2021 Tilled Fields Group Report for:

Farmer A
Farm B
Example 1

Thank you for participating in the Citizen Science Soil Health Project. In 2021, 48 growers participated in the project. Together, we are figuring out the best ways to grow healthy soils in Colorado. This report is a summary of your farm's 2021 soil health outcomes. Questions? Please contact:

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Participating growers - 2021

The Tilled-Fields Group

Wyatt Barnes – Red Wagon Farm
Elizabeth Black & Chris Brown - Christmas Tree Farm
JD Burch - Burch Farms
Angie Busby – CalWood Education Center
Bob Condon - Cottonwood Farm
Natalie & Jason Condon - Isabelle Farm
Anne Cure - Cure Organic Farm
John Ellis – Farmer John's
Sarah Kell - Growing Gardens
Daphne Kingsley & Cameron Genter - Light Root Farm
Larry Lempka - Los Rios Farm
Dan Lisco - Sombrero Farms
Catherine Long Gates - Long's Gardens Iris Farms
Scott Miller - Rock Creek Farm
Michael Moss - Kilt Farm
Mike Munson - Munson Farms
Todd and Steve Olander - Olander Farms
Ryan Ericson - Raisin Roots Farm
Sondra & Matthew Pierce - Matthew Pierce Farm
Mary and Bob Raynolds - Little Property Farm
Travis Rollins & Paul Hicks - Little Thompson Farm
Amanda & Brian Scott - 63rd St Farm LLC
John Schlagel - Niwot Farms
John Sekich - Sekich Land and Cattle Co
Kayann Short & John Martin - Stonebridge Farm
Eric & Jill Skokan - Black Cat Farm
Zach Thode - Zach Thode Farm
Jules Van Thuyne - Van Thuyne Farms
Tim Villard – The Food Project Farm, Growing Gardens
Mimi Yanus - Mimi's Garden

The Zero-Tillage Group

Ailsa Bier - Red Hen Farms
Keith Bateman - Bateman Farms
Elizabeth Black & Chris Brown - Christmas Tree Farm
Bob Condon - Cottonwood Farm
Jerry De Bruyne –Bar J Quarter Circle
Dina Elder - Routt Gulch Tree Farm
Rob Flemming - Saddleback Golf Course
Bill Howland - Nine Mile Ranch
Jake Jacobs - Flatirons Gold Course
Sarah Kell - Growing Gardens
Lauren Kolb – 4 OSMP ag sites
Dan Lisco - Sombrero Farms
Catherine Long Gates - Long's Gardens Iris Farms
Hunter Lovins - Nighthawk Ranch
Gustavo Lozada – Nature First Farm
Marcus McCauley - McCauley Family Farms
Todd and Steve Olander - Olander Farms
Cody Oreck - Orchard House
Doug Parker & Ginny Jordan - Ginny's Farm
Susy Reuter & Jeff Russell - Flatiron Grass Fed Beef
Joe Schaap & Paula Shuler - Schaap-Shuler Farm
Karel & Alice Starek - The Golden Hoof
Zach Thode - Zach Thode Farm
Dan Yechout - Bell Park Farm
Mary Vavrina - Lefhand Wool

HOW TO USE THIS REPORT

We have divided CSSHP growers into 2 peer groups based on tillage: the **Tilled Fields Group** and the **Zero Tillage Group**. One very clear trend in our data is that undisturbed grasslands, forests and perennial crops have higher soil health scores than row crops. Soil disturbance, that is tillage, has a large detrimental effect on soil microbial life and soil health scores. We realized that to be fair, we had to divide our growers into these two different peer groups. Most CSSHP growers are in just one peer group but 7 CSSHP growers tested several sites with different tillage managements. These 7 growers are in both peer groups, and so they have received 2 reports, one for each group.

The table below shows how 10 important measurements of your soil compare to others in your peer group. Graphs on following pages show how your soil health has changed over the last 3 years, and how you compare with peers on 3 management indicators of soil health: days of living cover, organic matter inputs and tillage intensity. Use these tests to identify strengths and constraints of your soil, and to figure out possible management changes.

