CARBON FARM PLAN

Solidarity Farm

Photo credit: Solidarity Farm, aerial photo by Bea Alvarez

Date: 8/12/2022

Planners:
Luis Ramos: Agriculture Program Director and
Bea Alvarez: Climate Resilience Projects & Outreach Coordinator

MISSION RESOURCE CONSERVATION DISTRICT

SOLIDARITY FARM

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Introduction

With proper management, soils have the ability to capture and store carbon from the atmosphere. Applying soil conservation practices to arable lands creates the potential to sequester excess carbon dioxide (CO2) from the atmosphere and store it in agricultural lands. Conservation practices include but are not limited to: adding soil amendments like compost or mulch, no-till practices, planting cover crops, rotational grazing, agroforestry and several others (*Soil Health, Soil Amendments, and Carbon Farming | USDA Climate Hubs*, n.d.). Of course, their effectiveness will vary across a multitude of climates, soil types, and geographies. Increasing soil carbon into arable soils welcomes benefits such as, improving soil structure, fertility, water-holding capacity, and improves overall climate resiliency; benefiting farmer's finances and yield productions.

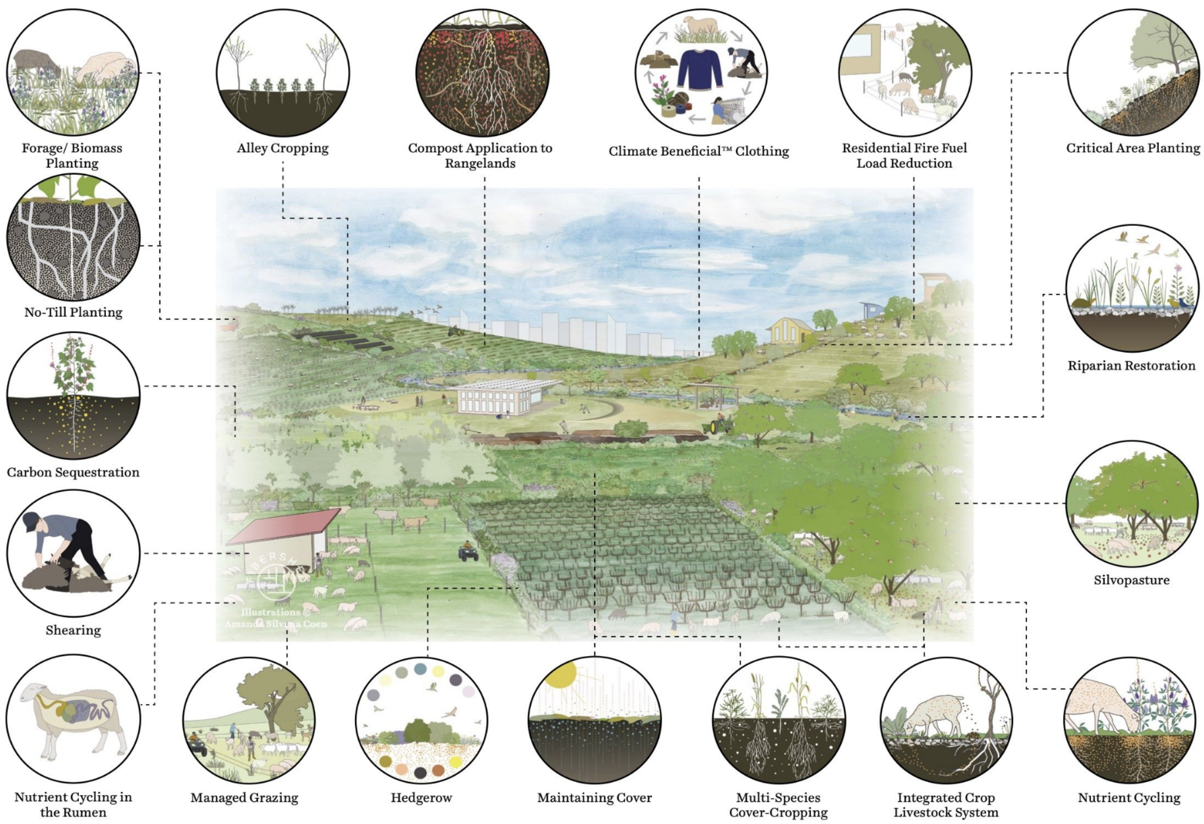
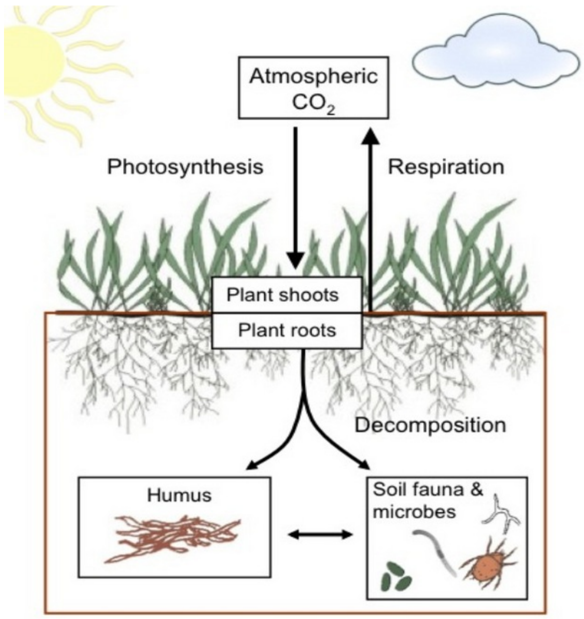


Figure 1 (Demonstrates soil conservation practices)

Soil Carbon

The carbon cycle is the exchange of carbon among the earth and its soils, oceans and bodies of water, the atmosphere and living things. Sequestering carbon dioxide from the atmosphere and storing it in soil in the form of organic matter is one of many stages of the Carbon Cycle (Kane, n.d.). Carbon sequestration is one method of reducing the amount of carbon dioxide in the atmosphere with the goal of mitigating global climate change.



Through its cycle, carbon has the potential to be either a source or a sink. Carbon sinks are pools that accumulate more carbon than they release, and carbon sources release more than they accumulate. At this moment, sinks like the atmosphere and ocean have too much carbon while soils have lost carbon at an unnerving speed due to development, conversion of native grasslands and forests to croplands, and agriculture practices that decrease organic matter (Kane, n.d.).

When plants grow and die, they leave behind organic, carbon-based compounds in the soil of different size and chemical makeup. Soil microorganisms will process these compounds,

Figure 2 (Brief illustration of carbon cycle)

by releasing them back out to the atmosphere as CO2 or putting it back into the soil. In the soil food web, carbon is continuously changing forms and utilized by new organisms or converted into different compounds.

The length of time carbon stays in soils is the way scientists categorize different sources or carbon, called "mean residence time." The most commonly used model includes three different groupings: the fast or labile pool, the slow pool, and the stable pool (Jenkinson & Rayner, 1977).

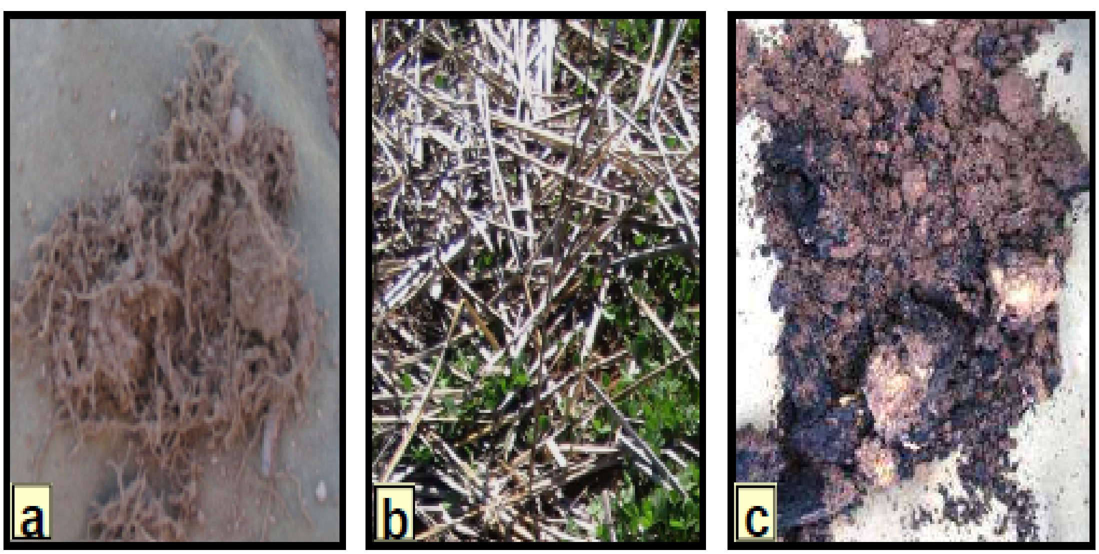


Figure 3, Representative pictures of a. the labile pool, b. resistant residues/slow pool and c. protected humus/stable pool.

