Citizen Science Soil Health Project

Elizabeth Black Project Manager 303-449-7532
Elizabeth@ElizabethBlackArt.com

Helping you PROVE you are IMPROVING your SOIL HEALTH!

CSSHP: 2022 IN REVIEW

2022 has been a busy and successful year for the Citizen Science Soil Health Project, despite COVID challenges.

- We secured grant funding from a second Western SARE Farmer-Rancher grant, for funding years 4-6 of our project, plus a generous partnership grant from St. Vrain and Lefthand Water Conservancy District, and a small grant from the Boulder County Sustainability Food and Agriculture Fund.
- We added 4 growers to our 48 growers and lost 1. We now have 51 growers participating in the project and will not accept any more growers unless others drop out.
- Our third annual meeting on 2/22/22 was both in person and on Zoom. Outside speakers and CSSHP growers discussed various ways to maximize water yield, including:
  - **Christine Newton NRCS**: increasing water infiltration by increasing soil health.
  - **Sharcy Ray NRCS and Paul Schlagel**: NRCS funding for water system upgrades and soil health initiatives.
  - **Joel Schneekloth CSU Extension and Michael Moss:** Soil Moisture Monitoring Technology
  - **Sean Cronin SVLHWCD**: Funding available from SVLHWCD for water system upgrades
  - **Jim Snow, Catherine Long Gates and Cody Oreck, Silver Lake Ditch:** Lining Irrigation Ditches
- We sent 140 samples to Regen Ag Labs for Haney and PLFA testing, compiled our growers' test results, and sent user-friendly results to all our growers. Over the 4 years of the project, our growers have collected 526 unique soil samples. On 202 of those samples, we ran Haney plus PLFA tests. On 324 samples we ran just Haney tests. We collected 93 test results in 2019, 148 test results in 2020, 145 test results in 2021 and 140 test results in 2022. We have gathered testing data on a total of 229 unique sites. We have 4 years'-worth of data on 57 sites, 3 years'-worth of data on 40 sites, 2 years'-worth of data on 35 sites and 1 year of data on 97 sites.
- We built and published our new website, www.SoilHealthProject.org, which includes our goals, processes, supporters, grower profiles, findings, articles, forms, and links to our videos on our You-Tube channel.
- Our You-Tube channel now has 127 subscribers and 9094 total views. Videos include:
  - Dale Strickler discusses cover crops for the semi-arid Front Range: https://youtu.be/lX8xxuKyNRw
  - 4 CSSHP growers relate their experiences with cover crops: https://youtu.be/Zushgp1HQak
  - Lance Gunderson explains the Haney soil test: https://youtu.be/buWErVOQSTw
  - Lance Gunderson explains the PLFA soil test: https://youtu.be/ueD_4yvnWq0
  - Silver Lake Ditch board members explain lining irrigation ditches: https://youtu.be/wMgcMM2TPXg
  - Jules Van Thuyne discusses water conservation for Colorado corn: https://youtu.be/vnPs8SgM5m4
- We developed and implemented our qualitative annual soil assessment tool to supplement Haney soil tests. We have incorporated this tool into the information gathered when we collect soil samples from our growers.
- We analyzed our data to find overall group trends and struggled to understand the variability we are seeing in our individual growers' data. Our 2022 findings are at the end of this report.

GOALS FOR 2023 & BEYOND

- Produce 5 more videos in 2023 and 2024 of CSSHP growers demonstrating various soil health techniques.
- Decipher the causes of the variability we are seeing in individual growers' soil test results.
- Develop individualized management suggestions for our growers, based on their test results.
- Provide opportunities for local agricultural consultants to become more familiar with soil health lab tests.
- Inform CSSHP growers about cost sharing programs for soil health improvements.
- Trial small group exercises at our annual meetings, to analyze fictional growers' test results.

Rocky Mountain Farmers Union · Boulder County Sustainability · City of Boulder Open Space & Mountain Parks · Boulder County Farmers Markets · St. Vrain & Left Hand Water Conservancy District · Longmont & Boulder Valley Conservation Districts · Boulder County Parks & Open Space · Boulder County Parks & Open Space Foundation · Western SARE Sustainable Agriculture Research & Education · BOSC Boulder Open Space Conservancy · Colorado Carbon Fund · District 6 Water Users Assn.

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2022 STATS

PROJECT MANAGER: Elizabeth Black.

PROJECT ADVISORS:

Lauren Kolb (Soil Health Coordinator, Boulder Open Space and Mountain Parks)
Vanessa McCracken (District Manager, Boulder Valley and Longmont Conservation Districts)
Sylvia Hickenlooper (Area Resource Conservationist for Planning, Natural Resources Conservation Service)
Brian Anacker (Research Advisor, Science Officer for Boulder Open Space and Mountain Parks)

51 GROWERS HAVE COMMITTED TO PARTICIPATE IN THE PROJECT.

13 BCPOS lessees
14 COB OSMP lessees
25 conventional farmers
26 organic growers
23 ranchers
2 golf courses,
2 sugar beet farmers

21 fruit or vegetable growers
9 small animal producers
3 tree farms
4 growers in Weld County
5 growers in Larimer County
42 growers in Boulder County