	YOUR FIELDS	PEER FIELDS		
	Example 1	Maximum	Median	Minimum
Soil Organic Matter	6.5	15.8	2.8	1.2
Soil Respiration	191.9	282.1	28.71	8.03
Water Extractable Organic Nitrogen (WEON) ppm N	32.55	41.67	16	5.12
Water Extractable 0rganic Carbon (WEOC) ppm C	340.5	499.3	185.5	53.26
Carbon Nitrogen Ratio	10.46	19.3	11.25	6.5
Soil Health Score	26.06	31.07	8.63	2.97
Soil pH	7.6	8.4	7.9	6.9
Available Nitrogen, lbs/acre	132.2	376.7	51.8	16.95
Available Phosphorus, lbs/acre	552.3	1650	76.74	4.09
Available Potassium, lbs/acre	283	742	159.5	37.3
Total Microbial Biomass	6946	6946	3720	798
Fungi:Bacteria ratio	0.156	1.044	0.18	0.04

DEFINITIONS:

Green = Good **Yellow = Average** **Red = Concerning**

Maximum: The highest score in your peer group

Median: Half your peers scored above this number and half scored below.

Minimum: The lowest score in your peer group

YOUR BIOLOGICAL SOIL HEALTH INDICATORS

	YOUR FIELDS	PEER FIELDS		
	Example 1	Maximum	Median	Minimum
Soil Organic Matter	6.5	15.8	2.8	1.2
Soil Respiration	191.9	282.1	28.71	8.03
Water Extractable Organic Nitrogen (WEON) ppm N	32.55	41.67	16	5.12
Water Extractable 0rganic Carbon (WEOC) ppm C	340.5	499.3	185.5	53.26
Carbon Nitrogen Ratio	10.46	19.3	11.25	6.5
Soil Health Score	26.06	31.07	8.63	2.97

Soil Organic Matter (SOM) is the percent of your soil that contains large complex carbon-based organic molecules made from living things. SOM is the "house" that soil microbes live in. SOM helps form stable soil aggregates, improves the water-holding capacity of your soil, and provides a slow-release supply of nutrients.

Soil Respiration measures the CO_2 released in 24 hours by your soil microbes, and reflects the abundance and activity of your soil microbiome. Soil respiration is influenced by Soil Organic Matter (SOM), soil texture, overall fertility, soil type and climate. Sandier soils and dryer climates tend to score lower.

Water-Extractable-Organic Nitrogen (WEON) is the small water-soluble portion of the organic nitrogen in your soil organic matter (SOM). WEON is made up of large molecules like proteins, so it is not easily lost from your soil by leaching or volatizing. Soil microbes break WEON down into smaller nitrogen molecules and make them available to your plants.

Water Extractable Organic Carbon (WEOC) is the small water-soluble portion of your Soil Organic Matter (SOM) that your soil microbes can easily feed on. Soil Organic Matter (SOM) is the house that microbes live in, but WEOC is the food they eat. WEOC tends to respond to changes in management sooner than Soil Organic Matter (SOM).

WEOC:WEON Ratio is Haney's version of a Carbon: Nitrogen Ratio. It compares the water-soluble portions of carbon and nitrogen that are not yet tightly bound in Soil Organic Matter (SOM). Too little WEOC, and there is not enough for your soil microbes to eat. Too little WEON, and there is not enough extra nitrogen available for your plants. Scores of 8-15 are good and 10-12 are ideal.

Soil Health Score represents the overall health of your soil system. Tracking your Soil Health Score over time allows you to gauge the effects of your management. In Colorado, a score greater than 18 is hard to achieve. Colorado soils are limited by soil pH, soil texture, and annual precipitation. Front Range native soil types vary widely, so compare your soil health score to others nearby with similar native soil types to set realistic goals for what you can achieve.