The fast pool is soil carbon that turns over and returns to the atmosphere quickly within a few days to a few years, resulting from the addition of fresh residue such as plant roots and living organisms (*Labile Carbon | Fact Sheets | Soilquality.Org.Au*, n.d.). This labile pool is the most readily used by soil microbes, since it breaks down very quickly and is an active source of nutrition for soil microbes, meaning it generates a great deal of CO2 (Kane, n.d.).

The slow pool is composed of more resistant plant remnants. They are microbial byproducts of the fast pool, and carbon molecules protected from microbes by physical or biochemical soil processes. The "mean residence time" or how long this type of carbon stays in the soil ranges years to decades. This range can be heavily influenced by soil texture, management, and climate (Kane,n.d.).

In contrast, the stable pool is more resistant to disturbances and is extremely slow to change, with mean residence times ranging from centuries to millennia. This pool is composed of what is often called humus, a term for a group of carbon compounds that are extremely resistant to decomposition, and soil carbon that is very well protected from microbial decomposition (Six et al., 2002). The relative size of each of these pools can vary in different soils. Generally, the size of the stable pool remains relatively constant, while the sizes of the labile and low pools are sensitive to management.

Based on what practices are adopted by farmers, dictates if that farm operation is contributing to or absorbing carbon dioxide (CO2). Carbon Farming is the adoption of applying land conservation practices that reduce or sequester carbon from the atmosphere and into the soil. A Carbon Farm Plan is, based on the NRCS Conservation Planning process, a holistic, systems approach to conservation planning with the carbon cycle and carbon capture as the organizing principle, it is also considered a living document that aids farmers and their farms in the assessment, planning and implementation of soil conservation practices that have the potential to provide environmental co-benefits such as on-farm climate resilience, soil health, and farm productivity (*Carbon Farm Planning*, n.d.) evaluating all the opportunities for greenhouse gas (GHG) reduction and carbon sequestration on their land.

Steps in Carbon Farming Process

The first step in the carbon farm planning process involves conducting an inventory of all soil management practices and GHG emission sources on the farm to determine a current net carbon sequestration potential. Next, opportunities to enhance soil carbon sequestration and reduce GHG emissions are identified. The second step identifies practices that the farmer wishes to implement. The farmer's goals and economic considerations help prioritize practices from the many opportunities that may exist. The carbon benefits of each practice, if actually applied at the farm scale, are quantified using the USDA greenhouse gas model, COMET-Farm, COMETPlanner, or similar tool, and data sources, to estimate tons of carbon dioxide equivalent (CO2e) that would be avoided or removed from the atmosphere and sequestered on farm by implementing each practice. A list of potential practices and their on-farm and climate mitigation benefits is then developed. The third step is implementation. Resource Conservation Districts (RCDs) work with farmers to identify funding sources to pay for the practices and provide technical assistance for implementation. Farmers will implement practices, as funding, technical assistance, and schedules allow. Over time, the CFP will be reevaluated and updated to meet changing objectives and implementation opportunities.

Property Description

Farm Name:	Solidarity Farm
Farm Owners/Leasers:	Pauma Band of Luiseno Indians
Farm Physical Address:	14909 Pauma Valley Dr, Pauma Valley, CA 92061
Farm Mailing Address:	PO Box 845, Pauma Valley, CA 92061
Email:	solidarityfarmsd@gmail.com
Phone:	(760) 297-0838 (text is best)
Website:	https://www.solidarityfarmsd.com/
Operation Type:	Row vegetables/Orchard
Assessor Parcel Numbers (APNs):	1300905300
Watershed and region	Pauma Creek-San Luis Rey River (180703030202) Region 9
Size:	20 acres where 10 acres are farmed, Currently 5 acres in production

Figure 4A, Aerial photo by Bea Alvarez

Background and History

Solidarity Farm is a cooperative family farm privileged to steward land owned by the Pauma Band of Luiseno Indians for the last 10 years. They grow a diversity of seasonal fruits and vegetables on 10 acres and strive to integrate regenerative methods that sequester carbon and build healthy soil. They believe beautiful, nutritious food should be accessible to all people and seek to distribute produce in ways that build a more equitable and just food system.

In 2018, Solidarity Farm partnered with Pauma Band of Luiseno Indians to create the Carbon Sink Demonstration Farm at Pauma Tribal Farms. The collective goal was to ground truth strategies for adapting to and mitigating climate change. They aim to evolve the food system through: re-integrating indigenous foodways, undertaking demonstration projects, and engaging technical assistance providers, consumers, policy makers, scientists and advocates to help accelerate change.

Previous to Solidarity Farm established its operation in 2012, the land was owned and managed by Tierra Miguel Farm and Foundation, a nonprofit farming operation with bio-dynamic practices in a demonstration farm of 55 acres, with recorded 12 acres planted at a time, hard times came for the farm in 2007 with the wildfires, and a transitional two-year period of selling and then leasing the farmland, Tierra Miguel Foundation sold it to the Pauma Band of Luiseño Mission Indians in 2007, during the transition phase not new planting was introduced for one and a half years.

In the maps below, it is apparent how the land use changed since 2007. Figure 4A, is gallery of images from Google Earth dated 2007, 2012, 2014 & 2016 (Google Earth, historical imagery). Figure 4B shows the most updated version of the satellite images from Solidarity farm (outside property boundaries painted green). This latest image clearly show the land transformation and how land management has built soil and increased the productive acreage of the farmland.

Figure 4B, Satellite images from Google Earth dated 2007, 2012, 2014 & 2016

Figure 4C, Satellite Image from Google Earth dated 2021

In July 2017, temperatures reached 122-degrees and crops withered, trees burned and animals were lost. With the threat of rising temperatures and increased incidents of flood and drought due to climate change, the warning was clear: start building resilience now, or give up on a livelihood derived from agriculture. Solidarity sought input from technical advisors, discussed opportunities to integrate traditional ecological knowledge, researched the most applicable practices for building healthy soil, and applied for funding to help offset costs and buffer their learning curve. In 2018, the farm began implementing a suite of "carbon farming" practices including: reducing or eliminating tillage, planting cover crops, establishing hedgerows and windbreaks, and applying compost and mulch to fruit and vegetable crops to increase soil organic matter.

Five years ago, Pauma Band of Luiseno Indians and Solidarity Farm embarked on a journey to increase resiliency and improve food sovereignty by building healthier soils.

Initial goals for Conservation Practices implementation for Carbon Sink Demonstration Farm:

- reduction or elimination of tillage on at least 80% of the farm;
- transition 70% of production to perennial crops;
- planting of cover crops in orchard to reduce soil temperatures
- improve cation exchange and decrease the application of water
- hedgerows and windbreaks implementation to improve pollinator habitat,
- increase the availability of traditional food, fiber, and medicine, and reduce wind erosion/evaporation
- the addition of compost and mulch to fruit and vegetable crops, with the goal of increasing soil organic matter.

Figure 4D, Fields, Conservation Practices implementation and Infrastructure on Solidarity Farm

Assessment

Soil Health

1. Describe any soil resource concerns. This may include previous soil lab results, visual observations including cracking, poor cover crop growth, compaction, poor water infiltration after storms, erosion, hard pan, invasive weeds, flooding, etc.
   Provide existing soil lab data if available.

Farm performs annual Soil Health Assessments during the Fall season, using several indicators validated by NRCS Cropland In-field to assess soil health principles in practice.

The farm uses four primary tools to quantify and verify carbon sequestration and soil health. The process begins with validating potential through COMET Planner. Then uses two, low cost, field-based tools that report results quickly. The Solvita Soil Respiration Test helps us monitor soil organic matter, and the Microbiometer measures Microbial biomass and fungal to bacteria ratios to help us understand our soil's capacity to integrate nutrients, as research has shown that Microbial biomass (MB) is the best single indicator of soil health (Doran, 2000).

In terms of soil resource concerns, the dry winter with limited rainfall affected the cover crops germination rate, late seedling and early frost may have also contributed to the poor growth on the non-irrigated 2 acres used for this practice.

