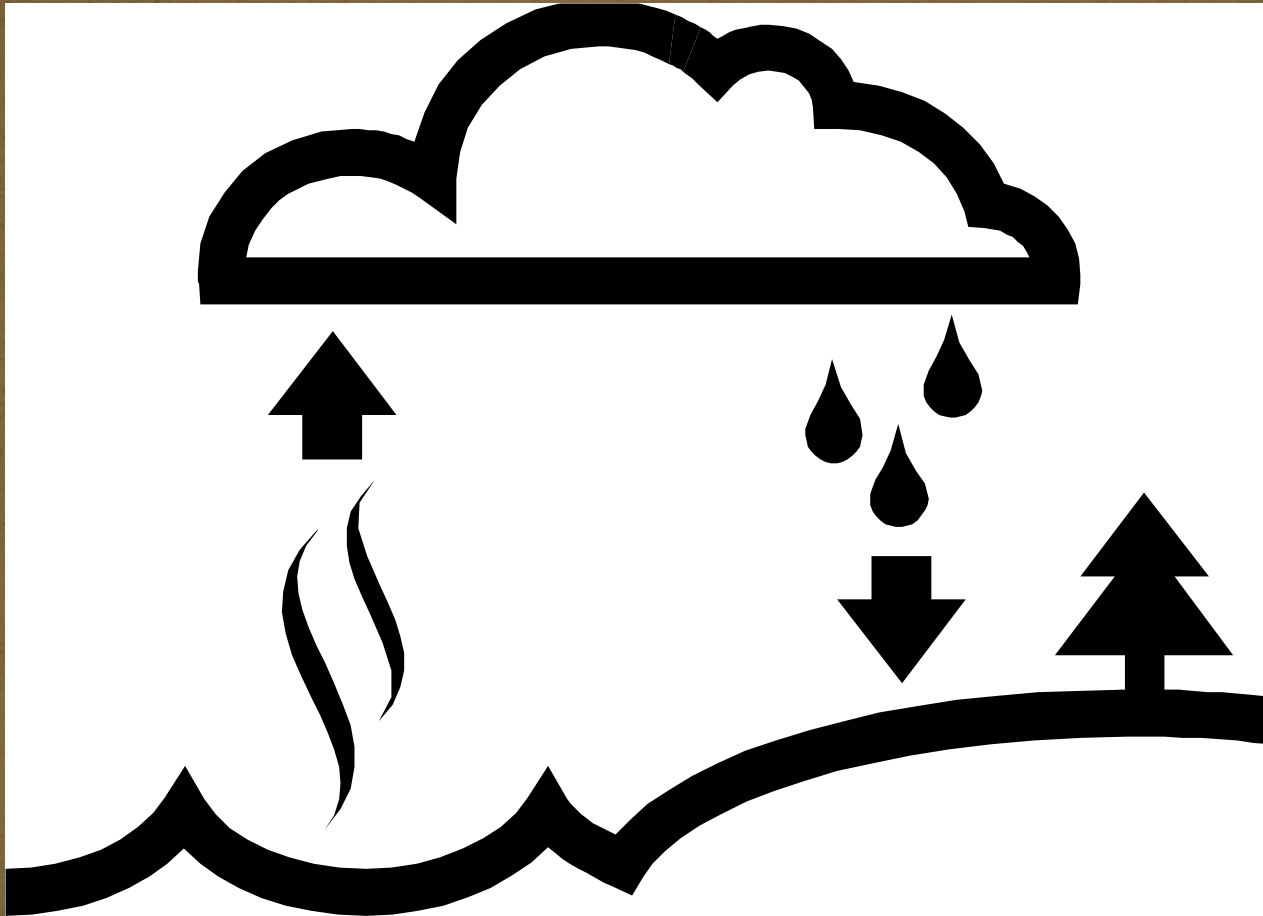


Soil is an Irreplaceable Resource



Once it is gone, it is gone for good, or at least a VERY LONG time

By protecting our soil... we protect our future





Hugh Hammond Bennett

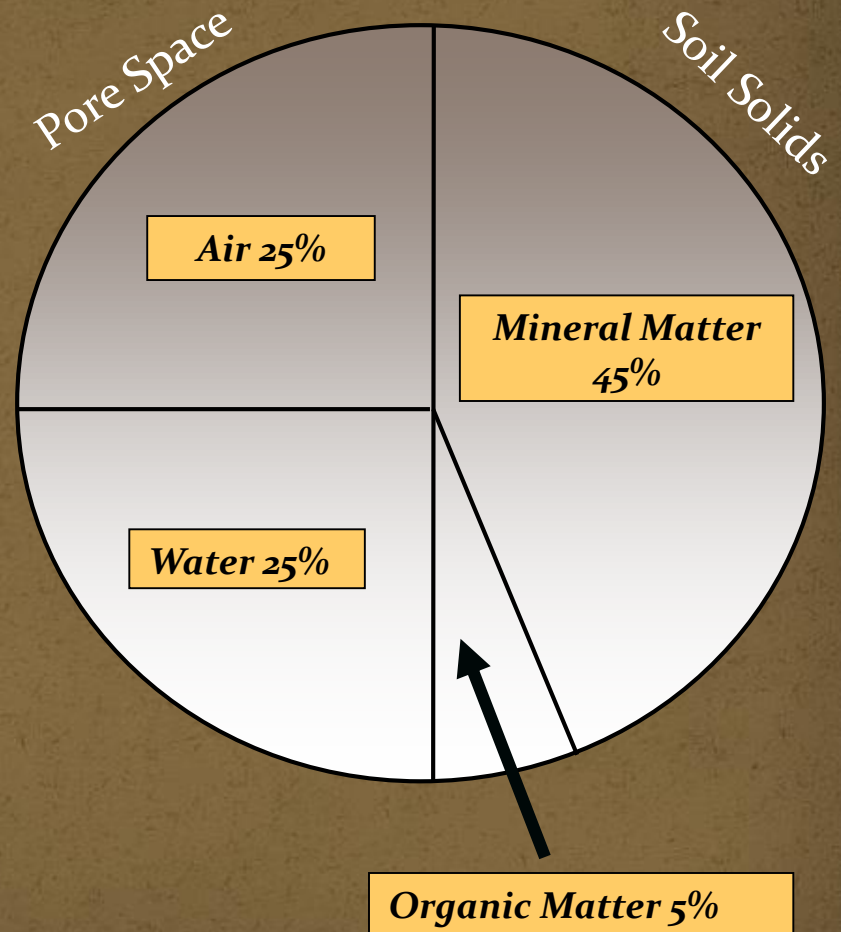
Father of Soil Conservation

“Conservation farming put first things first by attending to the needs of the soil—by seeing to it that the starting off place, the base, is put into sound health and kept that way. Any other approach, no matter what it may be, always has and always must lead eventually to agricultural disaster.”

“Take care of the land and the land will take care of you”

What is soil?

- Soils are made up of:
 - Minerals
 - Organic Matter
 - Air
 - Water
- Healthy soils have proper amounts of all elements
- Soil can change with use and management



Why is healthy soil important?

- Benefits productivity and profitability
- Increases infiltration, prevents soil erosion
- Provides habitat for beneficial soil life
- *Ensures soil will be productive for many years*

HEALTHY SOIL = PRODUCTIVE SOIL

Who can benefit from soil health?

- Farmers and Ranchers
- Land owners and managers
- Island communities
- Future generations



How to evaluate soil health

- Know your soil
 - Dig In!
 - Take Soil Samples
 - CTAHR ADSC

Agricultural Diagnostic Service Center (ADSC)

The ADSC is a service unit within the College of Tropical Agriculture and Human Resources (CTAHR). **ADSC conducts analyses and diagnostic tests for the people and businesses of Hawai'i.**

- Solvita Respiration (CO_2) Test
- Soil Penetrometer- test soil compaction



If you don't test your soil - how will you know what's missing

Soil Organic Matter



- Most important indicator of soil health

FIELD OBSERVATION:

- Soil color
 - Darker colors indicate higher amounts of organic matter
- Decomposing plant matter
 - Look for old roots, leaves, etc. at various stages of decomposition

Soil Organic Matter - Benefits

- Improves soil structure
- Increases water holding capacity
- Increases soil ability to hold on to nutrients
- Feeds important soil organisms
- Reduce Soil Erosion



healthy soil has amazing water-retention capacity.



Every

1%

increase in organic
matter results in
as much as

25,000

gal of available
soil water per acre.