YOUR CHEMICAL SOIL HEALTH INDICATORS:

	YOUR FIELDS	PEER FIELDS		
	Example 1	Maximum	Median	Minimum
Soil pH	7.6	8.4	7.9	6.9
Available Nitrogen, lbs/acre	132.2	376.7	51.8	16.95
Available Phosphorus, lbs/acre	552.3	1650	76.74	4.09
Available Potassium, lbs/acre	283	742	159.5	37.3

<u>**Soil pH**</u> is a measure of how acidic or alkaline the soil is. pH controls how available nutrients are to crops. Most Colorado soils are alkaline, with a pH between 7.2 and 8.3. If pH is too high (alkaline), phosphorous, iron, manganese, copper and boron become unavailable to plants.

pH

pH<5.5 - Concerning | 6.2<pH >7.0 Good | pH>7.7 - Concerning

<u>**Nitrogen**</u> is an essential building block of all life and 78% of our atmosphere. It is a major component of chlorophyll, proteins and DNA. Plants cannot take nitrogen directly from the atmosphere but instead rely either on soil microbes to break down organic material into small nitrogen molecules which they can absorb, or rely on chemical fertilizers. Adequate nitrogen levels are different in different parts of the growing season, and for different crops.

ADEQUATE NITROGEN DURING THE FALLOW SEASON

N<20 – Concerning | N>50 - Concerning | N>100 - Excessive

ADEQUATE NITROGEN DURING THE GROWING SEASON

N<20 – Concerning (unless a legume) | 75< N >150 Adequate for most non-legume crops | N>300 - Concerning

<u>**Phosphorous**</u> is an essential plant nutrient, used by plant cells to build DNA and regulate metabolic reactions. At high levels, Phosphorous can pollute waterways and at very high levels it interferes with plant uptake of iron and zinc. A value of 50-100 is adequate for most crops.

ADEQUATE PHOSPHORUS

P<20 - Concerning | 50< P >100 Good | P>300 - Concerning

<u>**Potassium**</u> is an essential plant nutrient that helps with heat and cold tolerance and promotes fruit development. Potassium levels are adequate to high in most Colorado soils, especially with annual applications of compost or manure. Deficiencies occasionally occur in soil with low organic matter and in sandy soils. A value of 100-500 is adequate for most crops.

ADEQUATE POTASSIUM

K<50 - Concerning | 100< K >500 Good | K>2000 - Excessive

YOUR SOIL'S MICROBIAL LIFE

	YOUR FIELDS	PEER FIELDS		
	Example 1	Maximum	Median	Minimum
Total Microbial Biomass	6946	6946	3720	798
Fungi:Bacteria ratio	0.156	1.044	0.18	0.04

Total Microbial Biomass represents the total microbial life in your soil. pH, temperature, moisture, soil type, Soil Organic Matter, intensity/type of tillage, crop rotations, cover crops, and herbicide or pesticide applications will all change this number. The higher the number, the more varied your microbial community is, and the better your soil health is. There is no baseline "normal range" for biological testing like there is for chemical analysis. These numbers are most useful for comparing different management over time.