Attaching Soil Lab test results, Soil respiration and Microbiometer results

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 21-323-019

CLIENT NO: 0067-D

SEND TO: CARBON SINK FARMS
PO BOX 845
PAUMA VALLEY, CA 92061

SUBMITTED BY: BEA ALVAREZ

GROWER: SOLIDARITY FARM

DATE OF REPORT: 11/23/21

SOIL ANALYSIS REPORT

PAGE: 1

SAMPLE ID	LAB NUMBER	Organic Matter * % Rating	Organic Matter ** ENR lbs/A	Phosphorus P1 (Weak Bray) **** * ppm	Phosphorus $NaHCO_3$-P (OlsenMethod) **** * ppm	Potassium K ***** * ppm	Magnesium Mg *** * ppm	Calcium Ca *** * ppm	Sodium Na *** * ppm	pH Soil pH	pH Buffer Index	Hydrogen H meq/100g	Cation Exchange Capacity C.E.C. meq/100g	PERCENT CATION SATURATION (COMPUTED) K %	Mg %	Ca %	H %	Na %
11507	53604	4.6H	123	210 *	125VH	178M	356H	1749M	170H	7.6		0.0	12.8	3.5	22.8	67.9	0.0	5.8
13007	53605	2.5M	81	129 *	41VH	109M	281H	1397M	122H	7.6		0.0	10.1	2.8	22.9	69.1	0.0	5.2
14507	53606	2.0L	70	76 *	25VH	61L	210H	1190H	75M	7.7		0.0	8.1	1.9	21.2	72.9	0.0	4.0
21508	53607	2.7M	83	118VH	35VH	207H	199M	1314H	85M	7.2		0.0	9.1	5.8	18.0	72.1	0.0	4.1
23008	53608	2.5M	79	92 *	27VH	162M	195M	1309H	98M	7.6		0.0	9.0	4.6	17.9	72.8	0.0	4.7

* Weak Bray unreliable at M or H excess lime or pH > 7.5

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
11507	18M	128VH	3.7H	2L	13M	0.4L	0.9M	L	2.4H						
13007	18M	112VH	1.6M	1VL	12M	0.4L	0.6L	L	1.8M						
14507	7L	64VH	0.7L	1VL	8L	0.3VL	0.3VL	L	1.1M						
21508	92VH	116VH	1.2M	1VL	10L	0.4L	0.5L	L	3.3H						
23008	31H	89VH	0.9L	1VL	10L	0.3VL	0.5L	L	1.8M						

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE

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24508	53609	2.0L	69	60VH	18H	85M	166M	1227VH	100H	7.4		0.0	8.1	2.7	16.8	75.2	0.0	5.3
31509	53610	2.7M	84	112VH	42VH	227M	325H	1714M	297H	7.5		0.0	13.1	4.4	20.4	65.3	0.0	9.9
33009	53611	2.1L	71	83 *	21H	124M	231M	1347M	208H	7.6		0.0	9.8	3.2	19.3	68.3	0.0	9.2
34509	53612	1.6L	63	61VH	17H	89M	200M	1199M	174H	7.5		0.0	8.6	2.6	19.1	69.5	0.0	8.8
41510	53613	2.7M	84	195 *	86VH	85M	252H	1350H	83M	7.8		0.0	9.4	2.3	22.0	71.8	0.0	3.8

* Weak Bray unreliable at M or H excess lime or pH > 7.5

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
24508	19M	89VH	0.5VL	1VL	10L	0.5L	0.4L	L	1.9M						
31509	33H	323VH	1.6M	2L	8L	0.4L	0.7L	L	5.6VH						
33009	12L	197VH	1.0L	1VL	8L	0.4L	0.6L	L	3.9H						
34509	18M	174VH	0.6L	1VL	6L	0.3VL	0.4L	L	3.3H						
41510	5L	94VH	3.7H	1VL	9L	0.3VL	0.4L	L	1.6M						

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43010	53614	1.5L	60	192 *	41VH	55M	164H	875H	62M	7.8		0.0	6.1	2.3	22.0	71.3	0.0	4.4
44510	53615	1.2L	53	155 *	34VH	61M	149H	769H	56M	7.8		0.0	5.5	2.9	22.4	70.2	0.0	4.5
51511	53616	1.7L	64	237VH	51VH	141M	205H	1053M	122H	7.5		0.0	7.8	4.6	21.5	67.1	0.0	6.8
53011	53617	1.3L	56	208VH	52VH	146M	228H	951L	214VH	7.5		0.0	7.9	4.7	23.7	59.9	0.0	11.8
54511	53618	1.0L	50	190 *	31VH	83M	154H	653M	122VH	7.6		0.0	5.3	4.0	24.0	61.9	0.0	10.1

* Weak Bray unreliable at M or H excess lime or pH > 7.5

SAMPLE NUMBER	Nitrogen NO_3-N ppm	Sulfur SO_4-S ppm	Zinc Zn ppm	Manganese Mn ppm	Iron Fe ppm	Copper Cu ppm	Boron B ppm	Excess Lime Rating	Soluble Salts mmhos/cm	Chloride Cl ppm		PARTICLE SIZE ANALYSIS SAND %	SILT %	CLAY %	SOIL TEXTURE
43010	3VL	51VH	2.3M	1VL	8L	0.2VL	0.3VL	L	1.1M						
44510	2VL	53VH	1.4M	1VL	8L	0.2VL	0.2VL	L	0.9M						
51511	20M	193VH	2.8M	1VL	8L	0.2VL	0.5L	L	2.9H						
53011	43VH	165VH	2.8M	2L	8L	0.2VL	0.4L	L	3.8H						
54511	24M	120VH	1.6M	1VL	6L	0.2VL	0.3VL	L	3.1H						

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** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

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Joe O'Brien
Joe O'Brien, CCA
A & L WESTERN LABORATORIES, INC.

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61512	53619	1.6L	62	197VH	80VH	70M	191H	1121H	79M	7.5		0.0	7.7	2.3	20.4	72.8	0.0	4.5
63012	53620	1.4L	59	272 *	94VH	77M	180H	1075H	71M	7.6		0.0	7.3	2.7	20.1	73.0	0.0	4.2
64512	53621	1.3L	56	217VH	85VH	96M	167M	1045H	63M	7.5		0.0	7.1	3.5	19.3	73.4	0.0	3.8

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61512	5L	80VH	4.9H	2L	10L	0.7L	0.3VL	L	2.0M						
63012	4VL	68VH	4.2H	1VL	10L	0.4L	0.3VL	L	1.7M						
64512	6L	72VH	4.0H	2L	9L	0.4L	0.3VL	L	1.9M						

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***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O

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Joe O'Brien
Joe O'Brien, CCA

Figure 6 , ***Soil Analysis Report 2021***

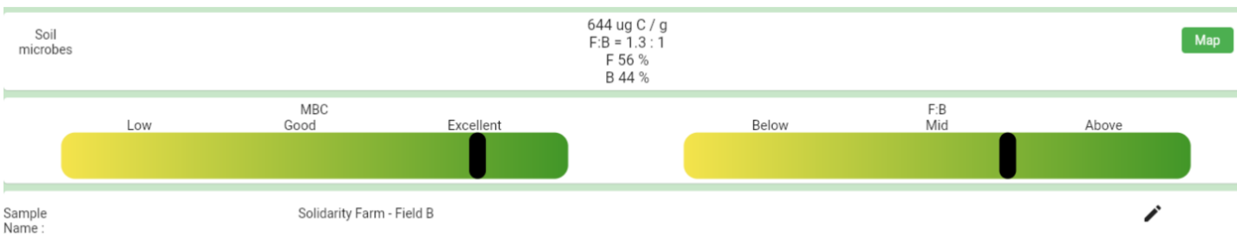

Figure 7, ***Microbiometer results Field B - Microbial Biomass - F:B ratio (https://microbiometer.com)***

Basic Calculator

English | Metric

Solidarity Farm - Field B / No Till

Solvita Field Test Color Number, 0 to 6.5	3.5 color
Your average soil temperature	64 ° f
Number of days in your crop's growing season	280 days
Adjusted CO_2-C based on the entered soil temp above	11 lbs/Acre
Likely Organic Nitrogen Mineralized over growing season	45 lbs/Acre
Dollars Saved due to Biological Nitrogen Per Acre	$43.19
Days your soil is ideal moisture	168 days
Potentially Mineralizable N for Season	38 lbs/Acre
Additonal Nitrogen to meet crop requirements	124 lbs/Acre
Nitrogen Savings Per Acre	$36.28
Sequestered Carbon lbs/Acre**	38,748 lbs/Acre

