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Supplement of

Soil health management outweighs edaphic properties in explaining soil organic matter across working organic farms

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Supplemental Information

S1 Supplemental Methods

Cover crop functional richness

The USDA defines six major functional groups for cover crops: cool season grasses, cool season legumes, cool season broadleaves, warm season grasses, warm season legumes, and warm season broadleaves. The benefits from these groups are considered for different seasonal niches, and including a broader range of functional groups is believed to provide complementary benefits (USDA-NRCS, 2019).

Microbial biomass carbon and nitrogen

Microbial biomass C and N were determined via the direct fumigation method as described in Setia et al. (2012). Briefly, two subsamples per were divided into two falcon tubes with 16.67g soil. To one of the falcon tubes, 2.08 ml of ethanol free chloroform was added and to both falcon tubes, 40 ml of 0.5M K_2SO_4 was added. Samples were shaken for 30 minutes, centrifuged, filtered and the supernatant was bubbled for one hour to remove chloroform. Samples were analyzed for C and N on an elemental analyzer (VarioTOC Cube©, Elementar).

References

Setia, R., Verma, S. L., & Marschner, P. (2012). Measuring microbial biomass carbon by direct extraction–comparison with chloroform fumigation-extraction. *European journal of soil biology*, *53*, 103-106.

USDA Natural Resources Conservation Service. (2019). Considerations for Building Cover Crop Mixtures. Jimmy Carter Plant Materials Center Technical Note.

S2 Supplemental Figures

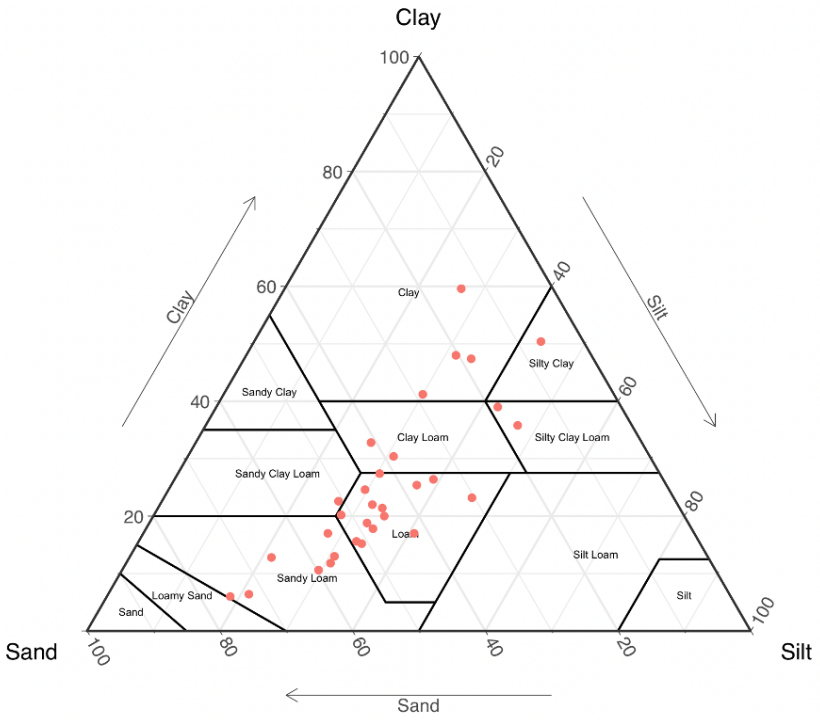


Figure S1: Soil texture across the 28 field sites (red circles).

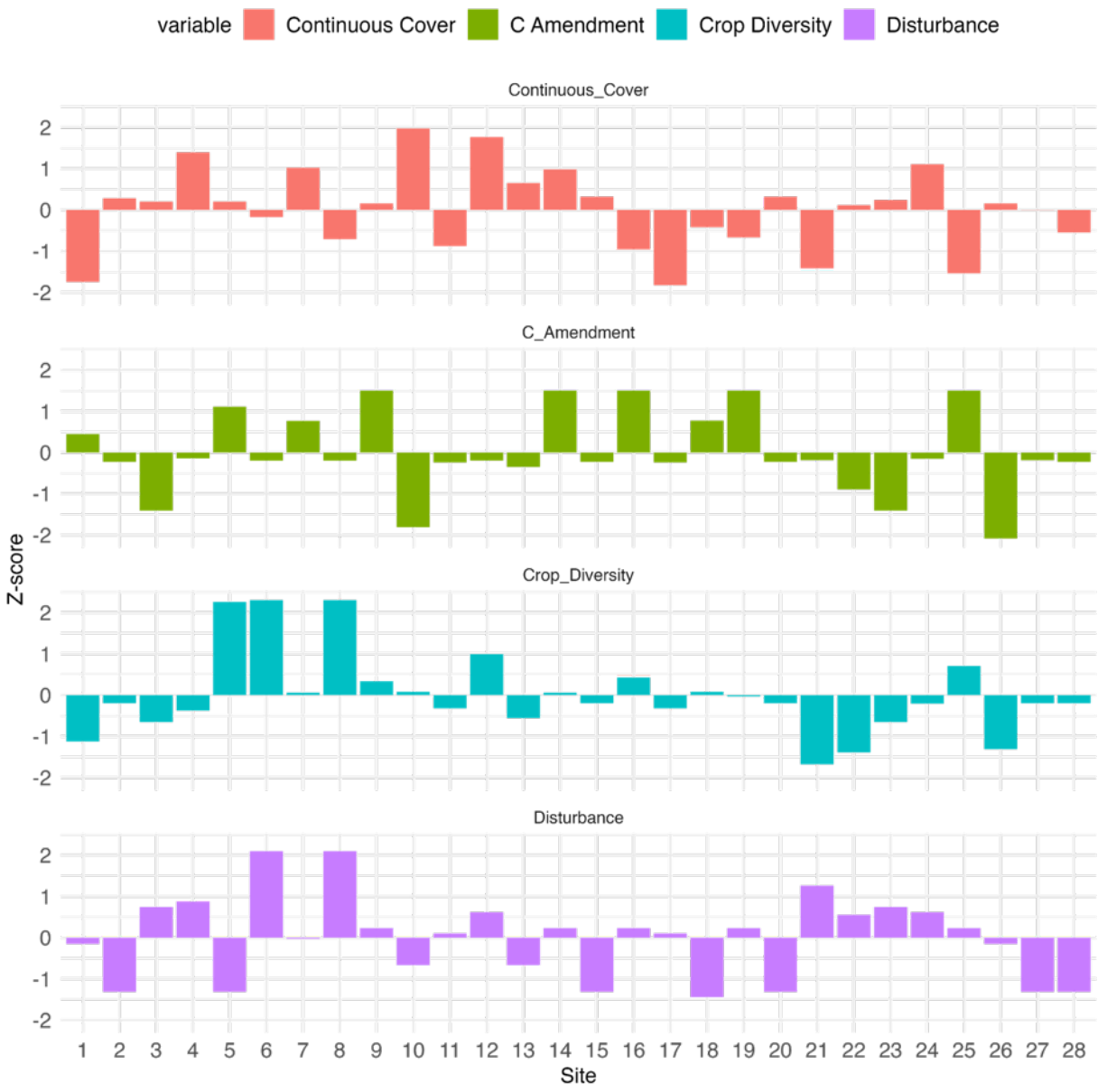


Figure S2: Scaled management Z-scores across 28 field sites, ordered by degree of soil health practice utilization. Higher values indicate higher utilization of a given practice.

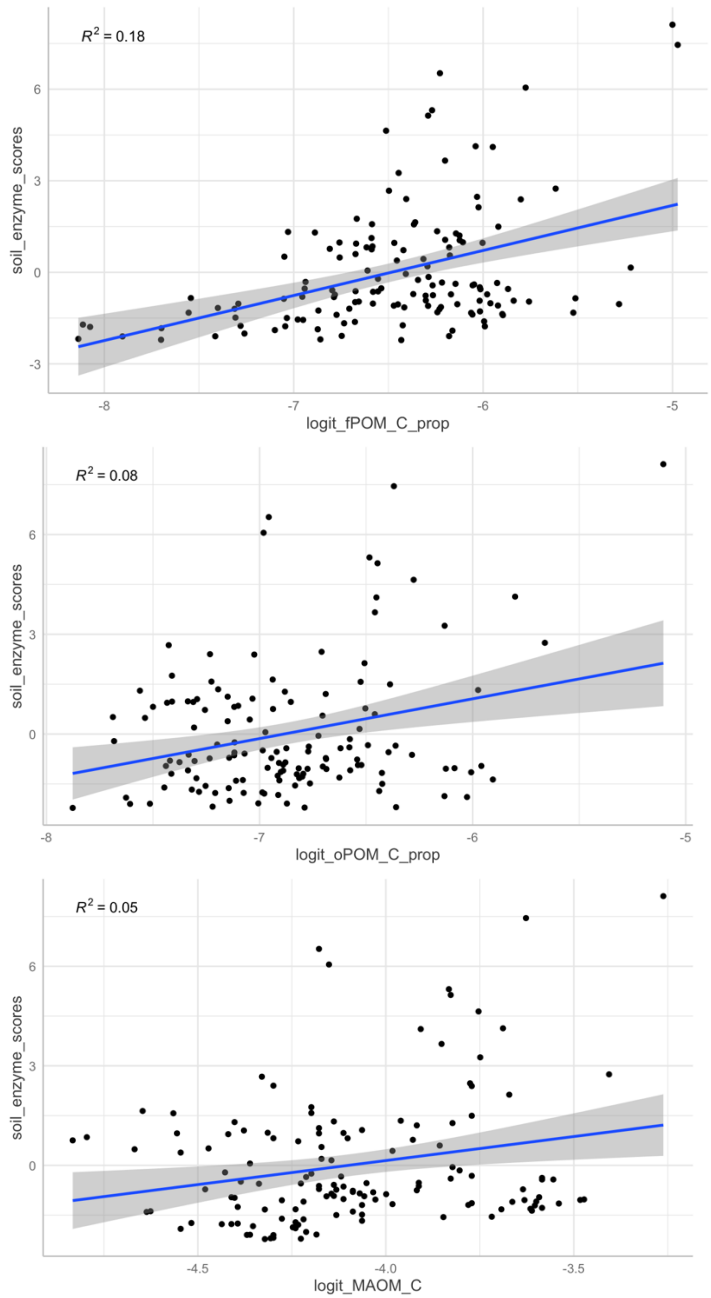


Figure S3: Bivariate relationships between fraction variables and soil enzyme scores (PC1 - Hydrolytic enzymes PHO, BG, NAG have largest contributions). Positive correlation is clearest for fPOM, while oPOM and MAOM are less clear.