Source: Kansas State Extension Agronomy e-Updates, Number 357, July 6, 2012



United States
Department of
Agriculture

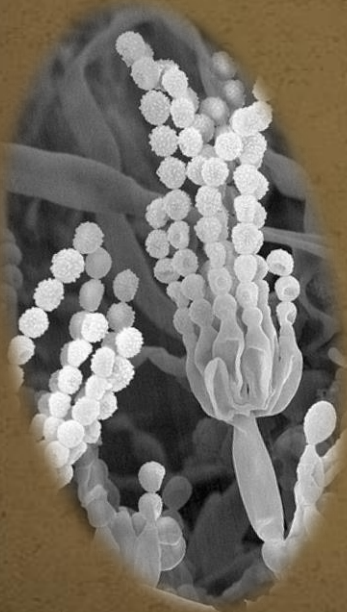
Want more soil secrets?
Check out www.nrcs.usda.gov

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Soil Organisms - MICROorganisms



- Decompose organic materials
- Cycle nutrients for plant uptake
- Activity & diversity dependent on food availability (organic matter)



Soil organisms - earthworms

- ✖ Worms create organic matter by breaking down plant waste
- ✖ They also churn and aerate the soil



USDA NRCS



SOURCE: landscapeforlife.org

FIELD OBSERVATION:

- ✖ Look for worms and their castings as well as other beneficial insects

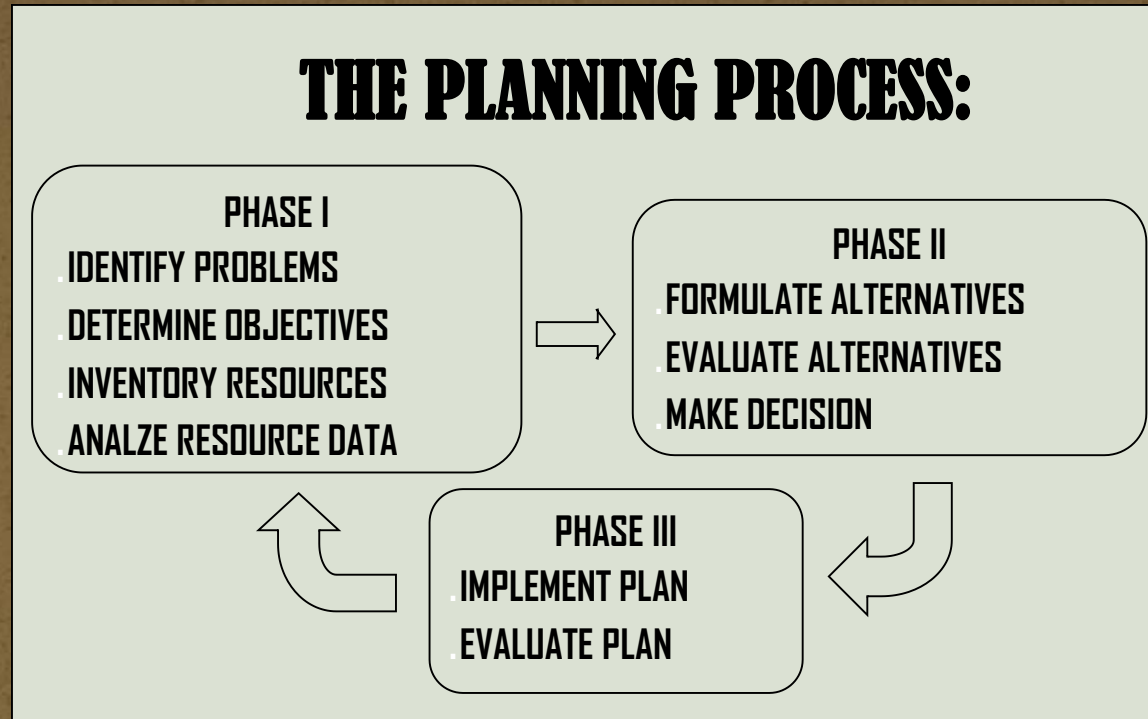
Natural Resources Conservation Service

Who we are and what we do:

- We are an agency within the federal US Department of Agriculture (USDA)
- Our job is to help people conserve, maintain and improve our natural resources and the environment.

We help people help the land...

Develop a Conservation Plan for Your Farm



- We work with land managers through the conservation planning process.
- The goal is to develop a conservation plan to help solve resource problems and to benefit the soil, water, air, plants, animals, humans and energy.

Farm Bill Programs

EQIP

(Environmental Quality Incentive Program)

- ♦ Provide financial assistance to producers to voluntarily address resource concerns.
- ♦ Payments are calculated based on payment rates calculated from average costs (~50-90%).