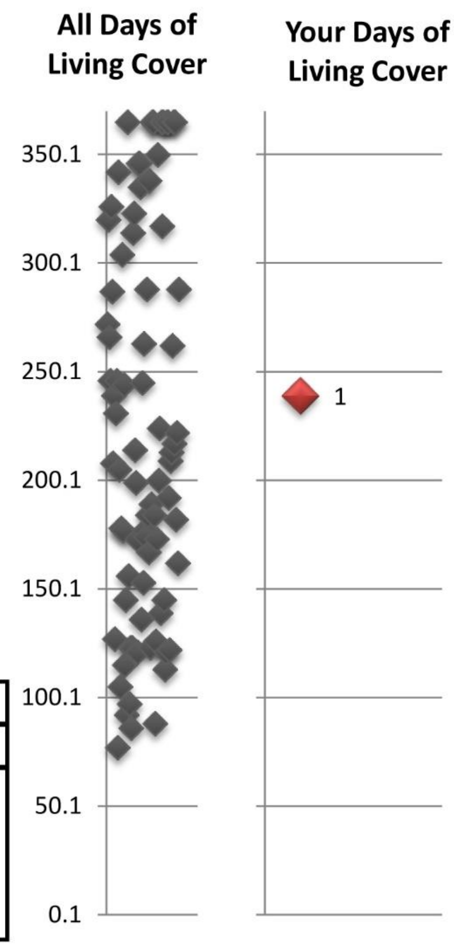
Fungi: Bacteria Ratio

Bacteria are the smallest, most plentiful and hardiest microbes in your soil. They can survive under harsh conditions like tillage. However, as single-celled organisms, they need a film of water to survive. When conditions are ideal, bacteria reproduce in 30 minutes, and have a short life span. Bacteria contain a lot of Nitrogen because they are the first microbes to digest new organic residues in the soil. When bacteria die, the Nitrogen in their cells is released to the soil in plant-available forms. Bacteria are like little bags of fertilizer that power your soil nutrient cycle.

Fungi are rapid-growing multi-celled organisms that need a constant food source. They form symbiotic relationships with plants, by tapping directly into a plant's roots for food. In exchange, Fungi send hyphae, or threads, many feet out into the soil to gather and transport water and nutrients back to the plant. They prefer slightly acidic, low disturbance soils, and high carbon residues. They are not as hardy as bacteria, and decline with conventional tillage. Fungi are good at storing Carbon in the soil.

Your **Fungi : Bacteria Ratio** will usually be less than 1 because bacteria are much more plentiful than fungi. Bacteria are important and needed, but Fungi are desired and usually indicate good soil health. Cover crops, organic inputs and less tilling will help your soil support more Fungi. Forests tend to have fungal-dominated soils. Highly productive agricultural soils tend to have higher ratios of Fungi to Bacteria. Grasslands and agricultural soils usually have bacterial-dominated soils. Bacteria dominate in early spring or late fall, in systems with fewer organic inputs, under dry conditions, in alkaline soils, and after tillage, grazing or compaction of soil.

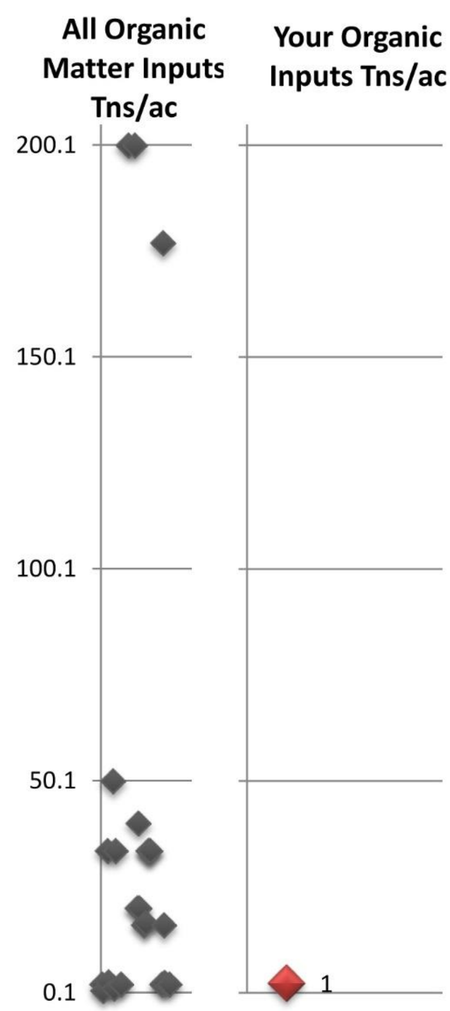
HOW TO READ THESE GRAPHS: We used the data from your year-end questionnaires to calculate 3 key indicators of soil health management: days of living cover, tillage intensity, and off-field organic matter inputs. For each indicator, we've plotted results from your farm relative to results from peer farms. In each graph, the gray dots show peer fields, and the red dots show your fields.