Basic Calculator

English | Metric

Solidarity Farm - Field C / Reduced Till

Solvita Field Test Color Number, 0 to 6.5	3 color
Your average soil temperature	64 ° f
Number of days in your crop's growing season	280 days
Adjusted CO_2-C based on the entered soil temp above	7 lbs/Acre
Likely Organic Nitrogen Mineralized over growing season	30.5 lbs/Acre
Dollars Saved due to Biological Nitrogen Per Acre	$29.38
Days your soil is ideal moisture	168 days
Potentially Mineralizable N for Season	25.5 lbs/Acre
Additonal Nitrogen to meet crop requirements	149 lbs/Acre
Nitrogen Savings Per Acre	$24.68
Sequestered Carbon** lbs/Acre	32,403 lbs/Acre

Basic Calculator

English | Metric

Solidarity Farm - Orchard / No Till

Solvita Field Test Color Number, 0 to 6.5	2.5 color
Your average soil temperature	64 ° f
Number of days in your crop's growing season	280 days
Adjusted CO_2-C based on the entered soil temp above	4 lbs/Acre
Likely Organic Nitrogen Mineralized over growing season	20.5 lbs/Acre
Dollars Saved due to Biological Nitrogen Per Acre	$19.74
Days your soil is ideal moisture	168 days
Potentially Mineralizable N for Season	17.5 lbs/Acre
Additonal Nitrogen to meet crop requirements	165 lbs/Acre
Nitrogen Savings Per Acre	$16.58
Sequestered Carbon** lbs/Acre	26,058 lbs/Acre

Figure 8, 9 & 10 ***Solvita Respiration test - CO2 Field Test estimator - Field B, Field C, Orchard (https://solvita.com/soil/basal-co2-guide/)***

2. Describe major soil types and conditions (soil sampling is not required but recommended). Description may include soil type, slope, drainage, erosion, potential, organic matter, etc. How many acres are actual planted acres? Description may be based on tests or Web Soil Survey. (See Soil Map in Figure 7)

The total size of Solidarity Farm is approximately 25 acres. Approximately, 20 acres are Visalia sandy loam soil, prime farmland if irrigated and less than an acre is indicated a Cieneba coarse sandy loam and considered not prime farm land (*Web Soil Survey*).

Visalia Soils

The Visalia series consists of moderately well drained, very deep sandy loams derived from granitic alluvium. These soils are on alluvial fans and flood plains and have slopes of 0 to 15 percent. The elevation ranges from 400 to 2,000 feet. The mean annual precipitation is between 14 and 18 inches, and the mean annual air temperature between 60° and 62° F. The frost-free season is 260 to 320 days. Areas close to the coast have only light frost. The vegetation is chiefly annual grasses, chamise, flat top buckwheat, California live oak, and scrub oak. In a representative profile, the surface layer is dark grayish-brown, slightly acid sandy loam about 12 inches thick. It is made up of 67.4% sand, 13.0% clay and 19.6% silt. The next layers are dark grayish- brown, slightly acid sandy loam and loam. This material extends to a depth of more than 60 inches. In some areas the soil is gravelly throughout. Visalia soils are used for avocados, citrus, walnut orchards, truck crops, irrigated pasture, field crops, tomatoes, flowers, and nursery stock.

Cieneba Soils

The Cieneba series consists of excessively drained, very shallow, to shallow coarse sandy loams. These soils formed in material weathered in place from granitic rock. They are on rolling to mountainous uplands and have slopes of 5 to 74 percent. The elevation ranges from 500 to 3000 feet. The mean annual precipitation is between 14 and 20 inches, and the mean annual air temperature between 60°F and 62°F. The frost-free season is 250 to 300 days. The lower elevations have only light frost in winter. The frost hazard is more severe at the higher elevations. The vegetation is chiefly flattop buckwheat, chamise, California sagebrush, and annual grasses and forbs.

In the representative profile the soil is brown, medium acid coarse sandy loam about 10 inches thick. This soil type is made up of 68.5% sand, 19.0% silt and 12.5% clay. Below this is weathered granodiorite. Cieneba soils are used mainly for avocados, range, wildlife habitat, recreational areas, and watershed. Small areas are used for citrus

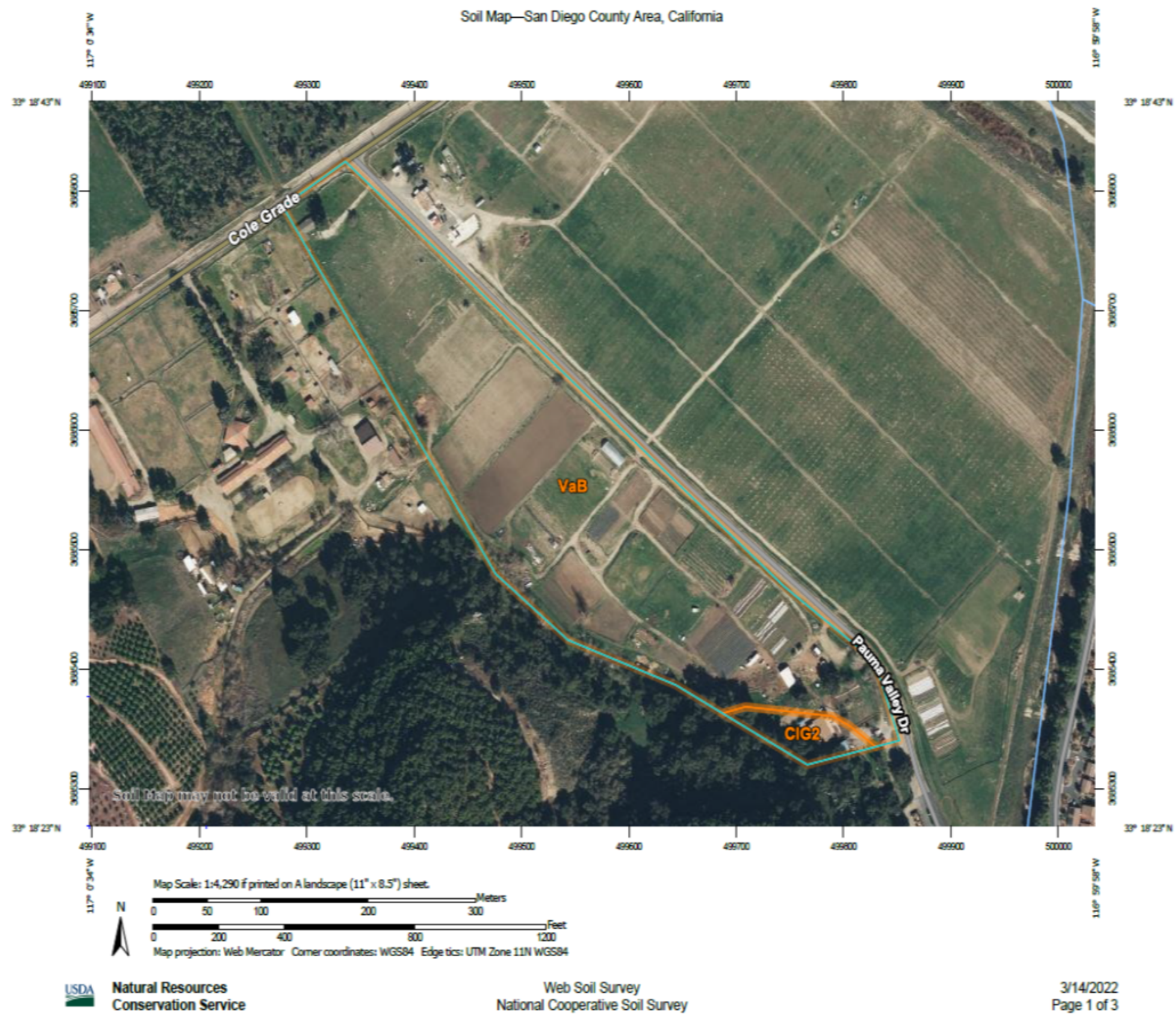

Figure 11 , ***Solidarity's Web Soil Survey Map***

3. Are there any nutrient issues: viruses or disease found in crops?

Strawberries fungus, white fly drives bacteria to leafy greens, during winter cold weather not enough biomass in certain parts of the fields, early blithe and purple curly top virus (tomatoes)., spinach turns leaves yellow accelerated by changing weather temperatures.

4. Describe all NRCS Conservation Practice Standards currently being implemented. See table: (We will make a chart using comet-planner)

No-till or reduce tillage crop field and the addition of quality compost application has helped us to achieve 4.4% of Soil Organic Matter, measured each year since 2018 results shown us that not only there was an increase in SOM but also finding SOM in deeper levels of the soil horizon, sequestration is measured by crop and by the amount of carbon in the soil, which we have increased from 1% to 4.4% since 2018. In 2020, this equated to a drawdown of nearly 600 metric tons of C02, offsetting the emissions of 80 American households.