PARTICIPATING GROWERS AS OF 2/1/23

Dave Asbury, Full Circle Farms
Wyatt Barnes, Red Wagon Farm
Keith Bateman, Bateman Family Properties LLC
Ailsa Biers, Red Hen Farm
C. Brown, E. Black, Neighborhood Christmas Tree Farm
J. D. Burch, Burch Farms
Angie Busby, CalWood Education Center
Jason and Natalie Condon, Isabelle Farm
Bob Condon, Cottonwood Farms
Anne Cure, Cure Organic Farm
Jerry De Bruyne, Bar J Quarter Circle
Dina Elder, Routt Gulch Tree Farm
John Ellis, Farmer John's
Ryan Ericson, Wellfed Farmstead
Rob Flemming, Saddle Back Golf Course
C. Genter, D. Kingsley, Light Root Community Farm
Catherine Long Gates, Long's Gardens Iris Farm
Rick Hageman, Eric Knutson, Caribou Ranch
Bill Howland, Nine Mile Ranch
Jake Jacobs, Flatirons Golf Course, Boulder P & R
Sarah Kell, Growing Gardens
Lauren Kolb, City of Boulder OSMP
Larry Lempka, Los Rios Farm
Dan Lisco, Sombrero Ranch
Hunter Lovins, Nighthawk Ranch
Gustavo Lozada, Nature First Farm

Marcus McCauley, McCauley Family Farm
Scott Miller, Rock Creek Farms
Michael Moss, Kilt Farm
Mike and Calvin Munson, Munson Farms
Dan Murphy, Boulder Better Wagyu
Todd and Steve Olander, Olander Farms
Cody Oreck, Orchard House
Doug Parker & Ginny Jordan, Ginny's Farm
Mary and Bob Raynolds, Little Property Farm
Travis Rollins, Larimer County Open Lands
Jeff Russell & Susy Reuter, Flatirons Grassfed Beef
Joel Schaap & Paula Shuler, Schaap-Shuler Farm
John Schlagel, Niwot Farms
Amanda and Brian Scott, 63rd Street Farm
John Sekich, Sekich Land and Livestock
Kayann Short & John Martin, Stonebridge Farm
Eric and Jill Skokan, Black Cat Farm LLC
Karel and Alice Starek, The Golden Hoof
Zach Thode, Lehi Ranch
Jules Van Thuyne, Van Thuyne Farms LLC
Mary Vavrina, Lefthand Wool
Tim Villard, Food Project Farm
Gene and Jan Wade, Wade Farms
Mimi Yanus, Mimi's Garden
Dan Yechout, Bell Park Farm

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2022 INCOME AND EXPENSES

2022 CSSHP INCOME/EXPENSE: 52 GROWERS	Income	Expense
Beginning Balance	$ 15,918.00	
2019 Western SARE last 1/4 of first grant	$ 4,960.00	
SVLHWCD grant	$ 4,250.00	
2022 Western SARE first quarter of second grant	$ 8,970.00	
City of Boulder Open Space and Mountain Parks contract	$ 4,000.00	
1st quarter Boulder County Sustainability Grant	$ 1,026.85	
2nd quarter Boulder County Sustainability Grant	$ 1,565.57	
EcoCycle pass-through anonymous donation	$ 2,000.00	
Anonymous donation	$ 2,500.00	
RMFU Foundation fiscal agent fee: 10% of 2022 deposits		$ 1,022.64
Annual Meeting Expenses: Soiley Awards, Food, Speakers' Gifts, Zoom		$ 759.60
Mailing Expenses: Office Supplies, Stamps		$ 553.67
Shipping Expenses: Shipping Supplies, Soil sample shipping		$ 824.25
Soil Testing Expenses: Regen Ag Lab and soil probes		$ 7,264.58
Repayments from growers for discounted soil tests	$ 2,810.00	
Grower $50-Stipend Expenses x 40 growers accepted		$ 2,000.00
Personnel: Fundraising, grant-writing, administration, organizing, networking, grower outreach, data analysis, report writing		$ 5,000.00
Website & Video Expenses: Domain hosting, Weebly, Template, Labor, Camera		$ 2,920.07
2022 TOTALS AND BALANCE		
TOTALS	**$ 48,000.42**	**$ 20,344.81**
YEAR END BALANCE	**$ 27,655.61**	
2022 TOTAL COST PER GROWER	**$ 343.82**	

To develop a steady dependable funding stream and to avoid the accusation that our findings are influenced by a single sponsor, we are soliciting relatively small pledges of annual support for 10 years from a broad spectrum of community organizations. Donors receive regular Project updates, year-end Project reports, and acknowledgement on all printed materials and at all events.

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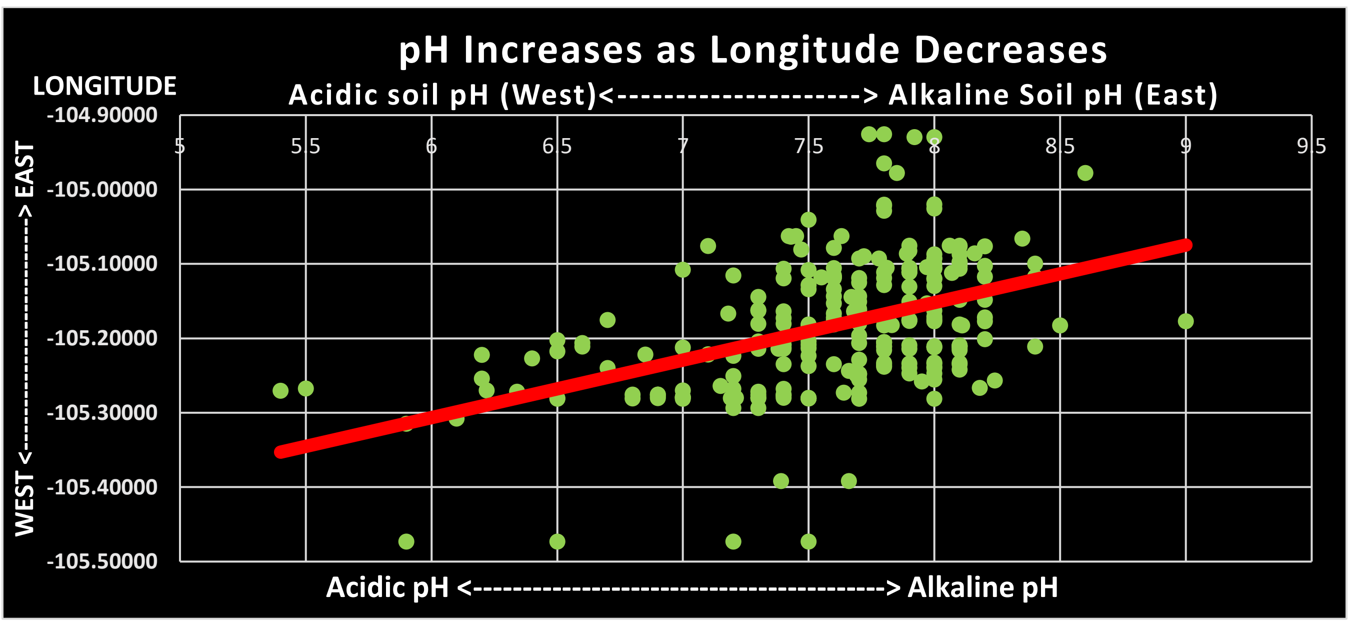
CSSHP 2022 FINDINGS