YOUR DAYS OF LIVING COVER

Living vegetation protects soil from wind and water erosion while also supplying the soil with fresh organic matter and feeding the soil microbiome. Linking together crops and cover crops to maximize days of living cover is a fundamental soil building practice. The "Days of Living Cover" score is the days between crop or cover crop seeding (or transplant) and termination (or winter kill).

	YOUR FIELDS		PEER FIELDS		
	Name	Days	Maximum	Median	Minimum
1	**Example 1**	239	365		
2				209	
3					
4					77.00



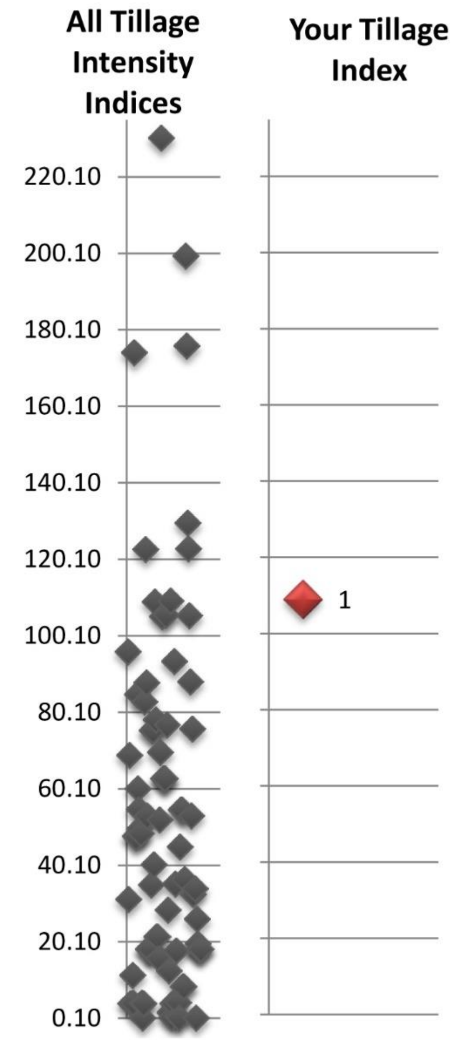
YOUR ORGANIC MATTER INPUTS

Organic matter inputs including composts, manures, and straw mulches can jump-start the formation of soil organic matter, add microbiology to the soil, and supply macro and micro nutrients. However, continuous inputs can also contribute to soil health challenges, such as excessive phosphorus levels. This organic input score shows the total organic inputs (composts, manures, and mulches) into each field, in units of tons per acre. This indicator only looks at inputs from "outside" the study field, and doesn't include manure deposited by animals grazing in that field or biomass generated by crops and cover crops.

	YOUR FIELDS		PEER FIELDS		
	Name	Tons/Ac	Maximum	Median	Minimum
1	**Example 1**	2.5	200		
2				20	
3					
4					0

YOUR TILLAGE INTENSITY INDEX

Tillage can degrade soil structure and organic matter, but it can also be a valuable tool for weed management and incorporating cover crops and other organic material. The tillage intensity index uses data from a Natural Resources Conservation Service soil erosion model to assign a soil disturbance score to all farm operations that can compact or disturb soil. For context, NRCS assigns a single pass with a chisel plow a score of 52.6, a disc harrow gets a score of 11.67, and a seeder gets a score of 0.59. At the bottom of the page is a table of your implements and the tillage scores we assigned for your fields.