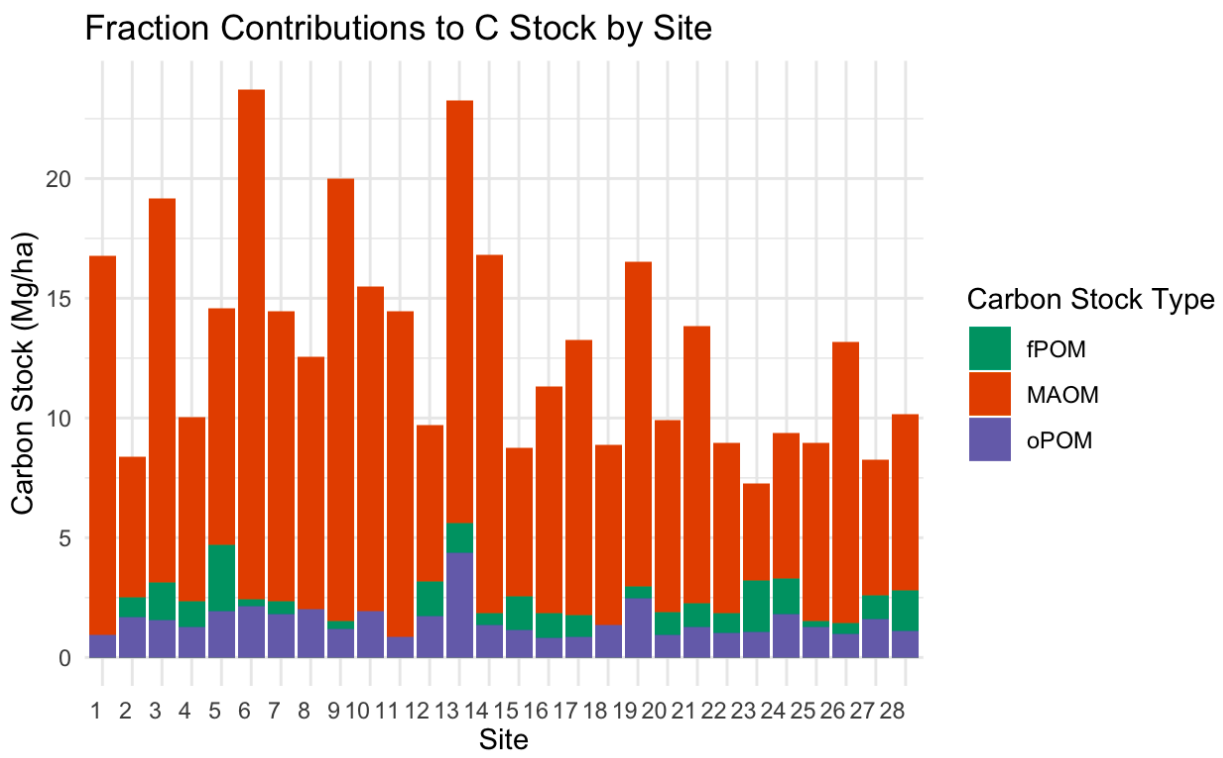


Figure S4: Fraction Contributions to C Stocks by site. Relative contributions of fPOM, oPOM, and MAOM to total carbon stock, estimated to 10 cm depth across one hectare.

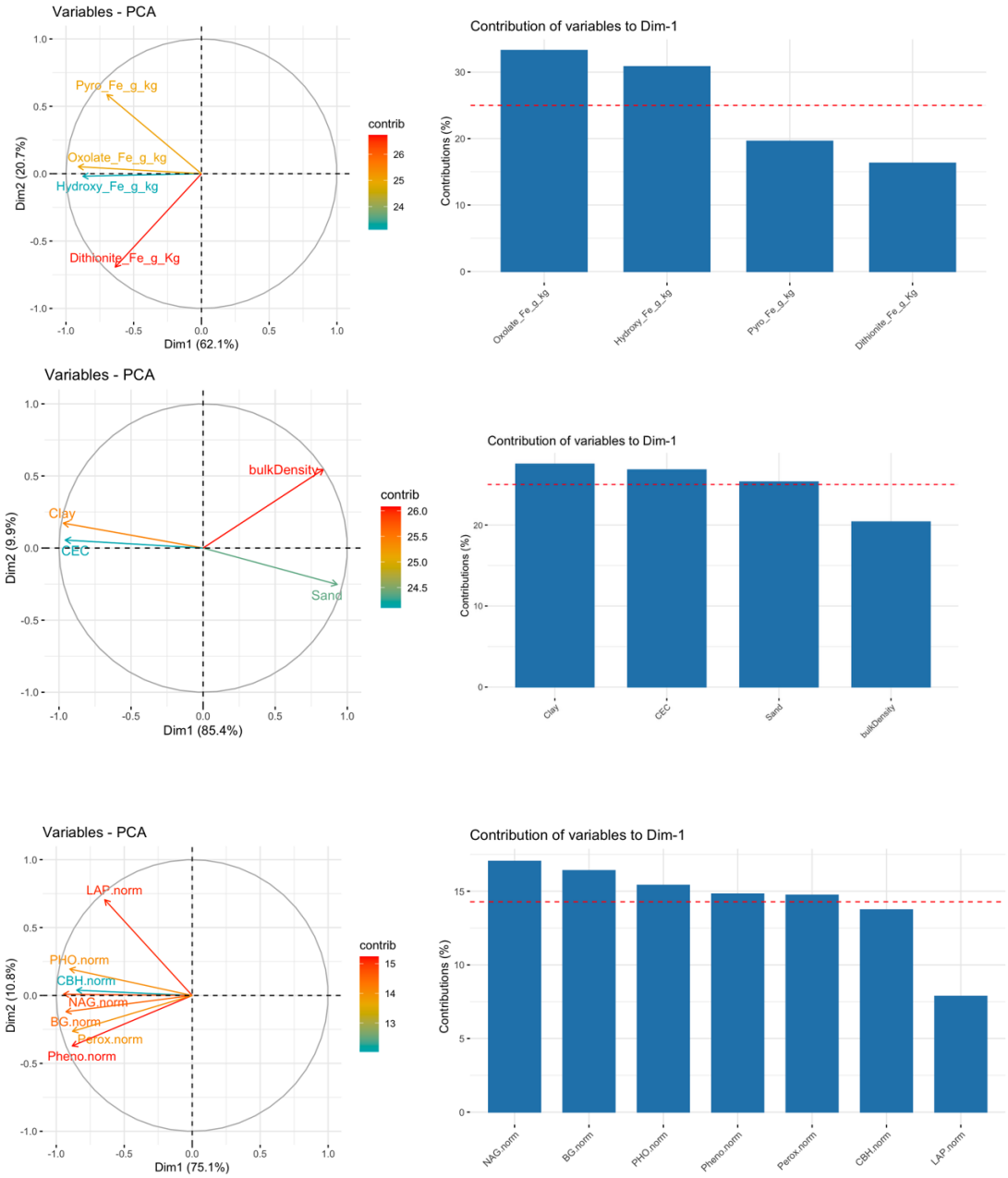


Figure S5: Principal component axes utilized for mixed models. Physical, Iron, and Extracellular Enzyme variable reduction.