SOIL PH AND LOCATION: In previous years, we have found that as pH increases and becomes more alkaline, soil health decreases. We wondered if geographical location could have anything to do with pH, and indeed it does. We compared our sites' soil pH with longitude (east-west location). **We found that sites further east out on the plains tend to have higher pH than sites closer to the Front Range foothills and up in the mountains.** This could be due to several things.

Precipitation is higher in the mountains and foothills than further out on the plains. Higher rainfall is associated with more acidic soils. Also, a site's original parent soil material is more acidic in the mountains and foothills than on the plains. Furthermore, the pH of irrigation water can change soil pH with repeated applications. Irrigation water becomes more alkaline as it travels further east, picking up tailwater, salts and minerals. All this means that the location of a field might determine its soil pH as well as its soil health, since soil pH has a significant effect on soil health.



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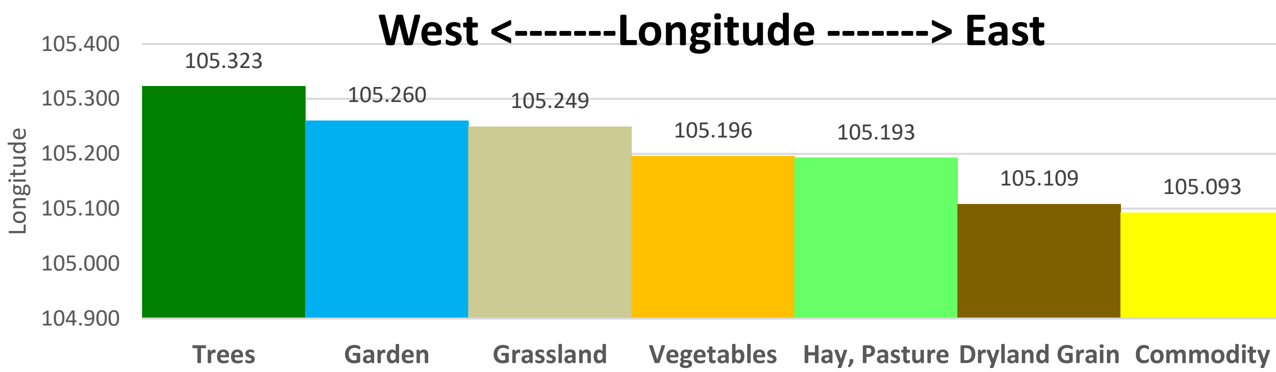
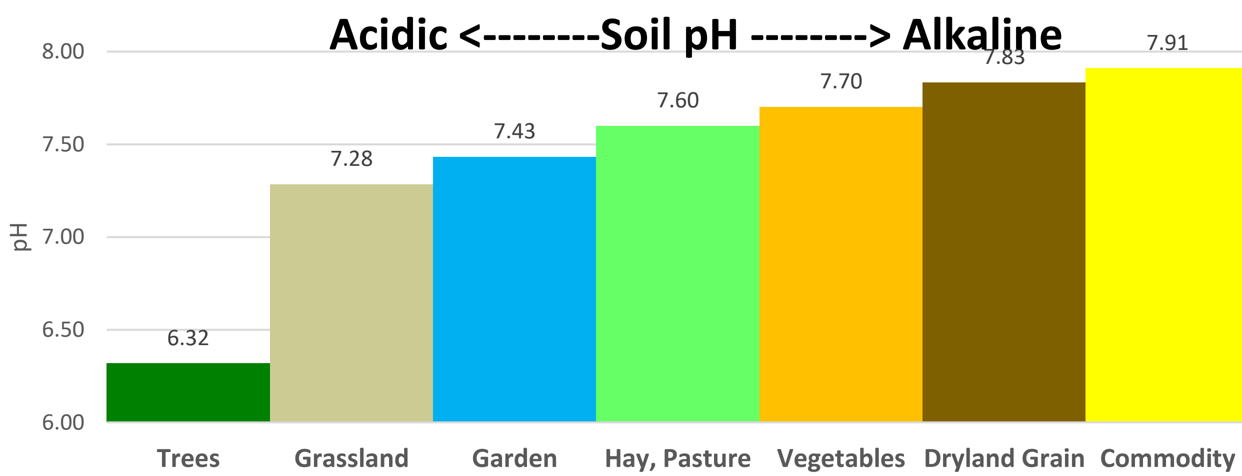
We wondered if certain kinds of sites might be located further east or west, thus influencing their soil pH. We sorted our sites into 7 groups. Most groups include both organic and conventional fields.