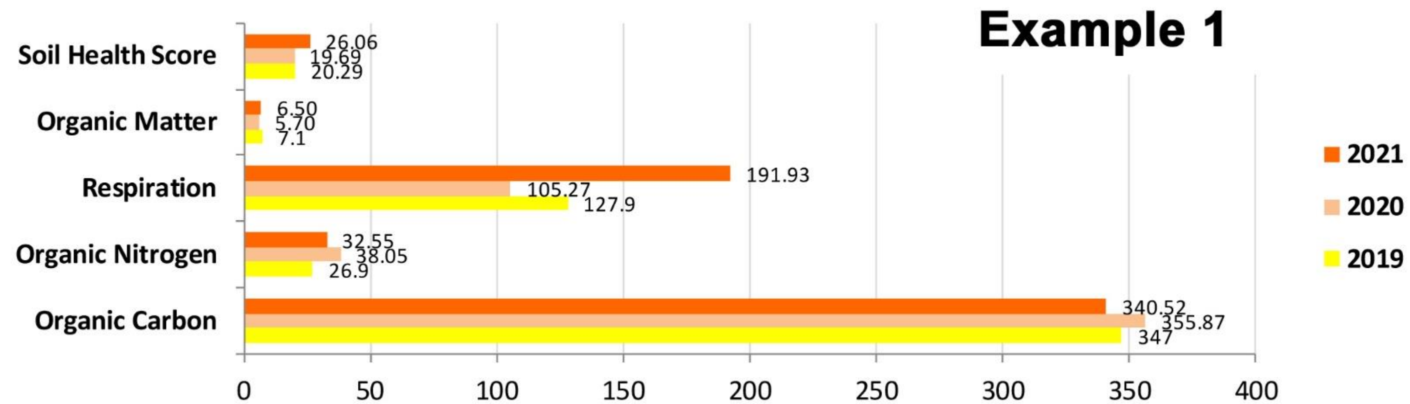


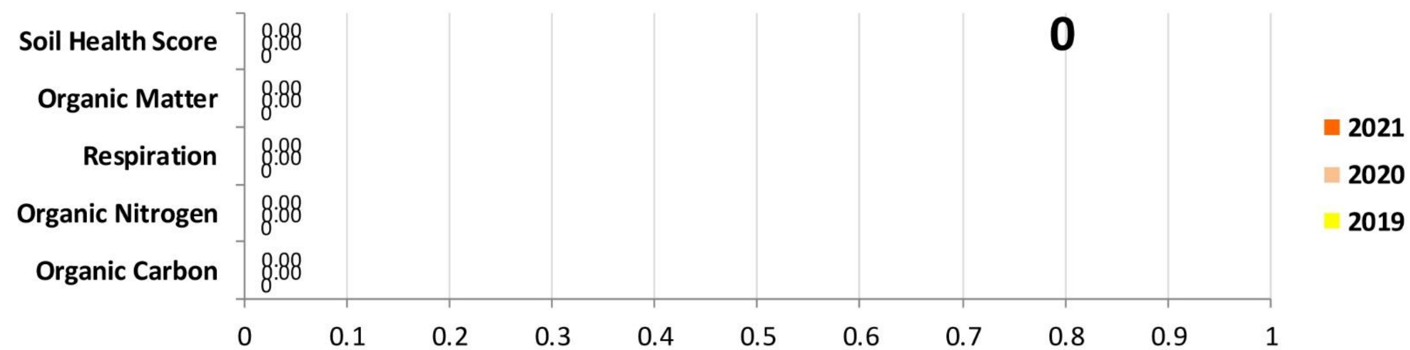
	YOUR FIELDS		PEER FIELDS		
	Name	Score	Maximum	Median	Minimum
1	**Example 1**	109.2	230.28	44.94	0
2					
3					
4					

Field	Operation	# Passes	Depth	% Disturbed	Tillage Intensity Index	Total Tillage Index
Example 1	Tiller, with 30" tiller	6	5 in	90%	109.2	
						109.2
0	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	0
0	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0	0	0	
	0	0	0		0	0

YOUR PROGRESS TO DATE:

The graphs below show the change over 3 years in 5 of your soil health indices: **soil organic matter** (SOM), **respiration**, **organic nitrogen** (WEON), **organic carbon** (WEOC), and **soil health score**. The yellow bars are your 2019 values, the buff bars are your 2020 values and the orange bars are your 2021 values. Each year, we will add to these graphs to show your overall trends. We are seeing a lot of variability in soil health scores year-to-year. Weather, soil temperature, crop rotations and perhaps other factors can cause large swings in these indices. Expect to see your organic carbon change first, with soil organic matter trailing behind.





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