On that 5-acre of food production converted to no-till methods we've seen an increase in plant yield, and the vegetables we are growing are increasing their resilience to extreme weather conditions and a significant reduction in reports of pest presence.

5. Describe tillage practices last year.

60% Reduced tillage or not till (or plough) 40% minimum tillage for conventional long crops using tractor equipment.

Figure 12 & 13 , ***Reduced Tillage (Gold Field) & No Till Field (Field B)***

6. Describe your seeding practices, seed mix and history

Direct seed and transplanting, 2 main seed mixes coarse mix with perlite and fine mix with vermiculite, seeds types: conventional, organic and heirloom (not so often).

7. Describe your soil amendment practices and history(composting and mulching, biochar). What types of fertilizers are used if any and from where?

The farm uses compost from local CalRecycle verified facilities and on-farm made open compost pile, the compost made in the farm it's mostly fungal dominated and we have seen more bacterial dominated from other sources. For mulching purposes the farm uses oak leaves between rows, woody mulch from San Pasqual Valley Soils for hedgerows, orchard and food forest, the latter are not so often mulched using straw.
In regards to Fertilizers, chicken manure, fish emulsion (PNW or Alaska), feather meal, alfalfa meal, Tru organics 10-8-2 are used at the farm.

8. Describe weed management practices in row crops, orchard, etc.

No pesticides or chemical biocides are used at the farm, for weed management practices we use Cultivating tools, hand method, flame and wheel hoe.

9. Describe on site composting, mulching, recycling

Fruit and vegetable production accelerated significantly over the last years at Solidarity Farms, placing new beds into no-till operation. No-till means that during harvest, crops are cut at ground level and soil is as undisturbed as possible. Only minimal raking and bed reshaping is done by hand before compost is applied. Standard operating procedure focused on "flipping beds" within 24 hours of final crop harvest and applying between 1/4 inch (for direct seeded crops) and 2 inches (for transplanted crops) of compost at each bed transition. Dry oak leaves and straw is used for mulching when needed between rows in no till crop fields.
On-site Composting is important because it saves materials that can promote long-term soil health and keeps biodiversity from being wasted in the landfill. Compost encourages a healthy root structure and good plant growth. Solidarity Farm uses an open outdoor composting method (piles), mixing horse manure, carbon, and nitrogen-rich materials, and produces about 25 yards a year. The comparison with bought compost shows Solidarity's mix has an excellent Microbial Biomass rate and higher fungal to bacteria ratio which is beneficial for our crops.

Compost applied 2018-2020 (values include Carbon Sink Farms (Pauma Tribal Farm + Solidarity Farm)
On-site composted shavings and horse manure: 500 yards
On-site field waste and wood chips: 180 yards
Purchased compost: 200 yards
Purchased biochar: 25 yards
Total applied compost: 905 yards

2021 (Solidarity Farm)
On-site composted shavings and horse manure: 20 yards
On-site field waste and wood chips: 40 yards
Produced Compost 25 yards
Purchased compost: 80 yards
Total applied compost: 100 yards


Figure 14 & 15, ***Compost pile & compost application to 100ft long 30" wide beds***

Fuel and Electrical Use

10. On average how much fuel/electricity do you use each year for all operations related to Solidarity Farm? If you do not have this information, it is recommended that you track this usage over the next year to better calculate carbon emissions.

22.38 pounds of CO_2 are produced by burning a gallon of diesel fuel.
The tractor vehicle became non-operational in early 2022 and currently the farm is searching for alternative powered tractors, until 2021 the fuel powered tractor on the farm consumed approximately 25 gallons/week to operate, releasing 14.5 tons of C02
The 4 staff/members at Solidarity Farm release approximately 12 tons each of C02/year for a total of 48 total tons.

11. What types of alternate sources of fuel or energy are used on the property? In this section it might be nice to break down all vehicles used on farm and deliveries and what fuel they run on

In 2021 a solar panel system was installed in collaboration with Hammond Climate Solutions; the solar panels are connected to the grid and power the cold storage, washing and packing station, offices and house.
Solar system size: 16,575 Kw - 24,842 kWh System production in year 1

On-farm vehicles: Kawasaki Mule, gas vehicle - 100 gallons a year aprox,
Delivery vehicle: Sprinter Van, diesel vehicle - used in partnership with Foodshed, consumes approximately 10 gallons/week releasing 5.8 tons of C02.


Figure 16 & 17, *Kawasaki Mule & Solar panels array*

Water Efficiency

12. Has an irrigation evaluation been completed in the past three years and has the system been managed according to recommendations from the evaluation? What are some issues you have with the water system? If you have a distribution uniformity report, please include it.

Imperical method for drip tape done by Mission RCD
Irrigation evaluation was initially conducted in 2018 as part of the Carbon Sink Farms goals setting. Irrigation systems in no-till and reduced tillage fields have been implemented according to TA recommendations. In regards to issues, it has been noted in the past that irrigation water is relatively high in sodium, and values have rosen significantly between 2018 and 2020. After lab tests in 2018, 2020 and 2021 some discrepancies have been seen in sodium levels, discrepancies could be attributed to different seasonal testing (2018 test was taken in early Spring, while the 2020 and 2021 tests were taken in October) In seasons without rainfall to purge excess sodium from the soil, the numbers can look somewhat inflated. The intention is to continue monitoring and testing seasonally in the fall to keep a close eye on sodium levels.

13. What water efficiency tools are used on property (Moisture sensors, pressure regulators, etc.). What type of irrigation system is being used on the property? How do you identify leaks, and how quickly are they fixed?

In 2020, Solidarity Farm installed 3 Irrometer Soil Moisture Sensor — MODEL 200SS-- in three strategic locations in no-till and reduced tillage fields. Each station automatically reports moisture levels and temperature to a website where graphs and data can be visualized online.
The reports are used to plan watering frequency, when moisture levels are too dry, irrigation is manually initiated. When moisture levels read wet, watering can be postponed.
Crop fields use lay flats and drip irrigation, Orchard and Food Forest use micro emitters, High Tunnels use overhead irrigation or drip tape depending on crop and plant maturity. Hedgerows uses ¾ poly tubbing and button drip emitters.