AMA

(Agricultural Management Assistance)

- ♦ Provide financial assistance to producers to voluntarily address resource concerns. Those focused on with this program include water quality, soil erosion and irrigation water management.
- ♦ Payments are calculated based on payment rates calculated from average costs (~50-90%).

CSP

(Conservation Stewardship Program)

- ♦ Encourages land stewards to improve their conservation performance by installing and adopting additional activities while maintaining existing activities.
- ♦ Must meet stewardship threshold and all eligible land must be enrolled.

CREP

(Conservation Reserve Enhancement Program)

- ♦ Landowners set aside highly-erodible cropland and pastureland from production and convert the land to native trees, shrubs, grasses.
- ♦ Lands must be adjacent to a stream or volcano tub.

Financial AID: Organic EQIP

EQIP

(Environmental Quality Incentive Program)

Payments received by producers through EQIP contracts after February 7, 2014 may not exceed \$450,000 for all EQIP contracts entered into during the period 2014 to 2018.

The EQIP Organic Initiative contracts are limited to \$20,000 per fiscal year and \$80,000 during any 6-year period for persons or legal entities. There is no authority to waive the annual payment limitation or total payment limitation.

Four Principles of Soil Health

1. Minimize Soil Disturbance (reduce tillage)
2. Keep the Soil Covered (cover crop/mulch)
3. Keep Living Roots in the Soil (keep plants growing)
4. Maximize Diversity (crop rotation/cover crops)



1



2



3



4

Lets Look at Soil Erosion



Excessive Plowing-Soil Prone to Wind Erosion

Lets Look at Soil Erosion



Bad Timing with Excessive Rainfall Events

Lets Look at Soil Erosion



Rich Soil Lost into Streams or the Ocean

Lets Look at Soil Erosion



“Rich Soil Donation Program” for your Neighbors –
Keep your most important Resource on your farm!

Conservation Practices that Reduce Soil Erosion & Promote Soil Health

Vegetative/Agronomic Practices

- ☐ Residue and Tillage Management
- ☐ Cover Crop
- ☐ Conservation Crop Rotation
- ☐ Windbreak
- ☐ Vegetative Barrier
- ☐ Filter Strip
- ☐ Pollinator Habitat/Wildlife Habitat (Tree/Shrub Establishment)
- ☐ Mulching

Engineering Practices

- ☐ Terrace
- ☐ Diversion
- ☐ Grassed Waterway
- ☐ Contour Farming
- ☐ Irrigation/Water Catchment-Storage

www.pia.nrcs.usda.gov

EXAMPLES of Vegetative Practices that Reduce Soil Erosion



No Till and Reduced Till

EXAMPLES of Vegetative Practices that Reduce Soil Erosion



Cover Crop (sunn hemp and buckwheat, sorgum/sudan grass)

EXAMPLES of Vegetative Practices that Reduce Soil Erosion



Cover Crop Cocktail Mix (Grass, Broadleaf, Legume)

BENEFITS OF COVER CROPS

1. Reduce Soil Erosion from Wind and Water
2. Adds Organic Matter to Soil which Will Improve Physical Condition and Structure
3. Cover Crops Compete for Light, Water, and Nutrients and may Suppress Weeds
4. Legume Cover Crops Add “Free” Symbiotically-Fixed Nitrogen to the Farming System
5. Crops Growing Late in the Season can Capture and Recycle Soluble Nutrients otherwise Lost such as Nitrogen, Potassium and some Micro-Nutrients
6. Cropping System Diversity may Create Habitat for Beneficial Insects and Pollinators
7. Cover Crops add an Opportunity for Crop Rotation to Break Insect or Disease Cycles
8. May serve as Insectory Plants that provide food/shelter to beneficial insects
9. May serve as a Bio-Fumigant (sunn hemp) against root-knot nematodes that damage crops such as sweet potato