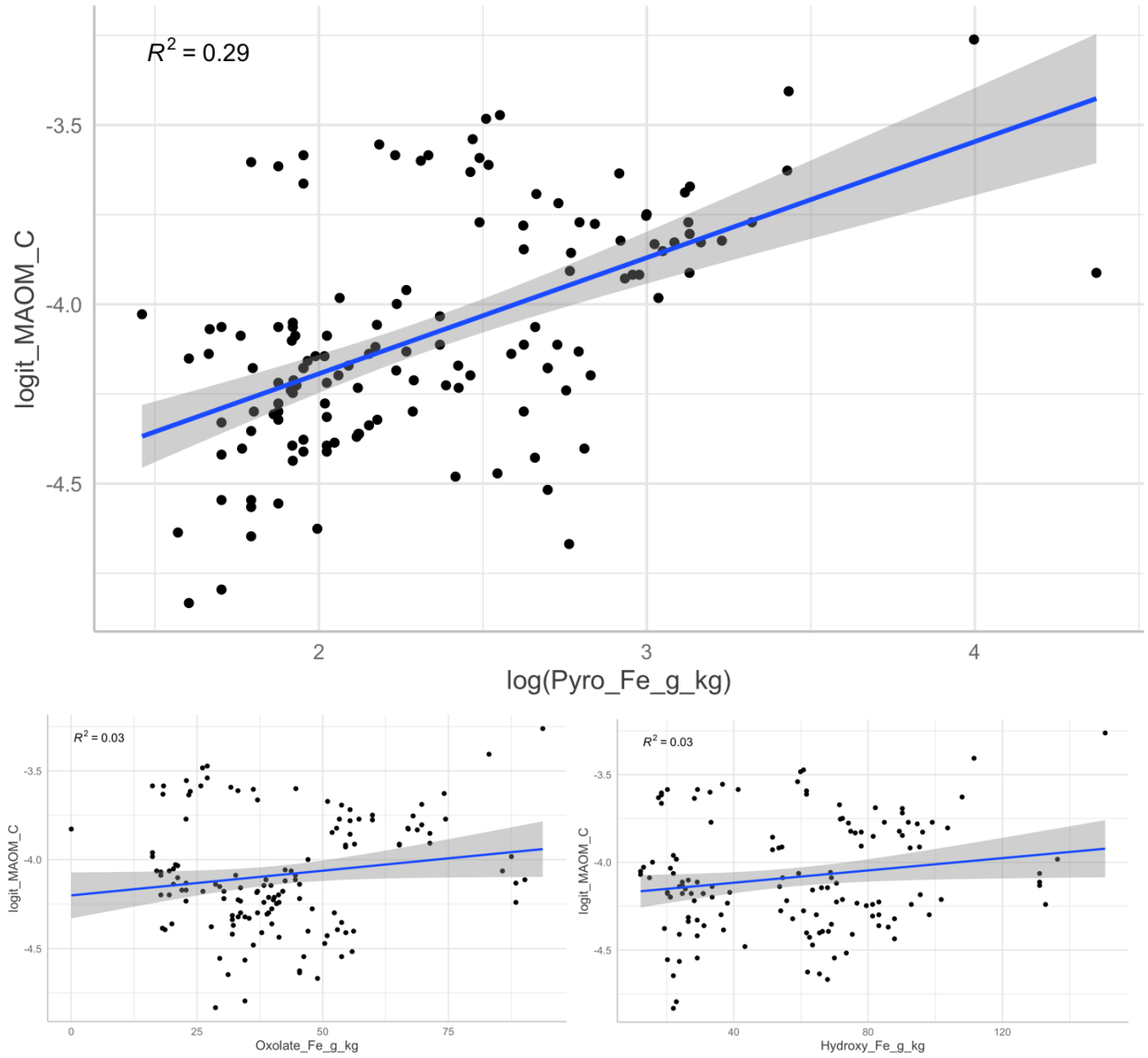


Figure S6: Soil Iron Fractions and MAOM C% (logit transformed). Pyrophosphate is log transformed to better display relationships given a larger spread of values.

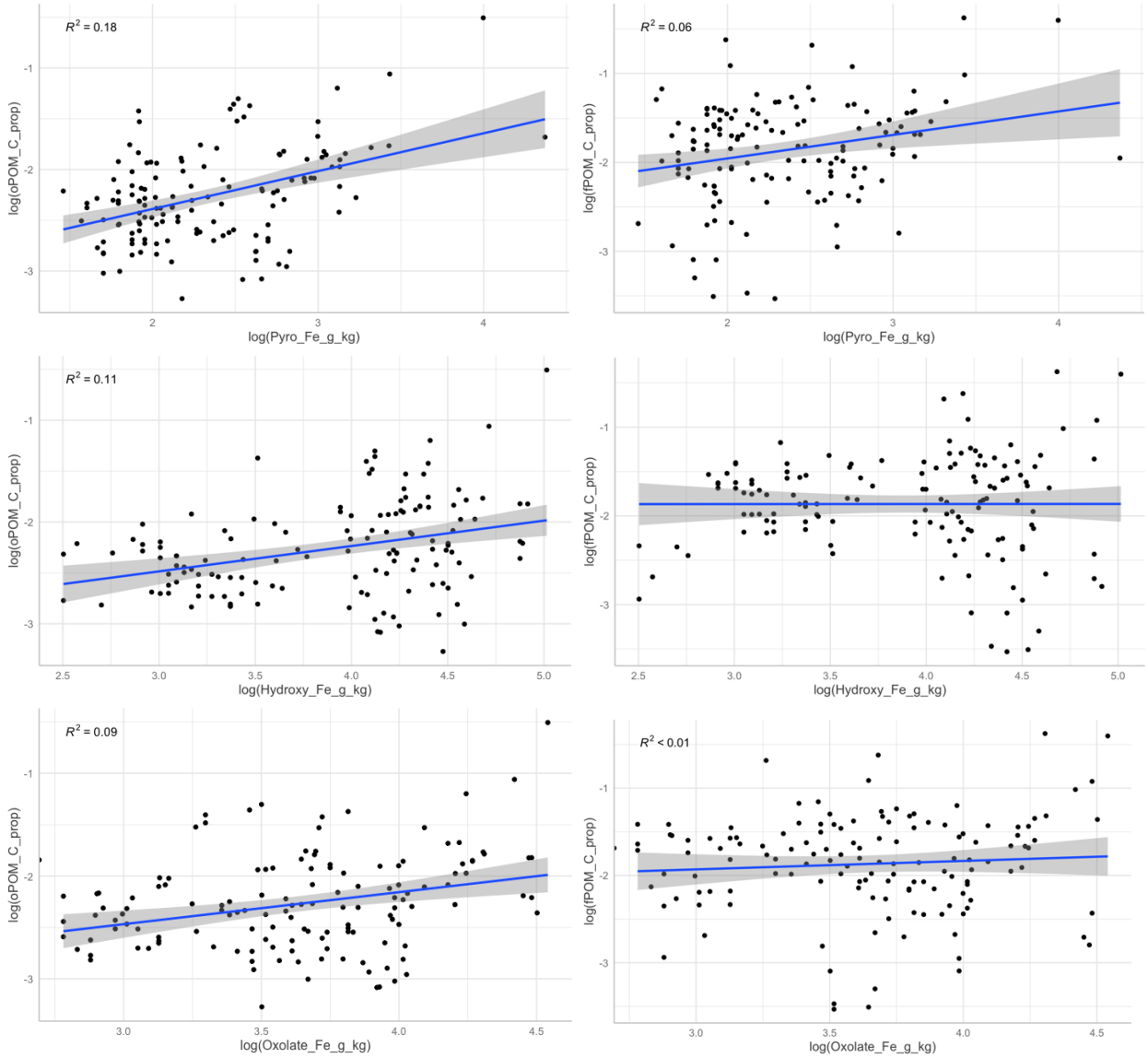


Figure S7: oPOM (left) and fPOM (right) plotted against three iron fractions

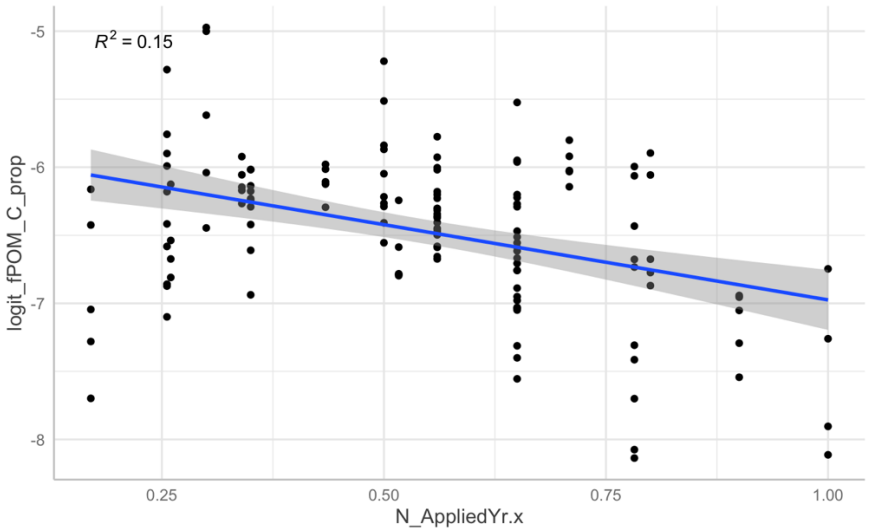


Figure S8: fPOM decreasing with increased nitrogen input

S3 Supplemental Tables

Site ID	Series	Sand (%)	Clay (%)	Silt (%)	CEC (Meq 100 g^{-1})	pH	Dominant Order
1	Sorrento	6.4	50.4	43.2	32.6	7.44	Mollisols
2	Salinas	40.8	32.8	26.4	27.3	7.52	Mollisols
3	Riverwash	37.6	25.4	37	20.38	7.74	Mollisols
4	Sorrento	30.4	23.2	46.4	23.36	8.24	Mollisols
5	Sorrento	20.4	48	31.6	43.52	7.8	Mollisols
6	Chualar	55.2	17	27.8	11.06	7.82	Mollisols
7	Chualar	72.4	6.4	21.2	12.06	7.68	Mollisols
8	Sorrento	18.4	47.4	34.2	36.64	7.44	Mollisols
9	Arnold	34.6	26.4	39	21.08	6.98	Entisols
10	Pinto	48	17.8	34.2	14.7	7.32	Mollisols
11	Danville	45.8	24.6	29.6	24.12	6.72	Mollisols
12	Tierra-Watsonville	38.6	30.4	31	26.82	7.52	Alfisols
13	Clear Lake	13.8	59.6	26.6	43.04	6.96	Vertisols
14	Chualar	56.2	13	30.8	10.2	7.7	Mollisols
15	Corducci-Typic Xerofluvents	51	15.2	33.8	13.24	7.72	Entisols
16	Watsonville	42.2	27.4	30.4	19.04	7.54	Mollisols
17	Pacheco	28.8	41.2	30	28.78	7.86	Mollisols
18	Conejo	46	22	32	19.5	7.1	Mollisols
19	Chualar	65.8	12.8	21.4	8.34	8.06	Mollisols
20	Placentia	44.8	21.4	33.8	16.1	7.42	Alfisols
21	Pinto	51.6	20.2	28.2	11.28	6.54	Mollisols
22	Mocho	17.2	35.8	47	25.2	8.26	Mollisols
23	Gloria	42.2	17	40.8	12.44	7.34	Alfisols
24	Placentia	45.2	20	34.8	15.02	7.08	Alfisols
25	Sorrento	18.6	39	42.4	25	8.06	Mollisols
26	Elder	57.4	11.8	30.8	11.84	6.68	Mollisols
27	San Andreas-Santa Ynez	59.8	10.6	29.6	8.44	7.7	Mollisols
28	Hanford	75.4	6	18.6	8.1	7.8	Entisols