- **Dryland Grains** : Dryland wheat and millet, no irrigation, using a crop-fallow system.
- **Commodity Row Crops**: Irrigated crops like corn, triticale, wheat, hemp, beans, sugar beets, barley, millet, silage.
- **Commercial Vegetable/Flower/Fruit** : Irrigated vegetables, flowers and fruit, sold commercially.
- **Perennial Hay/Alfalfa/Pasture**: Irrigated perennial pasture systems of grass, hay and alfalfa.
- **Home Gardens**: Vegetables, flowers and fruit trees for home consumption.
- **Non-farm Grasslands** : Dryland grasslands with no recent tillage or farming practices.
- **Trees** : Forests and tree farms.

We then calculated each group's average longitude, which is shown on the following graph. No surprise, trees are located to the west in our forests, with dryland gains and commodity crops located to the east, where large sections of undeveloped agricultural lands remain.



We next calculated the average pH for each of the 7 groups, as shown in the next graph.



You can see how the order of the average pH of the 7 groups closely corresponds to their relative longitude. Groups further east had the highest pH, while groups further west had the lowest pH. These 2 graphs suggest that some crop groups face more of a disadvantage than others when it comes to soil health, since their location can determine their soil pH, which in turn can make improving their soil's health more difficult.

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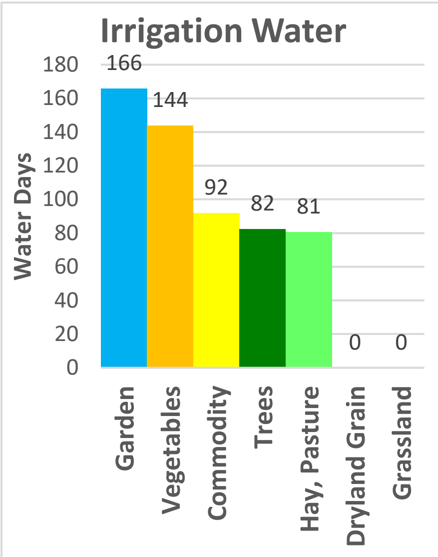
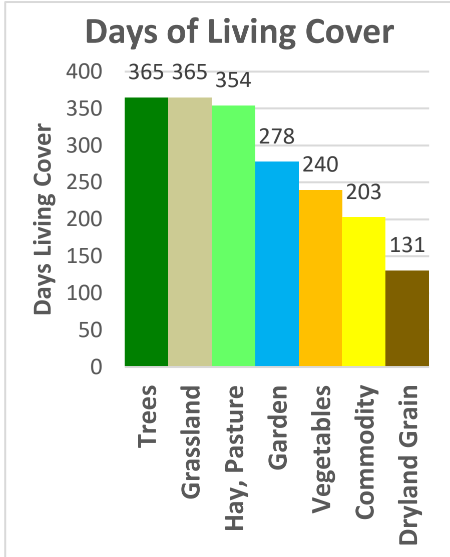
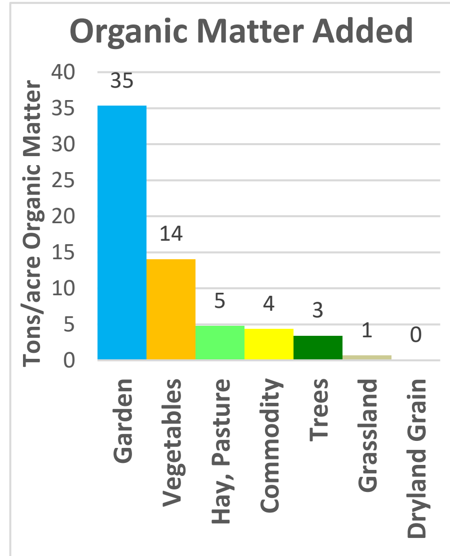
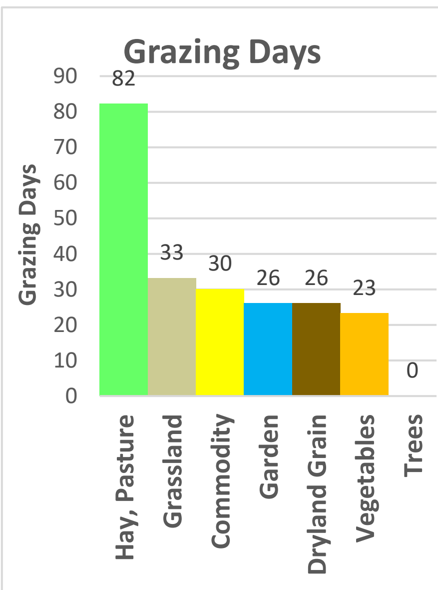
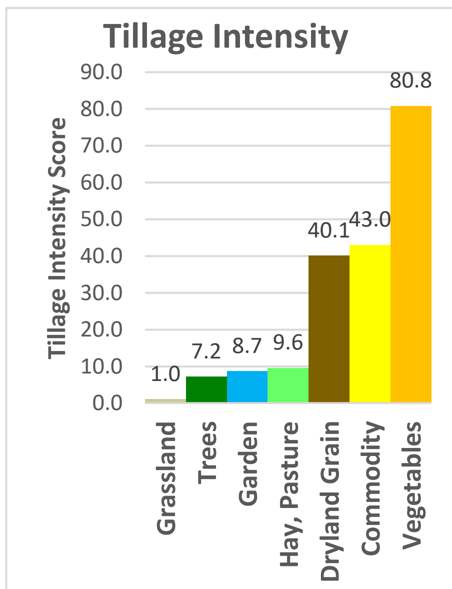
SOIL HEALTH OF DIFFERENT CROP GROUPS: In previous years, we learned that more supplemental irrigation water, more days of living cover, more organic matter inputs, more grazing days and more use of cover crops can all improve a site's soil health. We have also learned that lower tillage intensity and a lower soil pH improves a site's soil health as well. We decided to calculate the average use of each soil health practice for our 7 crop groups, and then use those averages to predict which crop groups would have the lowest and highest soil health scores. The graphs on the next page show the average soil health practices for all 7 crop groups. See if you can predict which crop groups with have the best and worst soil health scores, just by looking at their relative rankings on soil health practices. Remember that you are looking for HIGH water days, HIGH days of living cover, HIGH organic matter inputs and HIGH grazing days, but LOW tillage intensity and LOW soil pH to predict the highest soil health scores. It's just the opposite for the lowest soil health scores.