GRASS + BROADLEAF + LEGUME = Diversity

Cover Crop Chart for Hawaii

← Grass →		High Elevation				Low Elevation		← Grass →	
		Broadleaf							
		Legume				Sesame 4 lb/acre			
A Barley 70 lb/acre						(CA Blackeye 5', Purple Knuckle', TS Brown', MS Silver) Cowpea R 120 lb/acre	A Buckwheat 90 lb/acre	A Pearl Millet 15 lb/acre	
A Cereal Rye 100 lb/acre	A Canola 15 lb/acre	B Yellow Sweet Clover 20 lb/acre	A Woolly pod Vetch 75 lb/acre	P Jack bean 50-60 lb/acre			A Mustard 15 lb/acre	A Oat 90 lb/acre	
A Oat 90 lb/acre	A Mustard 15 lb/acre	P White Clover 15 lb/acre	A Hairy vetch 40 lb/acre	P Velvet Bean 40 lb/acre	R*	A Soybean 50-75 lb/acre	A Rape Seed 15 lb/acre	A Black Oat 75 lb/acre	
A Winter Wheat 120 lb/acre	A Rape Seed 15 lb/acre	S SP Red Clover 20 lb/acre	A Bell Bean 200 lb/acre	P Pigeon Pea 75 lb/acre		A/P Lablab 100 lb/acre	A Oil Radish 10 lb/acre	A Grain Sorghum 50-75 lb/acre	
A Annual Ryegrass 100 lb/acre	A Oil Radish 10 lb/acre	S P Alfalfa 20 lb/acre	(Moapa 60') R Austrian Winter pea 100 lb/acre	B P Perennial Peanut 40 lb/acre	R	A Sunn Hemp 75 lb/acre	R* A Marigold 3 lb/acre	R A Sorghum-Sudangrass 50-75 lb/acre	R

A = annual; B = Biennial; P = Perennial; SP = Short-term perennial.

R = resistant to root-knot but not reniform nematode; (note: only certain cultivars are resistant to root-knot nematodes for alfalfa and cowpea; cowpea is very susceptible to reniform nematode).

S = suppressive to plant-parasitic nematodes if soil incorporated.

R* = sunn hemp and velvetbean are resistant to root-knot and reniform nematodes; marigold, *Tagetes patula* is resistant to root-knot and reniform, *T. erecta* is only resistant to root-knot; sesame is resistant to southern and peanut root-knot nematode (*Meloidogyne incognita* and *M. arenaria*) but not Javanica root-knot (*M. javanica*).



Sunn hemp



Oil radish



Woolly pod vetch



Sudangrass + lablab



Buckwheat



Cowpea + marigold

Cover Crops benefit soil by adding Carbon, Bio-fumigant, Nitrogen

Cover Crop Chart (Dr. Wang, CTAHR)

EXAMPLES of Vegetative Practices that Reduce Soil Erosion



Crop Rotation

Pollinator Habitat



EXAMPLES of Agronomic Practices that Reduce Soil Erosion & Promote Soil Health



Mulching

Moisture management

Reduces erosion

Increases Organic Matter

Weed Suppression



Create your own mulch and nitrogen fertilizer with Legumes such as Gliricidia Also known as Mother of Cacao



EXAMPLES of Vegetative Practices that Reduce Soil Erosion and Promote Soil Health



Filter Strip (captures sediment)



Vegetative Barrier (captures sediment)



Windbreak (protects soil, conserves moisture, protects crop)

EXAMPLES of Engineering Practices that Reduce Soil Erosion & Promote Soil Health



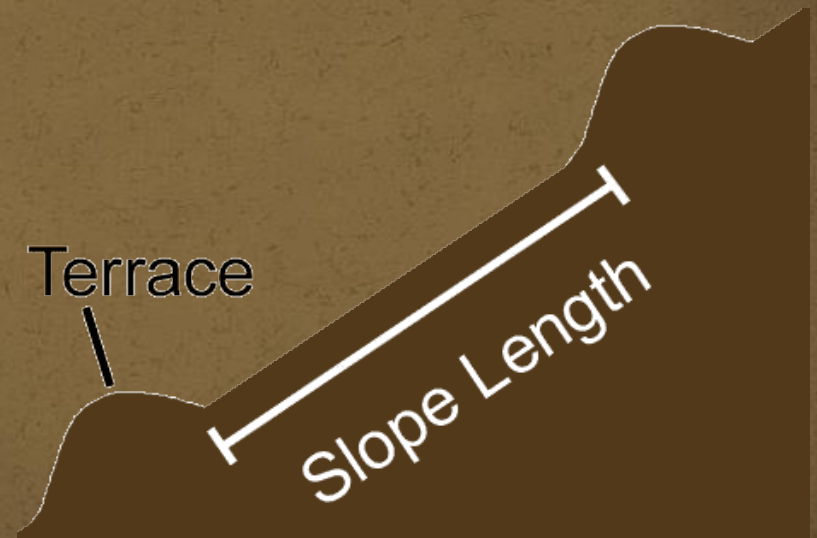
Contour Farming (sweet potato)