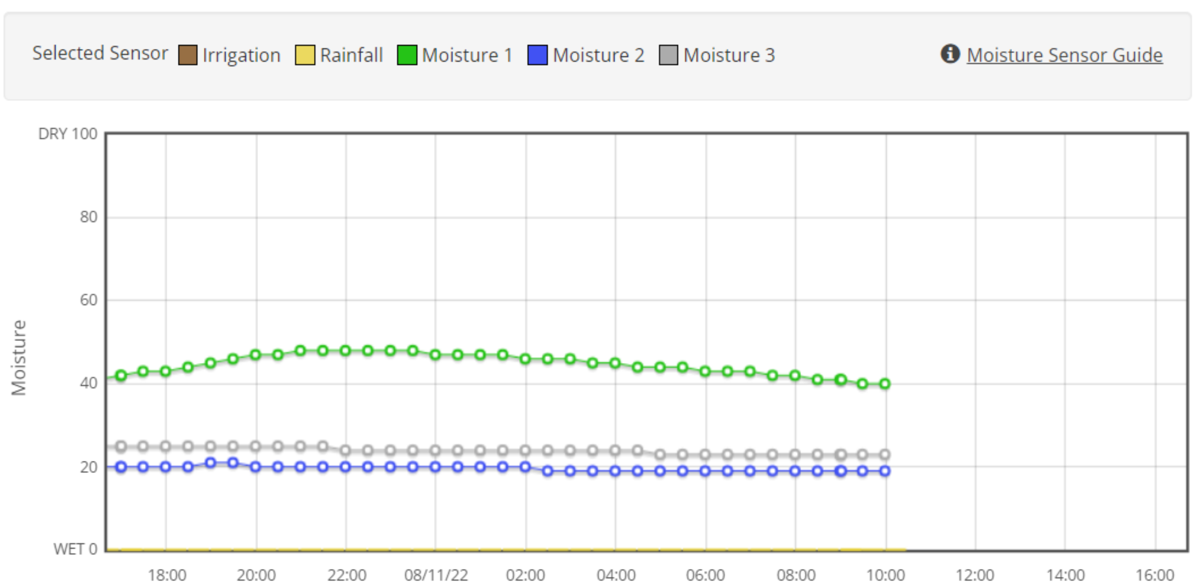

Figure 18, ***Sample moisture monitor reading.***

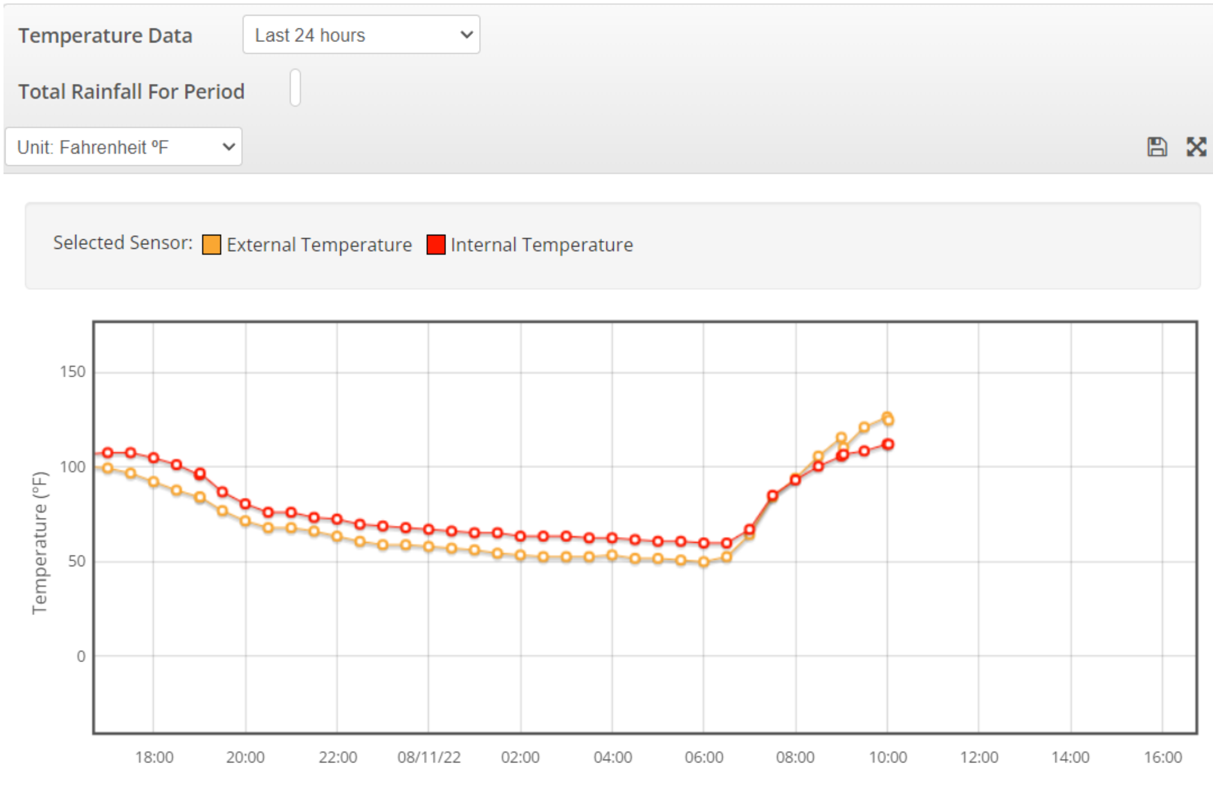

Figure 19, ***Sample temperature monitor reading.***

Animal Incorporation

14. How are animals incorporated into Solidarity Farm? Is there rotational grazing, what types of animals, what is their purpose in regards to carbon farming?

Animals are integrated as part of the educational programs and for grazing purposes. Until 2021 broiler chickens were raised for meat and rotational grazing was used in mobile chicken tractors on 1 acre of cover crop field. Laying chickens population has been drastically diminished, making it down to 8 birds out of 50 in january 2022, predatory activities by coyotes and mysterious chicken disappearance seem to be the cause of the decline of laying hens population. Rotation provides environmental perks and behavioral benefits for the chickens, coops were rotating every other day over cover cropped field. Horses and goats were also included in pasturing the cover crop field but on a less frequent schedule than the birds. Currently, horses are pasturing in a mobile corral at least twice a week.

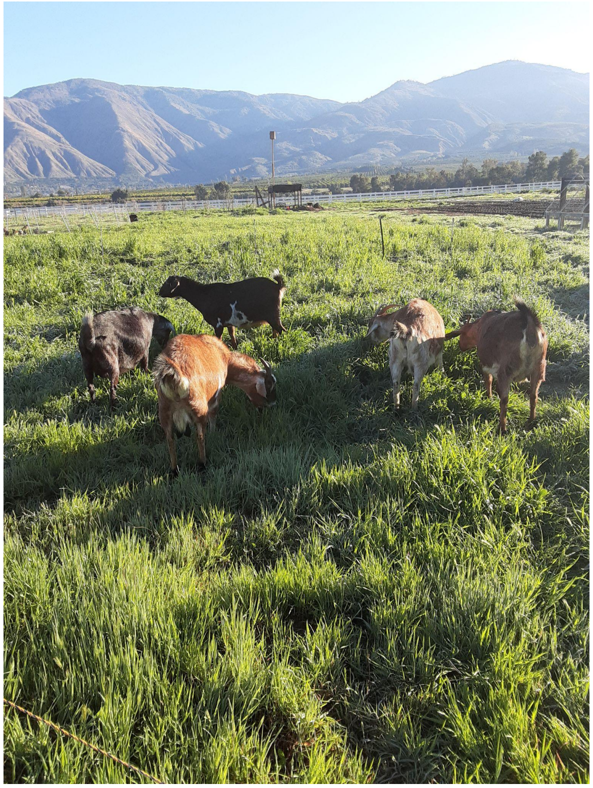

Figure 20 & 21, *Goats and chickens pasturing the cover crop fields.*

Farm Goals/Challenges

15. Farm Goals (what conservation practices will you continue and why, what new practices would you like to adopt, if you plan to expand practices and introduce new ones, which ones and how much in terms of acres or square feet).

Conservation practices that will continue in 2022, this practices had provided us with a baseline and goal-oriented management based on initial goals in 2018:

- Residue and Tillage Management - No-Till (CPS 329)
- Residue and Tillage Management - Reduced Till (CPS 345)
- Mulching (CPS 484)
- Hedgerow Planting (CPS 422)
- Tree/Shrub Establishment (CPS 612)
- Cover Crop (CPS 340)

(See Existing and Historical Carbon Beneficial Practices below for more details on purpose and benefits to these practices)

Additional Conservation Practices in consideration for 2023:

- Conservation Crop Rotation (CPS 328) - 2 acres
- Conservation Cover (CPS 327) - 1 acre
- Forage and Biomass Planting (CPS 512) - 1 acre

From the initial goals in 2018 we can share the following results from the 2020 report:

- Reduce or eliminate of tillage on 80% of farmed land
  - 75.7% reduced or eliminated tillage (90% if resting lands are included)
- Transition 60% of farmable land to perennial crops

- 61.6% in perennial crops
- Cover crops reduce soil temperatures, improve CEC and decrease the application of water
  - Minor increase in CEC, best results at lower levels is encouraging.
- Encircling the farm with hedgerows and windbreaks
  - 3 new hedgerows added to the original linear feet, total linear feet of hedgerows 5417.
- Add compost and mulch to increase % organic matter
  - +3.13% largest increase, no till site +1.3% smallest increase, mechanical till site

16. On Farm Challenges. What challenges are preventing you from continuing or expanding soil conservation practices on the farm.

Solidarity farm leases the property from the Pauma Band of Luiseño Indians and although there is a conservation easement on the land, the 10 years lease is due by the end of 2023, at the time of writing this report there is uncertainty about lease renewal, and/or new terms and conditions. The challenge is to envision new practices with short-term benefits that could be considered legacy projects and implement them for posterity.

Calculations of carbon sequestration: Using COMET-Planner to determine the GHG benefits of the NRCS conservation practice standards.

The climate impact of each recommended practice is obtained using COMET-Planner, this online tool dictates the combination of practices, and the way the practices are listed. Positive values indicate carbon sequestration and GHG emission reduction and negative values indicate loss of carbon or increased emission. All numbers have the same unit: CO2 equivalents, to be able to compare different GHGs such as methane and nitrous oxide that have a higher global warming potential than CO2.