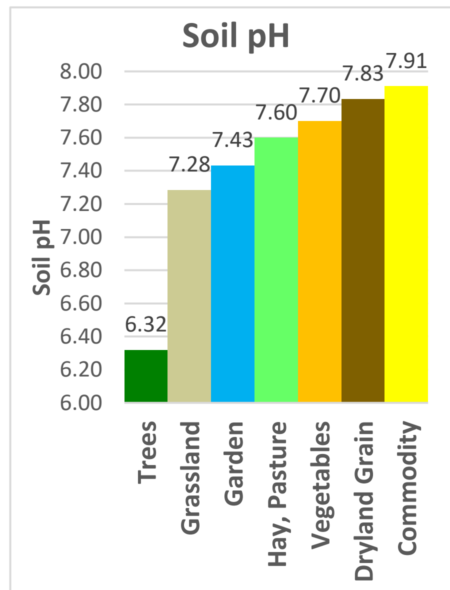










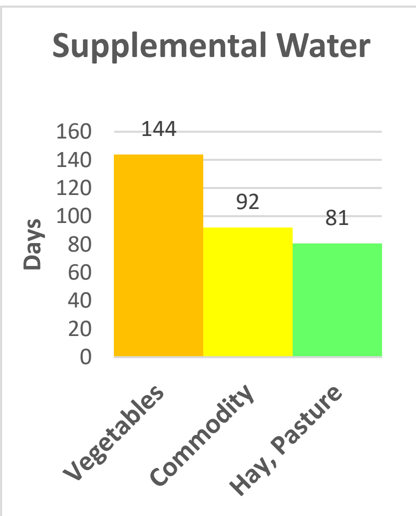


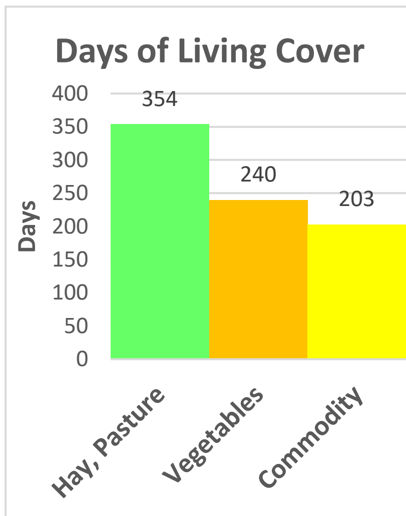
If you guessed that Dryland Grains would have the lowest average soil health scores, and that Trees, Wild Grasslands and Home Gardens would have the highest scores, you hit the jackpot. Dryland Grains have no supplemental water, no organic matter inputs, the shortest days of living cover, and high pH, which all gang up to give the group some of the lowest soil health scores. Home Gardens have the most supplemental water available, huge organic matter inputs, very low tillage intensity and low soil pH, which raises them to the top. Although Grasslands and Trees have no supplemental irrigation water generally and no organic matter inputs, they have the most days of living cover, no tillage and the lowest soil pH, so they do very well too. The following page has the average soil health scores of each of the 7 groups, for Soil Organic Matter, Soil Respiration, Organic Nitrogen, Organic Carbon, Soil Health Score, Total Microbial Biomass, and Number of Fungi.

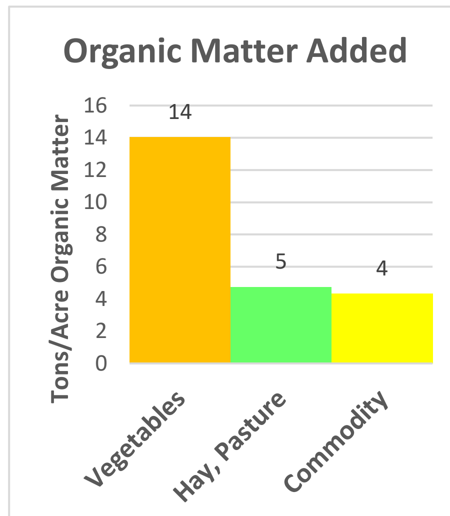
Please remember that the numbers in these tables and graphs are **<u>averages</u>**, a mathematical construct. There is no grower named “Average”, nor a field called “Average”. We are talking about an imaginary mathematically constructed “average” site in these tables and charts. Our real world is much more varied and complicated.

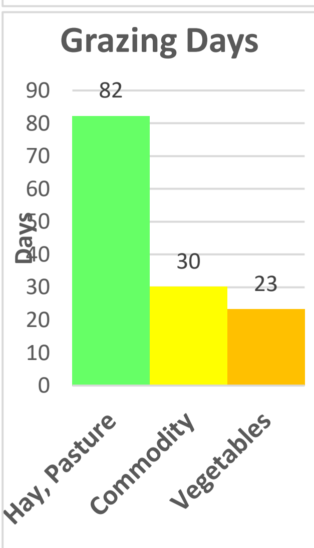
Crop Category	Soil Organic Matter	Soil Respiration	Organic Nitrogen	Organic Carbon	Soil Health Score	Total Microbial Biomass	Number of Fungi
Trees	7.16	227	18	278	23	5436	600.8
Home Garden	7.02	207	29	348	24	6005	633.5
Non-farm Grassland	3.83	138	22	326	19	4564	661.3
Perennial Hay Alfalfa Pasture	4.00	138	19	240	17	5161	589.3
Commercial Veg Flower Fruit	3.16	71	20	230	13	3434	400.4
Commodity Row Crop	2.58	35	16	175	9	2924	285.2
Dryland Grain	1.72	18	8	85	4	2669	140.1