Table S1: Site-level texture, CEC, pH, order and series data from lab analysis and SSURGO

Variable	Min	Median	Mean	Max
Clay (%)	5	23	26	60
Sand (%)	5	43	42	77
Silt (%)	18	32	33	49
CEC (meq $100g^{-1}$)	7.4	18.8	20.3	52.1
pH	6.4	7.5	7.5	8.4
BD (g cm^{-3})	0.88	1.34	1.33	1.60
TC (%)	0.74	1.39	1.50	3.95
Surface C Stock (Mg ha^{-1})	23.27	29.26	33.30	67.69
SOM (%)	1	2.15	2.36	6.8
MAOM C%	0.79	1.57	1.73	3.69
fPOM C%	5.73	29.59	29.53	43.60
oPOM C%	0.08	0.29	0.87	10.49

Table S2: Summary statistics across 28 field sites for surface soil (0-15 cm) texture, pH, and carbon values.

	MAOM C (%)		free POM C (% total C)		oPOM C (% total C)	Carbon Stock (0-15cm)
Model Name	MAOM1	MAOM 2	fPOM1	fPOM2	oPOM	Bulk
Intercept	-4.08 ± 0.05 (1.17e-10)	-4.08 ± 0.05 (1.49e-11)	-6.48 ± 0.079 (1.19e-06)	-6.475 ± 0.067 (<2e-16)	-6.87 ± 0.063 (6.08e-4)	1.058 ± 0.0033 (5.48e-11)
Management						
Continuous coverage	0.20 ± 0.199 (0.106)	**0.22 ± 0.12 (0.07)**	0.18 ± 0.19 (0.37)		0.14 ± 0.15 (0.38)	0.015 ± 0.0076 (0.068)
5 yr cover proportion				**0.46 ± 0.18 (0.017)**		
Reduced disturbance	**0.21 ± 0.117 (0.09)**	**0.21 ± 0.11 (0.07)**	0.033 ± 0.17 (0.84)		0.10 ± 0.14 (0.47)	0.0005 ± 0.0072 (0.95)
Deep tillage frequency				**-0.40 ± 0.16 (0.022)**		
Crop diversity	0.11 ± 0.12 (0.37)	0.11 ± 0.12 (0.37)	**0.34 ± 0.19 (0.083)**	0.05 ± 1.84 (0.79)	**0.36 ± 0.15 (0.024)**	0.0066 ± 0.077 (0.40)
Edaphic						
Iron	**0.13 ± 0.05 (0.02)**	**0.10 ± 0.06 (0.07)**	**0.33 ± 0.16 (0.045)**	0.23 ± 0.15 (0.13)	**0.40 ± 0.11 (0.001)**	0.0061 ± 0.0043 (0.16)
pH	**-0.11 ± 0.061 (0.06)**	-0.07 ± 0.06 (0.21)	-0.009 ± 0.145 (0.95)	-0.014 ± 0.13 (0.92)	-0.062 ± 0.11 (0.57)	-0.0048 ± 0.0043 (0.27)
Soil physical (Clay → Sand)	**0.19 ± 0.11 (0.07)**	0.14 ± 0.11 (0.18)	0.29 ± 0.20 (0.17)	0.011 ± 0.098 (0.91)	0.11 ± 0.16 (0.49)	**-0.021 ± 0.0073 (0.0074)**
Enzymes		**0.10 ± 0.05 (0.04)**				

Table S3: Summary of mixed-effects models. Standardized coefficient estimates with standard error are reported with p-values in parentheses. Standardization was performed following Gelman (2008) and allows for better comparison of variable effect sizes. Bolded values indicate significance level p<0.1. Blank cells indicate that the variable was not included in a given model. MAOM C%, and fPOM and oPOM C_{prop} were logit transformed, and C-stock was log transformed. Bulk C Stock model is Box-Cox transformed, hence the different scale of coefficients

Variable	MAOM C (%)		free POM C (% total C)		oPOM C (% total C)	Carbon Stock (0-15 cm)
Model	MAOM1	MAOM 2	fPOM1	fPOM2	oPOM	Bulk
Intercept	-3.23 ± 0.46 (1.17e-10)	-3.501 ± 0.47 (1.49e-11)	-6.476 ± 0.079 (1.19e-06)	-6.475 ± 0.067 (<2e-16)	-6.87 ± 0.064 (6.08e-4)	1.97 ± 0.47 (5.48e-11)
Continuous Coverage	0.103 ± 0.061 (0.105)	**0.11 ± 0.06 (0.073)**	0.087 ± 0.095 (0.37)		0.067 ± 0.075 (0.38)	0.0073 ± 0.0038 (0.068)
5 yr Cover Proportion				**0.23 ± 0.09 (0.017)**		
Reduced Disturbance	**0.103 ± 0.057 (0.085)**	**0.11 ± 0.056 (0.068)**	0.017 ± 0.087 (0.85)		0.051 ± 0.069 (0.47)	0.0002 ± 0.036 (0.95)
Deep Tillage Frequency				**-0.20 ± 0.08 (0.022)**		
C amendment	0.017 ± 0.064 (0.80)	0.022 ± 0.062 (0.72)	-0.13 ± 0.1 (0.21)	-0.039 ± 0.087 (0.66)	-0.095 ± 0.079 (0.24)	0.0009 ± 0.0040 (0.82)
Crop Diversity	0.057 ± 0.061 (0.37)	0.055 ± 0.060 (0.37)	**0.17 ± 0.094 (0.083)**	0.025 ± 0.092 (0.79)	**0.18 ± 0.074 (0.024)**	0.0033 ± 0.0038 (0.40)
Iron	**0.04 ± 0.029 (0.023)**	**0.032 ± 0.017 (0.068)**	**0.16 ±0.08 (0.045)**	0.12 ± 0.076 (0.13)	**0.20 ± 0.059 (0.001)**	0.0030 ± 0.0021 (0.16)
pH	**-0.11 ± 0.061 (0.064)**	-0.078 ± 0.062 (0.21)	-0.004 ±0.072 (0.95)	-0.007 ± 0.064 (0.92)	-0.031 ± 0.053 (0.57)	-0.0024 ± 0.0022 (0.27)
Soil Physical (Clay < Sand)	**0.053 ± 0.029 (0.073)**	0.039 ± 0.029 (0.18)	0.14 ± 0.102 (0.17)	0.011 ± 0.098 (0.91)	0.05 ± 0.078 (0.49)	-0.010 ± 0.0036 (0.0074)
Enzymes		**0.025 ± 0.012 (0.042)**				

Table S4: Summary of mixed-effects models. Unstandardized coefficient estimates with standard error are reported with p-values in parentheses. Bolded values are significant at p-values <0.1. Empty cells indicate that the variable was not included in a given model. MAOM C%, and fPOM and oPOM C_{prop} were logit transformed, and C-stock was log transformed. Bulk C Stock model is Box-Cox transformed, hence the different scale of coefficients

	MAOM C (%)		free POM C (% total C)		oPOM C (% total C)	Stock C
Model name	MAOM1	MAOM 2	fPOM1	fPOM2	oPOM	Bulk
Edaphic/Bio Variables*	0.060 (0.00 - 0.38)	0.081 (0.00 - 0.41)	0.039 (0.00 - 0.31)	0.030 (0.00 - 0.29)	0.12 (0.00 - 0.40)	0.25 (0.11 - 0.52)
Management Variables	0.19 (0.06 - 0.48)	0.20 (0.05 - 0.50)	0.12 (0.04 - 0.38)	0.25 (0.13 - 0.47)	0.17 (0.05- 0.44)	0.12 (0.00 - 0.41)
Full Model	0.30 (0.17 - 0.57)	0.32 (0.18 - 0.60)	0.18 (0.1 - 0.43)	0.31 (0.19 - 0.52)	0.29 (0.19 - 0.54)	0.34 (0.19 - 0.60)

Table S5: Marginal R^2 values for edaphic variable groupings (Physical PC1 – texture, CEC, pH) and management variables (continuous cover, reduced disturbance, C input, crop diversity Z scores) with confidence intervals from bootstrapping. R^2 values and confidence intervals obtained using 'partR2' package in R. CIs estimated via parametric bootstrapping with 1000 iterations.