COMET-Planner is a state-of-the-art tool that evaluates the GHG impacts of the recommended NRCS management practices to a spatial resolution of multi-county groups using a combination of data on local conditions and process-based modelling. For each practice, COMET Planner computes an “Emission Reduction Coefficient” (ERC). Each ERC includes changes in both carbon emissions or sequestration and nitrous oxide emissions in units of metric tons of carbon dioxide equivalents per acre per year (tCO2e/acre-yr), with a positive ERC indicating an emissions reduction.
The GHG impact of each recommended practice is defined as a change from the GHG emissions and carbon sequestration expected from the typical “business-as-usual” practice (the “baseline”). For example, the baseline practice for no-till is conventional intense tillage, while the baseline for cover crop use is leaving a field fallow.

Existing and Historical Carbon Beneficial Practices

- Residue and Tillage Management - No-Till (CPS 329)
- Purpose & Co-benefits
  - Reduce sheet, rill, and wind erosion and excessive sediment in surface waters.
  - Reduce tillage-induced particulate emissions.
  - Maintain or increase soil health and organic matter content.
  - Increase plant-available moisture.

- Reduce energy use.
- Provide food and escape cover for wildlife
- Increasing the rate of soil organic matter accumulation.
- Keeping soil in a consolidated condition and improved aggregate stability.
- Sequestering additional carbon in the soil.
- Further reducing the amount of particulate matter generated by field operations.
- Reduce energy inputs to establish crops.
- Forming root channels and other near-surface voids that increase infiltration

- Residue and Tillage Management - Reduced Till (CPS 345)
- Purpose & Co-benefits
    - Residue and tillage management, reduced till practice manages the amount, orientation, and distribution of crop and other plant residues on the soil surface year round while limiting the soil-disturbing activities used to grow and harvest crops in systems where the field surface is tilled prior to planting.
    - Reduce sheet, rill, and wind erosion and excessive sediment in surface waters (soil erosion).
    - Reduce tillage-induced particulate emissions (air quality impact).
    - Improve soil health and maintain or increase organic matter content (soil quality degradation).
    - Reduce energy use (inefficient energy use).

- Mulching (CPS 484)
- Purpose & Co-benefits
    - Applying plant residues or other suitable materials produced off site, to the land surface.
    - Conserve soil moisture
    - Reduce energy use associated with irrigation
    - Provide erosion control
    - Facilitate the establishment of vegetative cover
    - Improve soil health
    - Reduce airborne particulates

- Hedgerow Planting (CPS 422)
- Purpose & Co-benefits
    - Establishment of dense vegetation in a linear design to achieve a natural resource conservation purpose.
    - Increase carbon storage in biomass and soils.
    - Habitat, including food, cover, and corridors for terrestrial wildlife
    - To enhance pollen, nectar, and nesting habitat for pollinators
    - To provide substrate for predaceous and beneficial invertebrates as a component of ntegrated pest management
    - To intercept airborne particulate matter
    - To reduce chemical drift and odor movement
    - Screens and barriers to noise and dust
    - Living fences

- Tree/Shrub Establishment (CPS 612)
- Purpose & Co-benefits
    - Tree/shrub establishment involves planting seedlings or cuttings, seeding, or creating conditions that promote natural regeneration establishing forest cover
    - enhancing wildlife habitat
    - controlling erosion
    - improving water quality
    - capturing and storing carbon
    - conserving energy

- Cover Crop (CPS 340)
- Purpose & Co-benefits
    - Cover crop is growing a crop of grass, small grain, or legumes primarily for seasonal protection and soil improvement.
    - Increases soil organic matter and biological activity
    - Reduces erosion and runoff and transport of nutrients. Cover crops can uptake excess nutrients
    - Increased quality and quantity of vegetation provides more cover and food for wildlife.
    - Cover crops will add supplemental forage.
    - Increased cover during erosive periods will reduce soil detachment by water and wind.
    - Increased biomass and roots improve aggregation, which gives better resistance to compaction.
    - Improves infiltration, soil structure, and winter water use that may otherwise be lost. For dry climates (<20 inches/year); cover crops will compete for main crop's moisture.
    - Ground cover helps reduce wind erosion and generation of fugitive dust.
    - Vegetation removes CO_2 from the air and stores it in the form of carbon in the plants and soil.
    - Plants are selected and managed to maintain optimal productivity and health and can contribute to subsequent crop health and productivity.
    - Plants selected are adapted and suited.
    - Vegetation is installed and managed to control undesired species.

(see *Figure 4D* for location of practices implementation)

Comet Planner Chart with ongoing practices

Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions*
(tonnes CO_2 equivalent per year)

NRCS Conservation Practices	Acres	Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Irrigated Cropland	1.75	1	0	0	1
Residue and Tillage Management - Reduced Till (CPS 345) - Intensive Till to Reduced Till on Irrigated Cropland	4.5	1	0	0	1
Mulching (CPS 484) - Add Mulch to Croplands	10	2	0	N.E.**	2
Cover Crop (CPS 340) - Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Irrigated Cropland	2.5	1	0	0	1
Hedgerow Planting (CPS 422) - Replace a Strip of Cropland with 1 Row of Woody Plants	0.3	2	0	N.E.**	2
Tree/Shrub Establishment (CPS 612) - Conversion of Annual Cropland to a Farm Woodlot	1.5	28	0	N.E.**	28
Totals:	20.55	35	0	0	35

Table 1, ***COMMET PLANNER - Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions (tonnes CO2 equivalent per year)***

Emission Reduction Coefficients (ERC)
(tonnes CO_2 equivalent per acre per year)

NRCS Conservation Practices	Greenhouse Gases: Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)
Residue and Tillage Management - No-Till (CPS 329) - Reduced Till to No Till or Strip Till on Irrigated Cropland	0.32	0.03	0.00
Residue and Tillage Management - Reduced Till (CPS 345) - Intensive Till to Reduced Till on Irrigated Cropland	0.14	0.01	0.00
Mulching (CPS 484) - Add Mulch to Croplands	0.21	0.00	N.E.**
Cover Crop (CPS 340) - Add Non-Legume Seasonal Cover Crop (with 25% Fertilizer N Reduction) to Irrigated Cropland	0.24	0.01	0.00
Hedgerow Planting (CPS 422) - Replace a Strip of Cropland with 1 Row of Woody Plants	8.26	0.28	N.E.**
Tree/Shrub Establishment (CPS 612) - Conversion of Annual Cropland to a Farm Woodlot	18.95	0.28	N.E.**

Table 2, ***COMMET PLANNER - Emission Reduction Coefficients (ERC)***

Comet Planner Chart with potential/additional practices

NRCS Conservation Practices (Click Practice Name for Documentation)	Enter Acreage		Carbon Dioxide	Nitrous Oxide	Methane	Total CO_2-Equivalent
[Info]Forage and Biomass Planting (CPS 512) - Conversion of Annual Cropland to Irrigated Grass/Legume Forage/Biomass Crops [delete]	1	ac	1	0	0	1
[Info]Conservation Cover (CPS 327) - Convert Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover [delete]	1	ac	0	0	0	0
[Info]Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations [delete]	2	ac	1	0	N.E.**	1
Totals:	4.00		2	0	0	2

Table 3, ***COMMET PLANNER - Approximate Carbon Sequestration and Greenhouse Gas Emission Reductions (tonnes CO2 equivalent per year) for potential/additional future practice*****s**

	Emission Reduction Coefficients (ERC) (tonnes CO_2 equivalent per acre per year) Greenhouse Gases		
NRCS Conservation Practices	Carbon Dioxide (CO_2)	Nitrous Oxide (N_2O)	Methane (CH_4)
Forage and Biomass Planting (CPS 512) - Conversion of Annual Cropland to Irrigated Grass/Legume Forage/Biomass Crops	1.03	0.14	0.00
Conservation Cover (CPS 327) - Convert Irrigated Cropland to Permanent Unfertilized Grass/Legume Cover	0.33	0.22	0.00
Conservation Crop Rotation (CPS 328) - Decrease Fallow Frequency or Add Perennial Crops to Rotations	0.26	0.00	N.E.**

Table 4, ***COMMET PLANNER - Emission Reductoin coefficients (ERC) for potential/additional future practices***

The Soil-Water and Carbon Connection

NRCS estimates that a 1% increase in soil organic matter (SOM) results in an increase in soil water holding capacity of approximately 25,000 gallons per acre. A 1% increase in SOM equals approximately 20,000 pounds of organic matter, or 5 short tons of organic carbon. The implementation of the Conservation Practices listed on *Table 1* for the last 4 years with a recorded 4% increment in SOM results in about 2,055,000 gallons of additional water storage capacity associated with soil carbon increases.