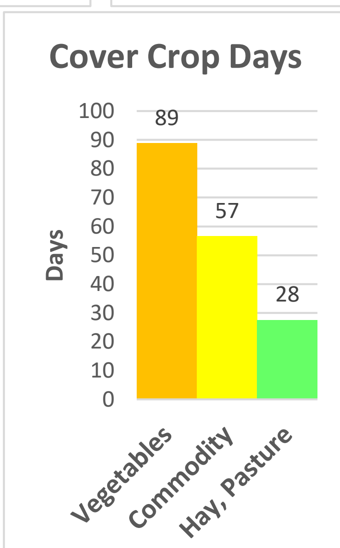
Most of the sites in the CSSHP fall into the middle 3 crop categories in the table above: **Perennial Hay/Alfalfa/Pasture**, **Commodity Row Crops** and **Commercial Vegetable/Flower/Fruit** . Let's look at soil health practices for just those 3 crop groups to see if they can explain their relative soil health scores.

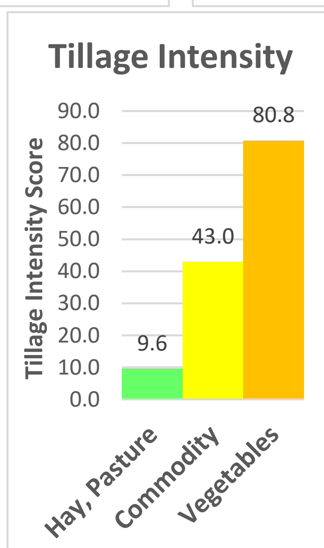


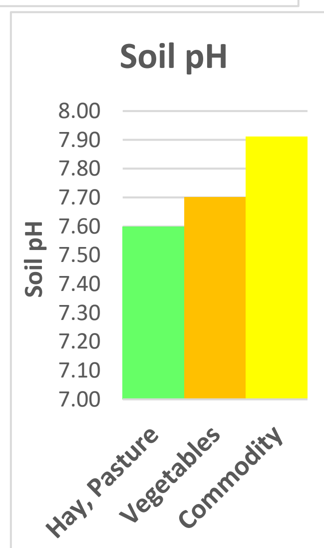












Perennial Hay/Alfalfa/Pastures : The Pasture group has the highest average soil health scores of these three crop groups. Although the Pasture group has lower supplemental water days and lower organic matter added, their very high days of living cover and very high grazing days, along with their very low tillage intensity and lower soil pH seem to more than make up for their water challenges, in terms of soil health.

Commodity Row Crops : The Commodity crop group has the lowest average scores of these three groups. Although they have done an excellent job of reducing their tillage intensity, that fact alone cannot make up for their high soil pH, lowest days of living cover and lowest organic matter added. They have only 2/3rds of the water availability as the Commercial Veg/Flower/Fruit group, which explains their lower days of cover crops that often require fall seeding and fall water. Interseeding cover crops aerially or when the main crop is still small are work-arounds but not always practical. Low commodity prices mean the cost of additional organic matter inputs like compost and manure are hard to justify.

Commercial Vegetable/Flower/Fruit : The Commercial Veg group has the highest tillage intensity by far, but also triple the organic matter inputs of the other 2 groups. These huge organic matter inputs, along with their longer water season, greater use of cover crops, and lower pH overpowers their intense tillage and boosts their average soil health scores above the commodity crops' averages. Their longer water season means they can plant more fall cover crops and string together succession plantings for a longer growing season. Their high value vegetables mean that they can afford organic matter input costs and hauling fees.