*For all models, this includes the soil physical PC1 (soil texture, CEC), soil iron PC1, and pH. For model MAOM2 this also includes enzyme activity PC1.

	MAOM			**fPOM**			**oPOM**		
Test	1	2	3	1	2	3	1	2	3
Intercept	-4.08 ± 0.05	-4.085 ± 0.049	-4.08 ± 0.050	-7.59081 ± 0.27848	-7.41 ± 0.324	-7.39 ± 0.99	-6.87 ± 0.06	-6.45 ± 0.83	-6.87 ± 0.06
Continuous Coverage	*0.12 ± 0.06*	*0.11 ± 0.054*	0.12 ± 0.054	Not Included	Not included	Not included	0.11 ± 0.07	0.08 ± 0.07	0.11 ± 0.07
Reduced Disturbance	*0.1 ± 0.057*	*0.10 ± 0.052*	0.11 ± 0.05	Not Included	Not included	Not included	0.06 ±0.07	REMOVED	REMOVED
C amendment	0.039 ± 0.0.06	REMOVED	REMOVED	REMOVED	-0.037 ± 0.085	-0.025 ± 0.07	REMOVED	-0.097 ± 0.07	REMOVED
Crop Diversity	0.04 ± 0.06	0.2529	REMOVED	-0.0087 ± 0.074	0.024 ± 0.09	REMOVED	0.14 ± 0.06	0.19 ± 0.07	0.14 ± 0.06
5 yr Cover Proportion	Not included	Not included	Not included	1.724 ± 0.469	1.40 ± 0.54	1.479 ± 0.42	Not included	Not included	Not included
Deep Tillage Frequency	Not included	Not included	Not included	-0.495 ± 0.172	-0.48 ± 0.19	-0.51 ± 0.16	Not included	Not included	Not included
Iron	0.35 ± 0.017	*0.030 ± 0.17*	*0.029 ± 0.017*	REMOVED	0.07 ± 0.05	*0.069 ± 0.038*	0.12 ± 0.03	0.12 ± 0.03	0.11 ± 0.03
pH	REMOVED	REMOVED	REMOVED	REMOVED	REMOVED	-0.009 ± 0.13	REMOVED	-0.05 ± 0.11	REMOVED
Soil Physical	0.05175 ± 0.03	0.036 ± 0.028	0.035 ± 0.028	-0.040 ± 0.0412	0.007 ±0.05	REMOVED	0.022 ± 0.04	REMOVED	0.01 ± 0.04
Enzymes	Not included	0.030 ±0.012	REMOVED	Not Included	Not included	Not included	Not included	Not included	Not included

Table S6: Model sensitivity tests removing variables to ensure stable outcomes. Bolded values are significant at $p<0.05$ and italicized values represent $p<0.1$

Disturbance tercile	Mean Disturbance_Z	0–15 cm (Mg C/ha)	15–30 cm (Mg C/ha)	30–60 cm (Mg C/ha)	Total 0–60 cm (Mg C/ha)	n sites
1 (most disturbed)	−1.15	29.02	23.27	32.63	84.91	10
2 (mid)	0.12	30.00	26.02	49.19	105.21	10
3 (least disturbed)	1.05	28.74	25.80	41.19	95.73	10

Table S7: Bulk carbon stock by depth across the disturbance gradient. Sites divided into terciles of standardized disturbance score (Disturbance_Z; higher values indicate less disturbance). Values are mean bulk (unfractionated) carbon stock at each depth increment, measured on harvest-season samples.

Disturbance tercile	Mean Disturbance_Z	Mean soil iron score	Mean soil physical score	Mean pH	n sites
1 (most disturbed)	−1.15	−0.30	0.72	7.54	10
2 (mid)	0.12	1.08	−1.10	7.34	10
3 (least disturbed)	1.05	−0.84	0.43	7.63	10

Table S8: Edaphic characteristics across the disturbance gradient. Reported to allow assessment of whether edaphic conditions, particularly soil iron (independently associated with higher carbon; main text §3.2, §4.2), confound the depth-carbon pattern in Table S7. Note that tercile 1 has higher iron than tercile 3, which would predict more, not less, carbon at tercile 1 if edaphic conditions were driving the pattern in Table S7.

Depth	Predictor	Estimate	SE	df	t	p
0–15 cm	(Intercept)	**3.896**	**0.472**	**95.0**	**8.258**	**<0.001**
	soil_iron_scores	**0.039**	**0.019**	**126.8**	**2.094**	**0.038**
	soil_phys_scores	**−0.064**	**0.026**	**38.2**	**−2.460**	**0.019**
	pH	−0.075	0.063	96.1	−1.194	0.235
	CoverCrop_Z_rem	*0.093*	*0.051*	*23.2*	*1.816*	*0.082*
	Disturbance_Z	0.009	0.047	21.0	0.194	0.848
	CropDiv_Z	0.044	0.051	21.5	0.873	0.392
	Cinput_Z	0.006	0.053	22.9	0.103	0.919
15–30 cm	(Intercept)	**3.473**	**0.519**	**71.2**	**6.687**	**<0.001**
	soil_iron_scores	0.020	0.021	112.0	0.939	0.350
	soil_phys_scores	**−0.111**	**0.027**	**35.2**	**−4.171**	**<0.001**
	pH	−0.041	0.069	71.8	−0.600	0.550
	CoverCrop_Z_rem	0.076	0.050	23.8	1.522	0.141
	Disturbance_Z	0.037	0.045	21.5	0.824	0.419
	CropDiv_Z	0.044	0.049	22.1	0.903	0.376
	Cinput_Z	−0.016	0.051	23.8	−0.304	0.764
30–60 cm	(Intercept)	**3.908**	**0.794**	**44.7**	**4.923**	**<0.001**
	soil_iron_scores	**0.085**	**0.036**	**73.5**	**2.391**	**0.019**
	soil_phys_scores	**−0.120**	**0.037**	**31.3**	**−3.227**	**0.003**
	pH	−0.042	0.106	44.8	−0.396	0.694
	CoverCrop_Z_rem	0.006	0.065	23.4	0.092	0.927
	Disturbance_Z	**0.138**	**0.058**	**21.3**	**2.380**	**0.027**
	CropDiv_Z	−0.006	0.063	22.0	−0.102	0.919
	Cinput_Z	0.073	0.068	23.5	1.073	0.294

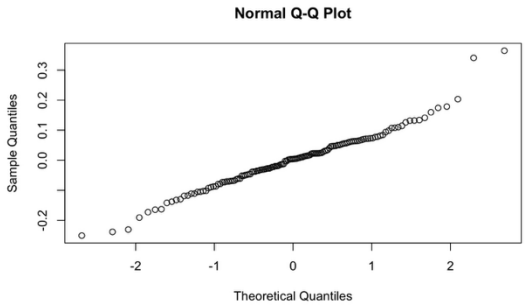
Table S9: Mixed-effects model summaries for bulk carbon stock at each depth increment.
Response variable: log(carbon stock, Mg C/ha) at the indicated depth. Site included as a random intercept in all models. Bolded rows indicate $p < 0.05$, and italics indicate <0.1.

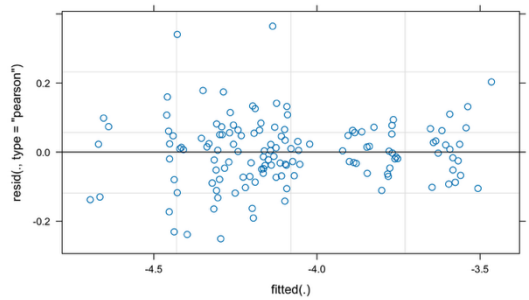
Gradient	Tercile	Mean Z-score	Mean bulk density (g cm^{-3})	n sites
Continuous cover	1 (lowest cover)	−1.10	1.334	10
	2 (mid)	0.09	1.310	10
	3 (highest cover)	1.01	1.357	10
Disturbance	1 (most disturbed)	−1.15	1.396	10
	2 (mid)	0.12	1.285	10
	3 (least disturbed)	1.05	1.319	10

Table S10: Surface (0–15 cm) bulk density across continuous-cover and disturbance terciles. Sites divided into terciles of standardized continuous-cover (CoverCrop_Z_rem) and disturbance (Disturbance_Z) scores; higher values indicate more continuous cover or less disturbance, respectively. Bulk density was measured directly at 0–15 cm (§2.2.2). Neither gradient shows a consistent directional trend in bulk density across terciles, and the range within each gradient (0.05–0.11 g cm^{-3}) is small relative to the full dataset range (0.88–1.60 g cm^{-3}; Table S2).