Figure 22 & 23, ***Orchard aerial view & Food Forest.***

Figure 24, 25 & 26, ***High Tunnel, Hedgerow 1 & Hedgerow 2.***

Figure 27, ***Cover Crop field and blend detailed collage***

Charts

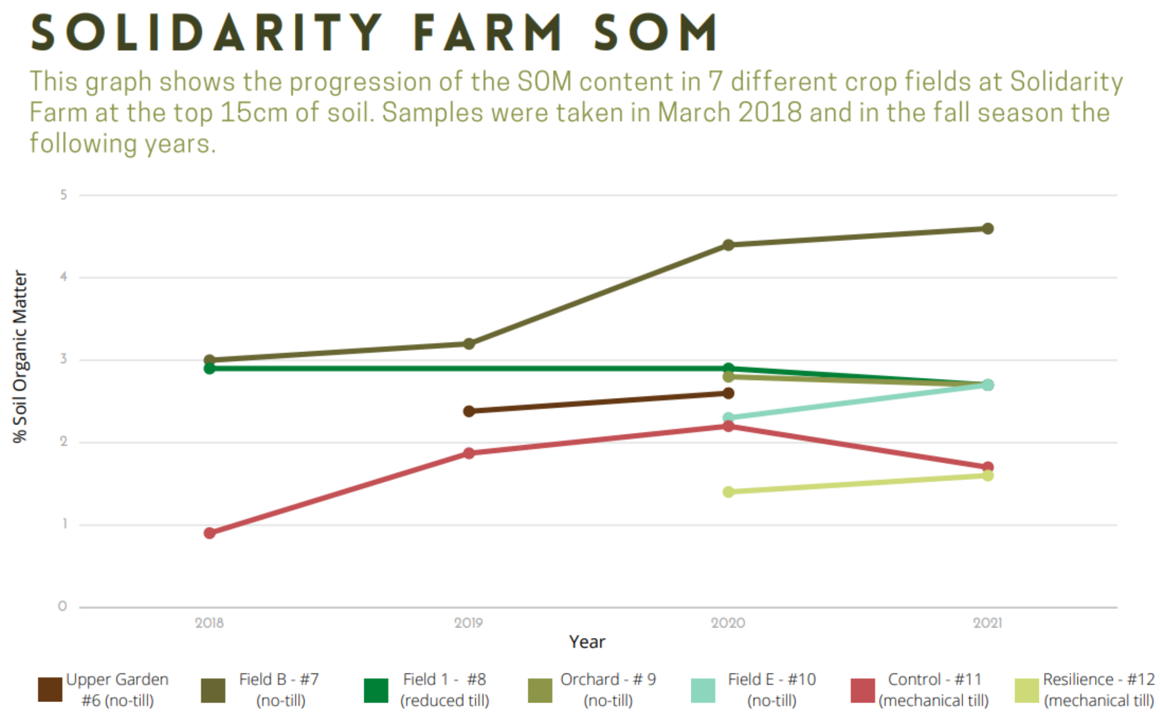

Chart 1, ***Solidarity Farm SOM - 0 to 15cm soil depth - 2018 to 2021***

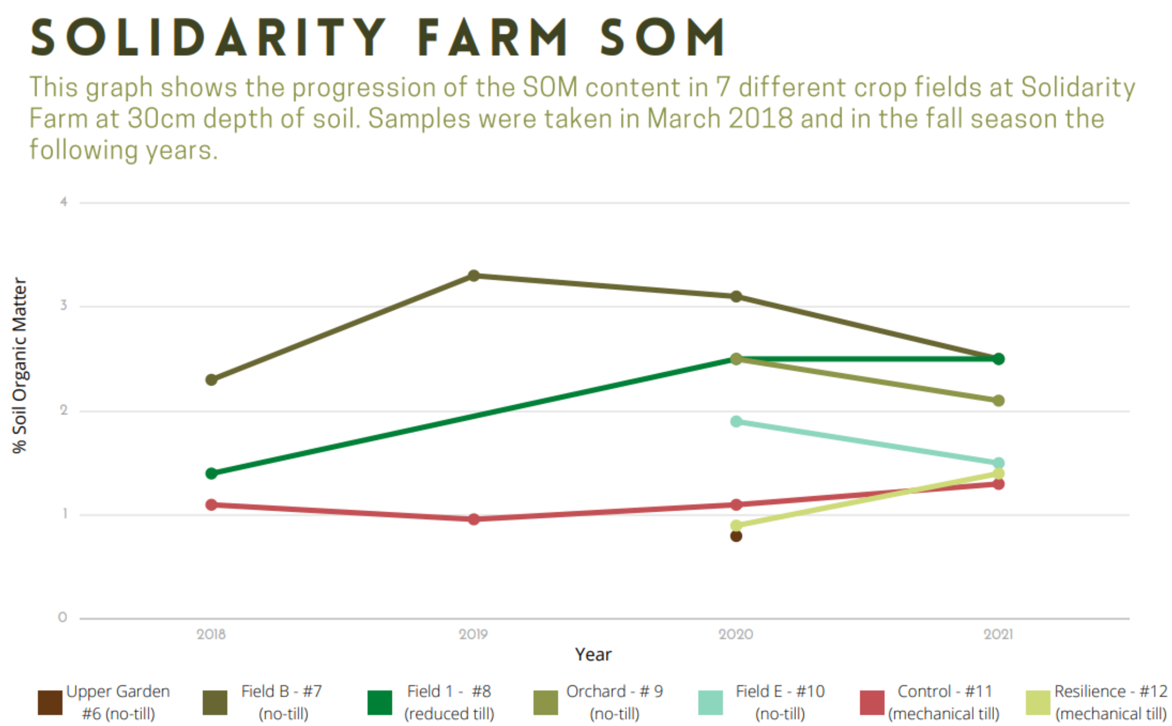

Chart 2, ***Solidarity Farm SOM - 15 to 30 cm soil depth- 2018 to 2021***

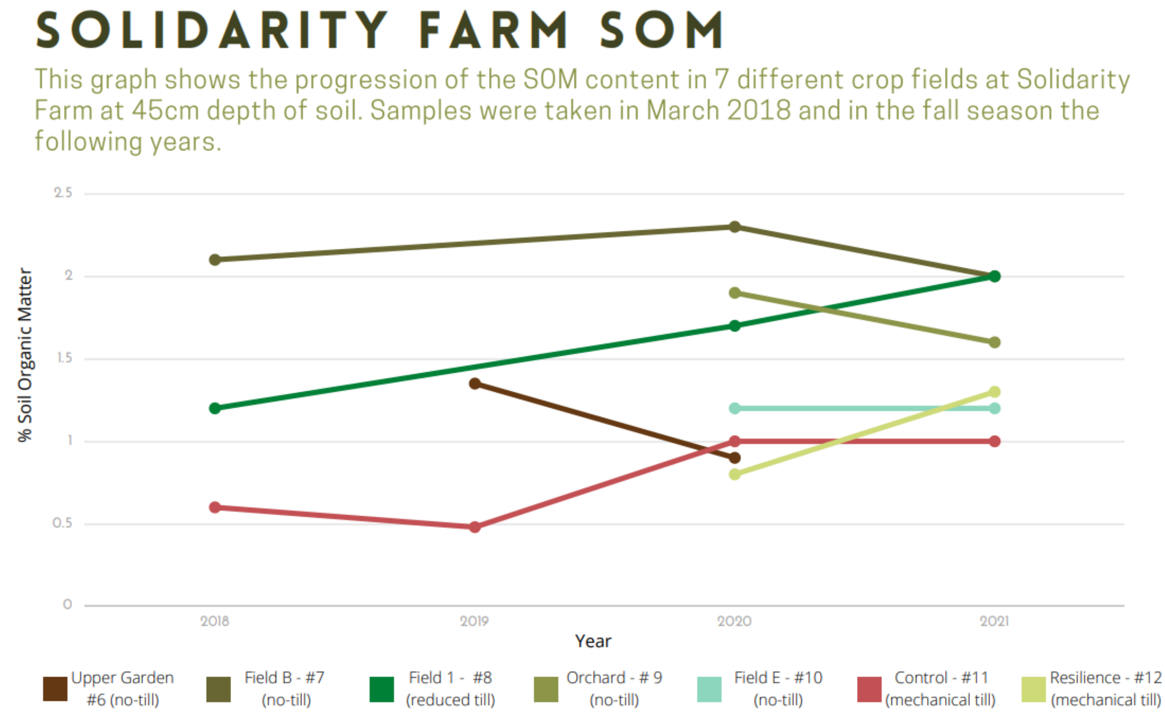

Chart 3, ***Solidarity Farm SOM - 30 to 45 cm soil depth- 2018 to 2021***

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