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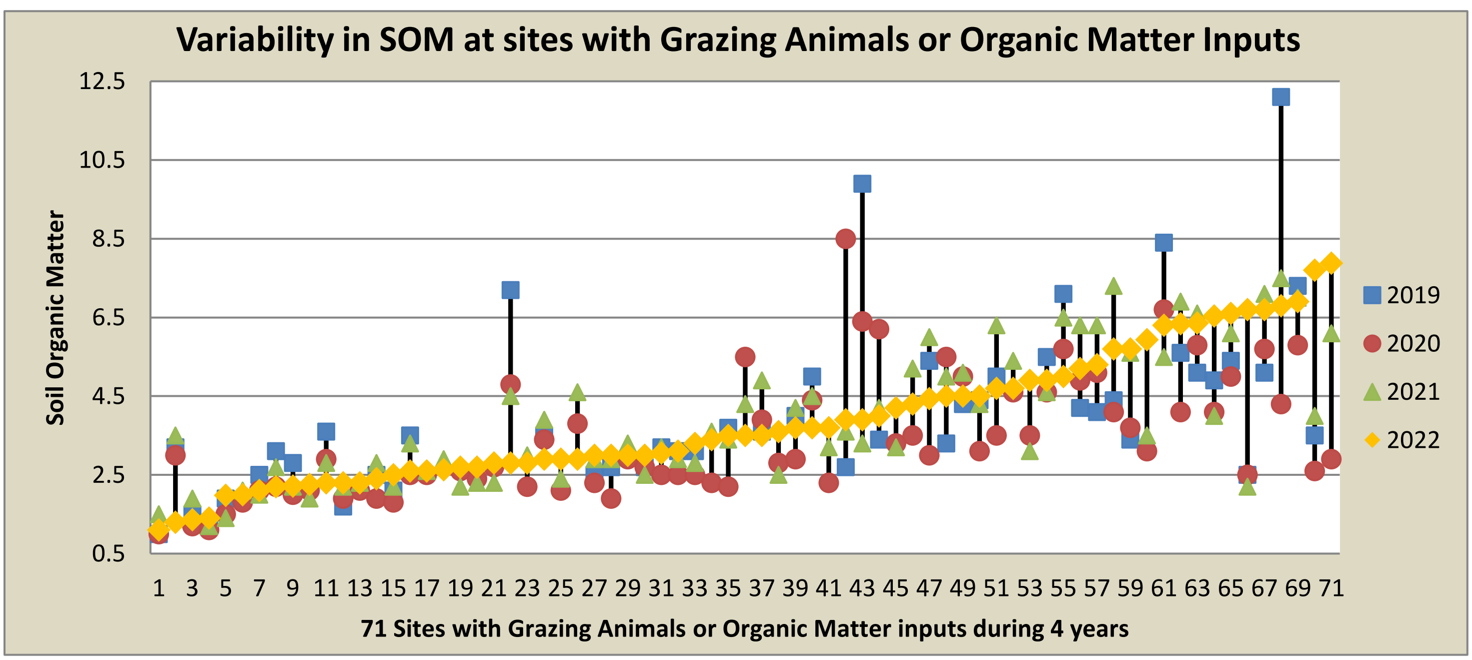
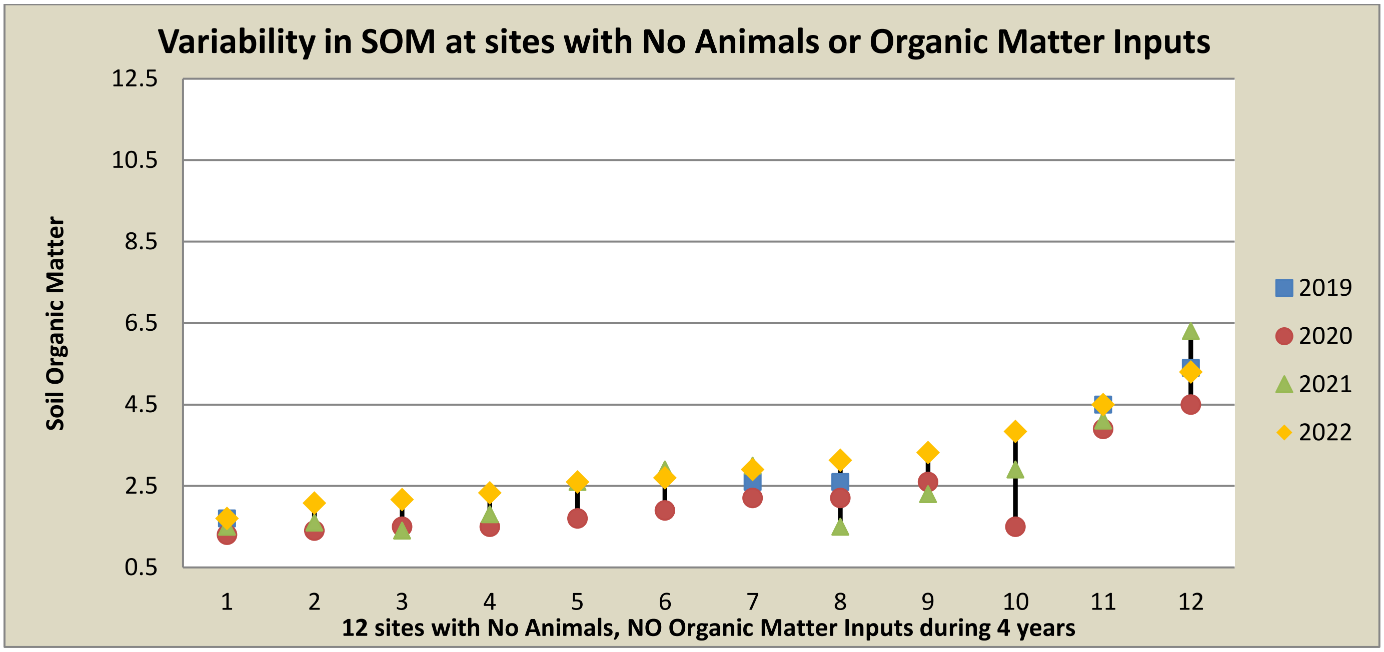
VARIABILITY: We continue to be plagued with a great deal of variability in our lab results when we compare sites with themselves year-to-year. Last year we determined that grazing animals contribute to variability in lab results. This year we asked, **"Does adding organic matter like compost, manure and mulches to a site also make lab results more variable year-to-year?" The answer: It does!** It's clear that it could. More organic matter increases soil microbial life, which can cause a boom-and-bust cycle if microbial food is scarce later on.

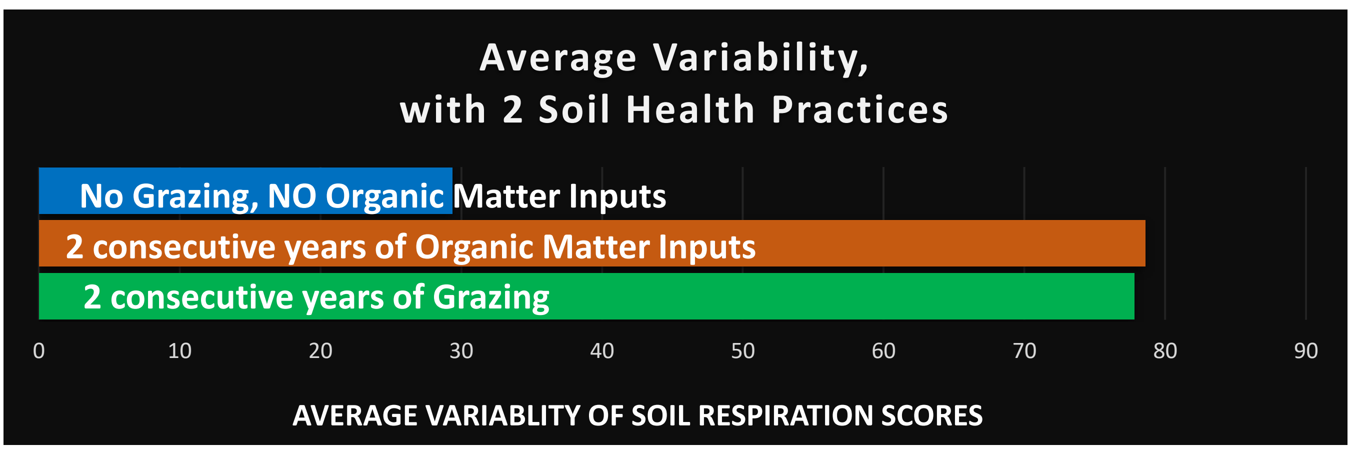
In the graph below, 71 sites with both grazing animals and organic matter inputs (OMI) are each represented by a quadruplet of data points connected by a vertical black line (a blue square for 2019, red circle for 2020, green triangle for 2021, and yellow diamond for 2022). Each square-circle-triangle-diamond combo represents the Soil Organic Matter (SOM) values for one site for 4 years. According to the literature, SOM is supposed to be quite stable and very difficult to change, and yet we are seeing large swings in individual sites' SOM data, especially when grazing animals are present or organic matter is imported to the site, as is the case in the graph below.