S4 Model Fit Checks

MAOM Model 1



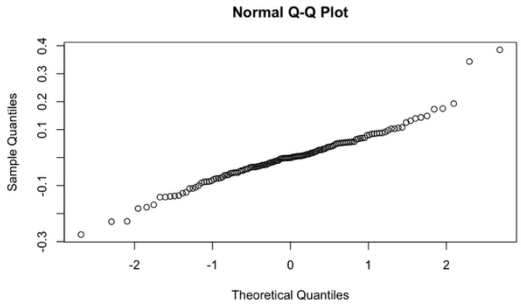


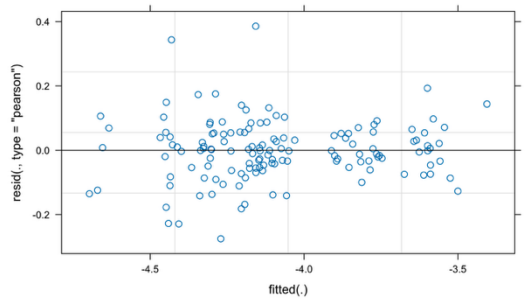
VIF:

soil_phys_scores	soil_iron_scores	pH	CoverCrop_Z_rem	Disturbance_Z
1.360383	1.194374	1.063132	1.338636	1.162723

CropDiv_Z	Cinput_Z
1.338195	1.450155

MAOM Model 2



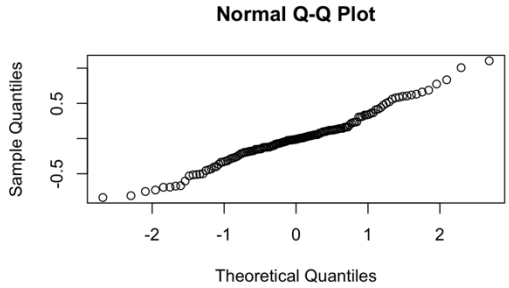


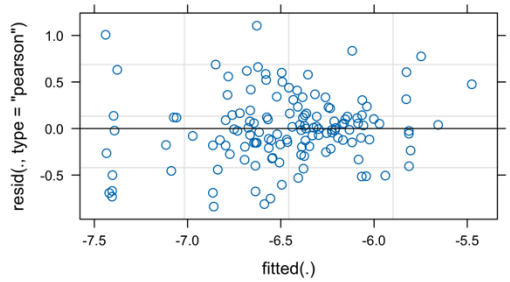
VIF:

soil_phys_scores	soil_iron_scores	soil_enzyme_scores	pH
1.434775	1.252872	1.160380	1.152377

CoverCrop_Z_rem	Disturbance_Z	CropDiv_Z	Cinput_Z
1.348097	1.165278	1.339506	1.455429

fPOM Model 1



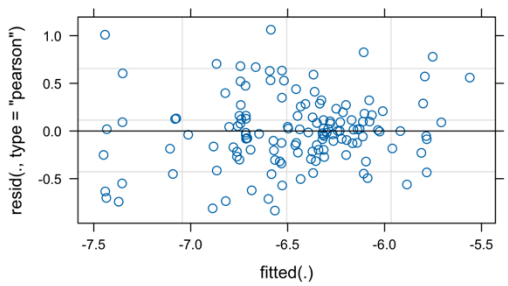


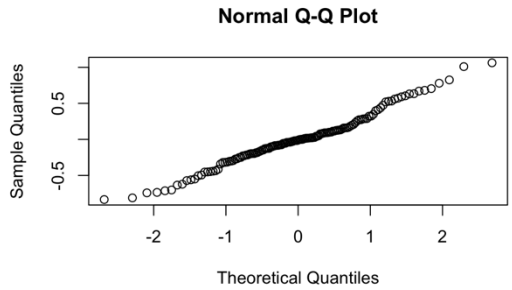
VIF:

Soil_phys_scores	soil_iron_scores	pH	CoverCrop_Z_rem	Disturbance_Z
1.732324	1.493375	1.116042	1.478738	1.189019

CropDiv_Z	Cinput_Z
1.395103	1.598201

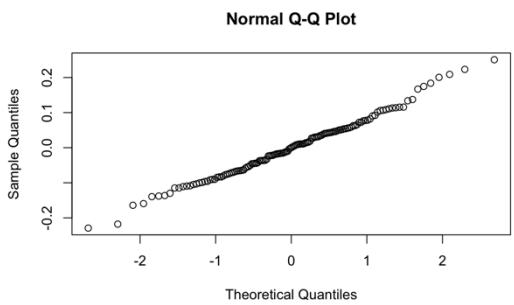
fPOM Model 2

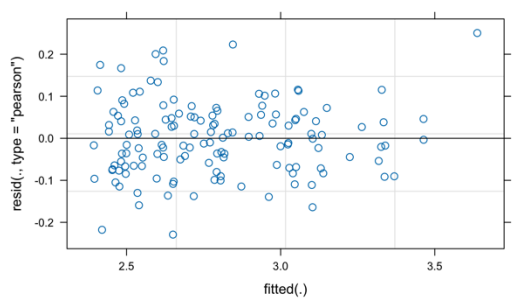




VIF:
soil_phys_scores soil_iron_scores pH Prop5yr DeepTillageFreq
2.222199 1.681237 1.115935 1.824689 1.397168 CropDiv_Z Cinput_Z
1.868738 1.679382

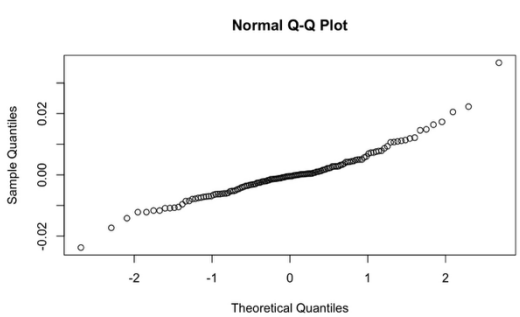
oPOM Model

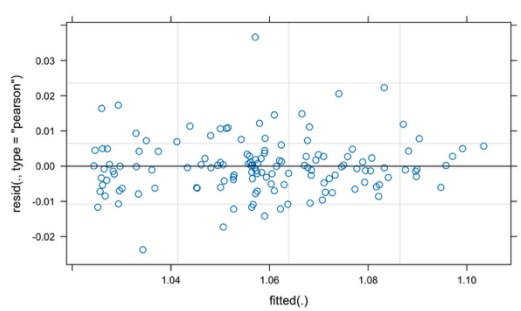




VIF:
soil_phys_scores soil_iron_scores pH Prop5yr Disturbance_Z
1.830358 1.295353 1.052876 1.596217 1.232987
CropDiv_Z Cinput_Z
1.396249 1.326742

C stock (bulk) Model





soil_phys_scores soil_iron_scores pH CoverCrop_Z_rem CropDiv_Z
1.449288 1.246023 1.068774 1.379489 1.353208
Disturbance_Z Cinput_Z
1.172728 1.488132

Carbon Stock model results with standard management z-scores:

log(C_fraction_stock) ~ soil_phys_scores + soil_iron_scores + pH
+ CoverCrop_Z_rem + Disturbance_Z + CropDiv_Z + Cinput_Z
+ (1 | Site)

	Est.	S.E.	t val.	d.f.	p
(Intercept)	3.41	0.39	8.81	103.69	3.14e-14
soil_phys_scores	-0.05	0.02	-2.33	40.58	0.03
soil_iron_scores	0.07	0.02	4.95	129.00	2.29e-06
pH	-0.08	0.05	-1.61	105.06	0.11
CoverCrop_Z_rem	0.05	0.04	1.03	23.54	0.31
Disturbance_Z	0.04	0.04	0.88	21.41	0.39
CropDiv_Z	0.06	0.04	1.44	21.77	0.16
Cinput_Z	-0.03	0.05	-0.71	23.22	0.49

fPOM RF Variable Importance (root MSE of predicted versus permuted):

fPOM_C_stock	fPOM_N_stock	soil_enzyme_scores
0.195	0.171	0.095
poxC	N_AvailabilityMax	N_AvailabilityAverage
0.092	0.090	0.086
ProportionCovercroppedOperation	CBH	Prop5yr
0.084	0.078	0.078
N_AvailabilityMin	N_fraction_stock	Prop_Cover2017
0.076	0.075	0.075
soil_nitrogen_scores	N_AppliedYr	Pres_AbsJan2018
0.072	0.071	0.067
DeepTillageFreq		
0.063		

oPOM model with specific managemennt variables:

logit_oPOM_C_prop ~ soil_phys_scores + soil_iron_scores + Prop5yr +
TillageDepth + CropDiv_Z + Cinput_Z + (1 | Site)

FIXED EFFECTS:

	Est.	*S.E.*	*t val.*	*d.f.*	*p*
(Intercept)	*-6.90*	*0.31*	*-22.24*	*25.70*	*4.21e-10*
soil_phys_scores	*0.01*	*0.04*	*0.34*	*36.02*	*0.73*
soil_iron_scores	*0.13*	*0.04*	*3.60*	*104.53*	*0.000678*
Prop5yr	*0.40*	*0.46*	*0.86*	*25.64*	*0.40*
TillageDepth	*0.32*	*0.29*	*1.10*	*22.05*	*0.28*
CropDiv_Z	*0.16*	*0.08*	*2.07*	*22.20*	*0.05*
Cinput_Z	*-0.10*	*0.07*	*-1.47*	*23.63*	*0.15*

Bulk C model w/ Prop5yr:

FIXED EFFECTS:

	Est.	S.E.	t val.	d.f.	p
(Intercept)	1.0580	0.0030	358.0558	21.5634	0.0000
soil_phys_scores	-0.0281	0.0075	-3.7329	46.2097	0.0005

soil_iron_scores	0.0047	0.0042	1.1133	128.6745	0.2676
pH	-0.0053	0.0041	-1.2935	92.6334	0.1990
Prop5yr	0.0242	0.0075	3.2469	27.3039	0.0031
CropDiv_Z	0.0033	0.0070	0.4653	22.7899	0.6461
Disturbance_Z	-0.0053	0.0066	-0.8017	23.3423	0.4308
Cinput_Z	0.0005	0.0068	0.0788	23.6054	0.9379