Diversion



Terrace

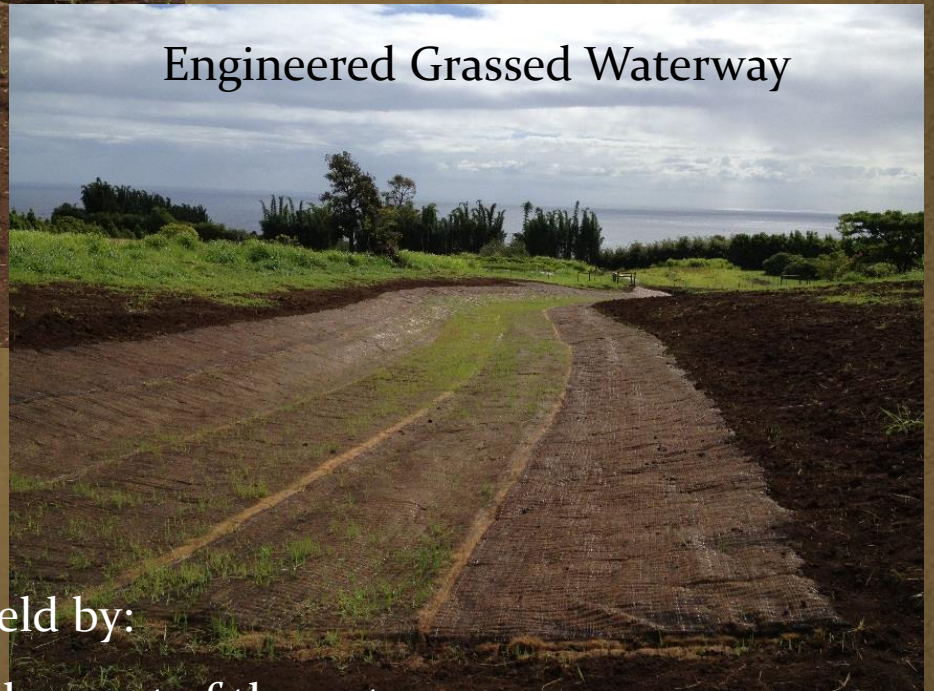


EXAMPLES of Engineering Practices that Reduce Soil Erosion

This field needs a grassed waterway
To keep your rich topsoil on your farm



Engineered Grassed Waterway



Grassed Waterway will keep soil on your field by:

1. slowing down water & allowing soil to drop out of the water
2. Stabilizes soil in the existing water channel

OTHER CONSERVATION PRACTICES



High Tunnel System



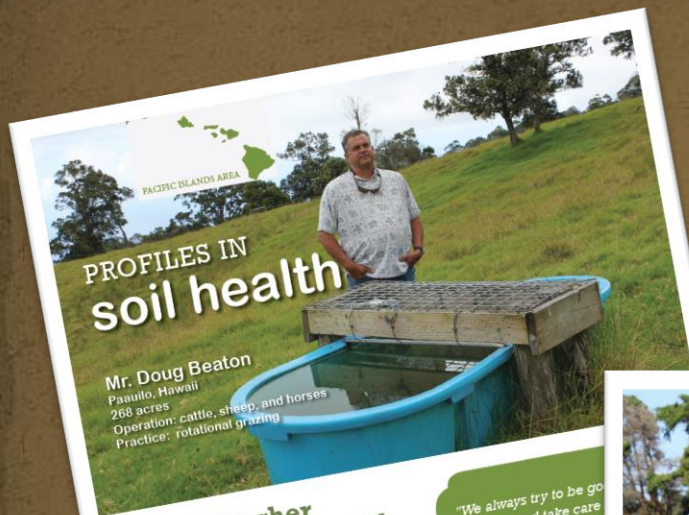
Deep/Dry Litter System



Nutrient Management & Integrated Pest Mgt



Deep Tillage/Break Up Soil Compaction



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 of 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 that 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 said Doug Beaton. It's just a matter of the management practices.

The Practices

At Puuwaia 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: leeks, 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 a little longer. Robb likes to grow bell peppers, Austrian peas, and other crops very well. The farm with a longer

residual effect.

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 when he started out he had a shoe string budget. "Without the assistance from NRCS, there's no way I could have pulled it off."

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"Soil health and land stewardship are one in the same. You leave the land better than how you found it."

- Chris Robb, Waimea Farmer

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Need more information?



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- **Learn more about soil:**

- Web Soil Survey

- SoilWeb Smartphone App

- Soil Health

- www.nrcs.usda.gov

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