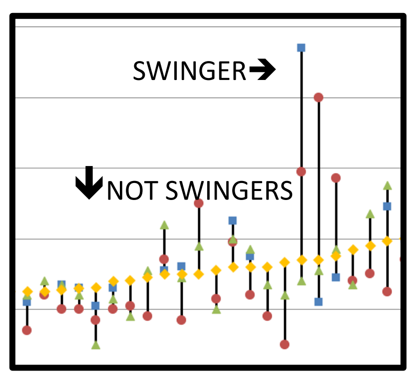


We only have 12 sites in our study which have no grazing animals or imported organic matter for 3 or more years. The graph below shows that the variability in SOM values for these 12 sites is much less than for sites in the previous graph.



We then sorted our sites into 3 groups and calculated the average variability for each group. The bar graph below shows that the groups which grazed animals or added organic matter to their sites for 2 consecutive years have approximately three times as much variability in their lab results as the group with NO grazing animals and NO organic matter inputs.

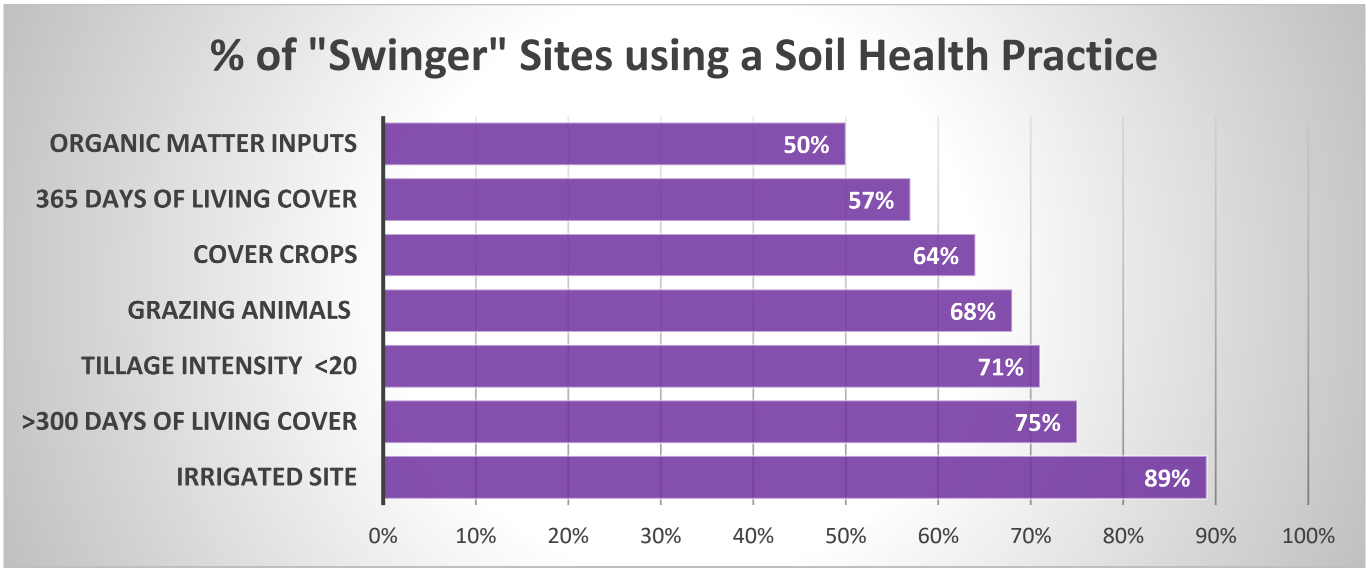




Finally, we examined the 28 sites which have the most variability in their soil health scores. We call these sites our "Swingers", and they are evenly split between organic and conventional growing methods.

Over half the "Swinger" sites are pastures with the rest split evenly between home gardens and commercial vegetable sites. Their most common crop is grass hay with mixed vegetables coming in second. Their average water season is 127 days long. "Swinger" sites have an average soil health score of 27.6, which is very high, especially for Colorado. The growers of these

"Swinger" sites are all Soiley Award winners or nominees. They have adopted many soil health practices, as you can see in the following graph.



The lesson here seems to be that no good deed goes unpunished. It seems that one result of adopting good soil health practices may be a great deal of variability in soil health lab results. If you see your Haney test results bouncing around a lot, year-to-year, it does not necessarily mean that you are doing anything wrong. It may mean that you are doing many things right! We will explore this hypothesis further in coming years as we gather more data.

Many thanks for reading all the way to the end! I hope you have found it interesting and informative.