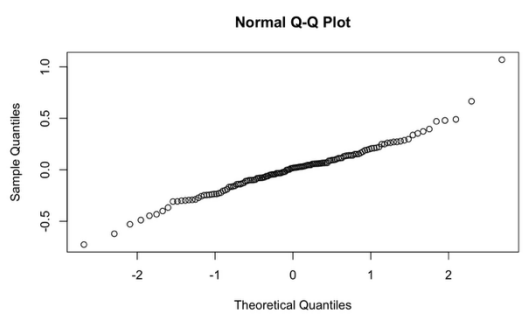
---

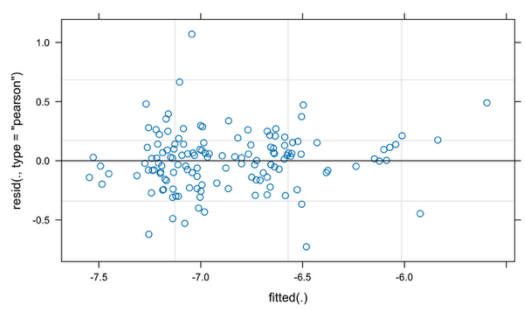
oPOM Model with N-input

logit_oPOM_C_prop ~ soil_phys_scores + soil_iron_scores + lm_df$N_AppliedYr.x + CoverCrop_Z_rem + Disturbance_Z + CropDiv_Z + Cinput_Z + (1 | Site)

FIXED EFFECTS:

	Est.	S.E.	t val.	d.f.	p
(Intercept)	-6.75	0.31	-21.87	20.89	0.00
soil_phys_scores	0.03	0.04	0.61	33.52	0.54
soil_iron_scores	0.12	0.04	3.42	100.92	0.00
N_AppliedYr	-0.21	0.56	-0.38	20.95	0.71
CoverCrop_Z_rem	0.06	0.09	0.62	21.12	0.54
Disturbance_Z	0.04	0.07	0.56	20.83	0.58
CropDiv_Z	0.16	0.09	1.75	21.47	0.09
Cinput_Z	-0.06	0.10	-0.67	23.12	0.51



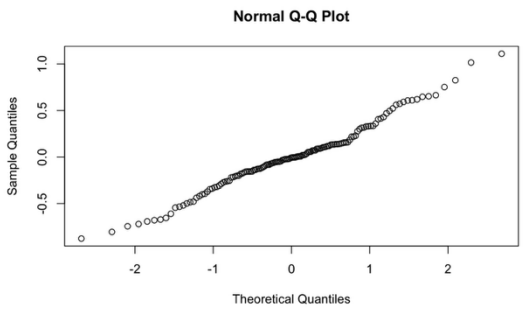


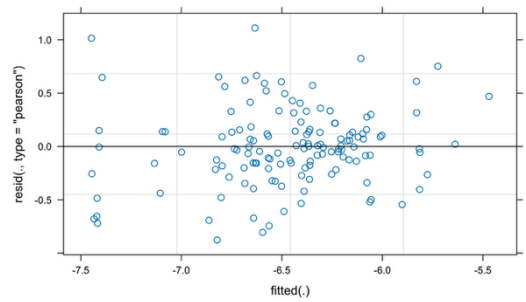
fPOM Model with N-input

logit_fPOM_C_prop ~ soil_phys_scores + soil_iron_scores + N_AppliedYr.x + CoverCrop_Z_rem + Disturbance_Z + CropDiv_Z + Cinput_Z + (1 | Site)

FIXED EFFECTS:

	Est.	S.E.	t val.	d.f.	p
(Intercept)	-6.14	0.39	-15.78	20.89	0.00
soil_phys_scores	0.07	0.06	1.26	31.77	0.22
soil_iron_scores	0.10	0.05	1.88	81.13	0.06
N_AppliedYr	-0.62	0.70	-0.89	20.96	0.38
CoverCrop_Z_rem	0.03	0.12	0.30	21.09	0.76
Disturbance_Z	-0.01	0.09	-0.10	20.72	0.93
CropDiv_Z	0.11	0.11	1.02	21.53	0.32
Cinput_Z	-0.07	0.12	-0.55	23.32	0.59



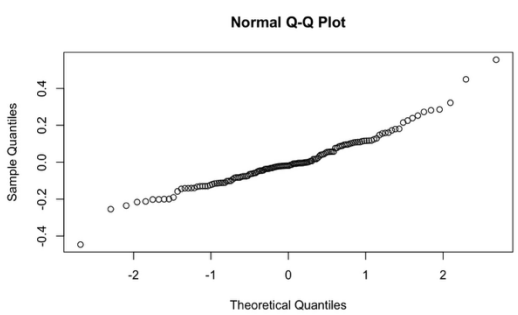


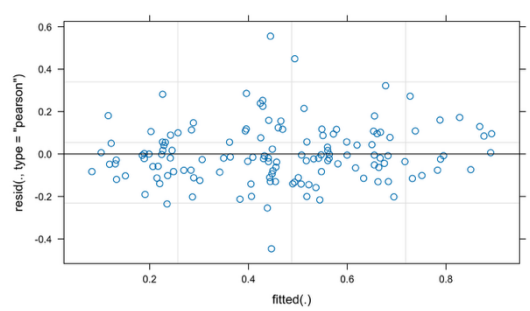
Yield Model showing Compost input as significant

standardized_yield ~ soil_phys_scores + soil_iron_scores + CoverCrop_Z_rem + Disturbance_Z + CropDiv_Z + Cinput_Z + (1 | Site)

FIXED EFFECTS:

	Est.	S.E.	t val.	d.f.	p
(Intercept)	0.46	0.03	13.52	21.70	4.82e-12
soil_phys_scores	0.01	0.02	0.37	34.17	0.71
soil_iron_scores	-0.05	0.02	-2.63	95.94	0.01004
CoverCrop_Z_rem	0.05	0.04	1.14	24.36	0.27
Disturbance_Z	-0.01	0.04	-0.28	21.95	0.78
CropDiv_Z	-0.10	0.04	-2.57	22.31	0.02
Cinput_Z	0.15	0.04	3.62	24.03	0.00138





oPOM and fPOM stock models:

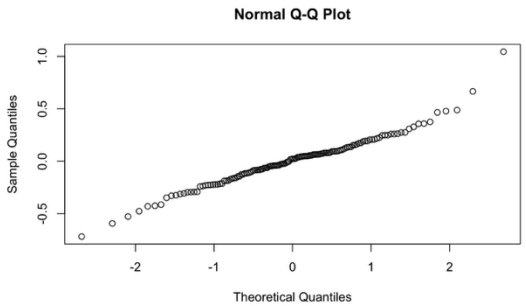
When we run the same model structures for fPOM and oPOM stocks rather than carbon proportion values, the results for oPOM differ slightly in that soil physical characteristics are significant. fPOM results remain unchanged in terms of which variables are significant. In the case of oPOM, we find that the oPOM stock increases slightly with sandier soils because they will have less carbon in the MAOM fraction, which dominates the overall carbon stock across all samples.

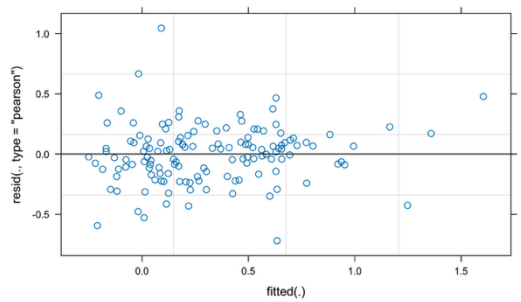
log(oPOM_C_stock) ~ soil_phys_scores + soil_iron_scores + pH + CoverCrop_Z_rem + Disturbance_Z + CropDiv_Z + Cinput_Z + (1 | Site)

FIXED EFFECTS:

	Est.	S.E.	t val.	d.f.	p
(Intercept)	0.55	0.82	0.67	55.66	0.51

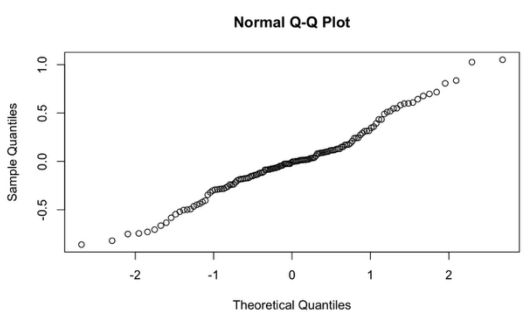
soil_phys_scores 0.09 0.04 2.13 31.94 0.04
soil_iron_scores 0.14 0.04 3.86 94.38 0.0002
pH -0.03 0.11 -0.28 56.00 0.78
CoverCrop_Z_rem 0.07 0.07 0.96 22.62 0.35
Disturbance_Z 0.04 0.07 0.56 20.42 0.58
CropDiv_Z 0.15 0.07 2.13 21.08 0.04
Cinput_Z -0.07 0.08 -0.95 22.63 0.35

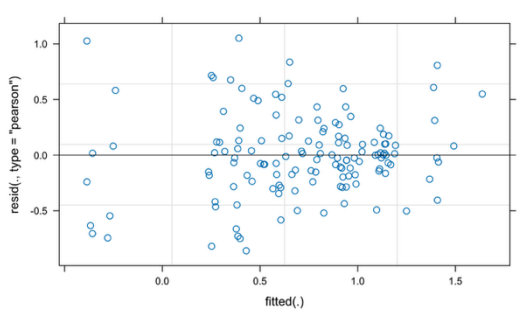




soil_phys_scores soil_iron_scores pH CoverCrop_Z_rem Disturbance_Z
1.667712 1.427696 1.102020 1.460060 1.186524
CropDiv_Z Cinput_Z
1.386764 1.575725
log(fPOM_C_stock) ~ soil_phys_scores + soil_iron_scores + pH +
Prop5yr + DeepTillageFreq + CropDiv_Z + Cinput_Z + (1 | Site)
<u>FIXED EFFECTS:</u>

	Est.	S.E.	t val.	d.f.	p
(Intercept)	-0.39	1.02	-0.38	35.68	0.71
soil_phys_scores	0.07	0.05	1.39	32.81	0.17
soil_iron_scores	0.09	0.05	1.84	70.27	0.07
pH	0.02	0.13	0.16	40.35	0.87
Prop5yr	1.42	0.52	2.75	24.65	0.01
DeepTillageFreq	-0.48	0.18	-2.61	20.83	0.02
CropDiv_Z	-0.01	0.09	-0.10	22.11	0.92
Cinput_Z	-0.01	0.08	-0.16	23.04	0.88





soil_phys_scores soil_iron_scores pH Prop5yr DeepTillageFreq
2.275531 1.730738 1.125883 1.844375 1.398467
CropDiv_Z Cinput_Z

S5 Survey Instrument

Barriers and Incentives for Diversified Practices - V4

Survey Flow

Standard: Introduction (8 Questions)
Standard: Soil amendments and fertilizers intro (1 Question)
Standard: Soil amendment and fertilizer open-ended loop (9 Questions)
Standard: Cover crops (11 Questions)
Standard: Crop rotation (8 Questions)
Standard: Tillage (11 Questions)
Standard: Irrigation (11 Questions)
Standard: Other Fields (2 Questions)
Standard: Compost Social Qs (8 Questions)
Standard: Cover cropping social Qs (7 Questions)
Standard: Crop rotation social qs (6 Questions)
Standard: Irrigation Social Qs (4 Questions)
Standard: Conclusions (8 Questions)

Page Break

Start of Block: Introduction

Q1 Dear Participant, Thank you for working with us. We are a team of researchers from the Department of Environmental Science, Policy, and Management at the University of California, Berkeley. We are studying farms growing lettuce in the Central Coast region. As you may recall, you have been in touch with Jennifer Thompson about the field sampling we are currently conducting. This soil science sampling will look at the diversity and number of microbes in your soil, the amount of soil carbon, the amount of water your soil can hold, and levels of various nutrients. **This questionnaire asks about practices that take place on the specific field we are sampling** so that we can learn how they impact the soil measurements we are taking, and share that information back with you. **Your study data will be handled confidentially.** If results of this study are published or presented, individual names and other personally identifiable information will not be used. Participation in research is completely voluntary. You may decline to participate or to withdraw at any point in this study. If you have any questions or concerns about this study, you may contact Tim Bowles, project team leader: timothy.bowles@berkeley.edu; 510-642-5277. Clicking the "Next" button indicates that you have read and understood the above information, and that **you agree to participate in this survey**.

Page Break

Q2

You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link. You can also use the 'back' arrow if you need to view or revise previous responses.

Q3 Name of farm operation?

_____

Q4 Which of the following best describes your role(s) in this operation?

- ☐ Farm owner/operator (3)
- ☐ Farm/ranch manager (2)
- ☐ Crop adviser (1)
- ☐ Other (4) _____

Display this question:

If Q4 = Farm owner/operator

Q5 As the owner of the farm, do you oversee the production decisions?

- ○ Yes (1)
- ○ No (2)

Page Break

Q6 We emailed you a map of the field where we will do soil sampling. We would like you to answer the following questions as they pertain to the field that is marked with a pin. Will you answer the questions based on the field that is marked with a pin?

- ○ Yes (4)
- ○ No (5)
- ○ I'm not sure which field this is (6)

Display this question:

If Q6 = I'm not sure which field this is

Q7 Please pause the survey and contact Jennifer Thompson (jbthompson@berkeley.edu) to discuss the field location. You can return to the survey later using the same URL link.

Page Break

Q8 How long has this field been in production under the management of your farm business?

- ○ Less than a year (1)
- ○ 1-5 years (2)
- ○ 5-10 years (3)
- ○ 11-15 years (4)
- ○ More than 15 years (5)
- ○ Not sure (6)

End of Block: Introduction

Start of Block: Soil amendments and fertilizers intro

Q9 **Soil Amendments and Fertilizer.**

The next set of questions ask about the soil amendments and fertilizers you use. You will be asked about these amendments or fertilizers one at a time, until you indicate that you have described all of your amendments and fertilizers. When answering these questions, **please consider all different types of amendments or fertilizers that you use**, including for example: plant-based compost, composted manure, chicken manure (pelletized), fertilizer blends, bone/blood/feather meal, seabird/bat guano, compost tea. We will use this information to assess the relationship between management techniques, soil health outcomes, and yields. Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

End of Block: Soil amendments and fertilizers intro

Start of Block: Soil amendment and fertilizer open-ended loop

Display this question:

If Loop all: Q10 != No

And Loop 1: , Not Current Loop

Q10 Do you have another soil amendment or fertilizer that you use in this field?

- ○ Yes (1)
- ○ No (2)

Page Break

Display this question:

If Loop all: Q10 != No

Q11 Please give the full product name of a soil amendment or fertilizer you use, if possible. *For example, "Nutri-Rich 4-3-2 Fertilizer Pellets."*

_____

Page Break

Display this question:

If Loop all: Q10 != No

Q12 Have you or will you use ${Q11/ChoiceTextEntryValue} in this field for the current lettuce crop (Fall 2019 - Summer 2020)?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not sure (4)

Skip To: End of Block If Q12 = No

Display this question:

If Loop all: Q10 != No

Q13 How much ${Q11/ChoiceTextEntryValue} per acre did you/will you apply to this field (fall 2019-summer 2020)? *Enter according to whichever units you normally use. You only need to enter one line.*

_____ tons/acre (1)
_____ pounds/acre (2)
_____ other units (for example, pounds-N/acre) (please specify units) (3)

Page Break

Display this question:

If Loop all: Q10 != No

Q14 How often do you apply ${Q11/ChoiceTextEntryValue} to this field?

- ○ Twice per year or more (2)
- ○ Once per year (1)
- ○ Every other year (3)
- ○ Every few years (4)
- ○ Every five years or less (5)
- ○ Never (6)

Page Break

Display this question:

If Loop all: Q10 != No

Q15 When did you (or will you) apply ${Q11/ChoiceTextEntryValue} to this field?

- ○ In the fall prior to this lettuce crop (1)
- ○ Weeks or days before planting this lettuce crop (2)
- ○ At planting or shortly after planting the lettuce crop (3)
- ○ Close to lettuce thinning or another time while lettuce is growing (4)
- ○ After lettuce harvest (5)
- ○ Other (please specify) (6) _____

Page Break

Display this question:

If Loop all: Q10 != No

Q16 How do you apply the ${Q11/ChoiceTextEntryValue} to this field?

- ☐ Banded application (1)
- ☐ Broadcast application (2)
- ☐ Incorporated into soil (3)
- ☐ Fertigation/ in irrigation water (4)
- ☐ Other (please specify) (5) _____

Page Break

Display this question:

If Loop all: Q10 != No

Q17 What source/brand do you use for ${Q11/ChoiceTextEntryValue}?

_____

Display this question:

If Loop all: Q10 != No

Q18 What is the N-P-K for this brand/source of ${Q11/ChoiceTextEntryValue}? *If you are unsure, please leave blank or give your best estimate.*

_____

Page Break

End of Block: Soil amendment and fertilizer open-ended loop

Start of Block: Cover crops

Q19
Cover Crops. The following questions ask about whether and how you use cover crops in the field we are sampling.

Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

Page Break

Q20 Does your farm operation practice cover cropping?

- ○ Yes, we currently practice cover cropping (3)
- ○ No, not currently, but we have practiced cover cropping in the past (2)
- ○ No, we have never practiced cover cropping (1)
- ○ Don't know (5)

Skip To: End of Block If Q20 = No, we have never practiced cover cropping
Skip To: End of Block If Q20 = No, not currently, but we have practiced cover cropping in the past

Q21 Have cover crops been planted in this field during the following years? In the write in, please describe what species were planted.

- ☐ 2019 (1) _____
- ☐ 2018 (2) _____
- ☐ 2017 (3) _____
- ☐ 2016 (4) _____
- ☐ Prior to 2016 (Please indicate if you have used cover crops in the years before 2016) (5) _____

Display this question:

If Q21 = 2019

Q22 When was the planting date for the winter cover crop in 2019/2020?

_____

Page Break

Q23 Will you plant a cover crop in this field next winter (2020/2021)?

- ○ Yes (1)
- ○ No (2)

Q24 Will you plant a summer cover crop this year (2020)?

- ○ Yes (1)
- ○ No (2)

Display this question:

If Q24 = Yes

Q25 When is the planting date for the summer cover crop?

_____

Display this question:

If Q23 = Yes

Or Q24 = Yes

Q26 What seed mix or species of cover crop do you plan to plant this summer (2020) or winter (2020/2021)?

_____

_____

_____

_____

_____

Q27 What is the seeding rate you use?

_____

Page Break

Q28 During which month do you typically incorporate the cover crop back into the soil (for the winter 2019/2020 cover crop)?

- ○ January (1)
- ○ February (2)
- ○ March (3)
- ○ April (4)
- ○ May (5)
- ○ June (6)
- ○ July (7)
- ○ August (8)
- ○ September (9)
- ○ October (10)
- ○ November (11)
- ○ December (12)

Display this question:

If Q20 = Yes, we currently practice cover cropping

Q29 How much of your lettuce field acreage is planted with a cover crop each season?

	0	10	20	30	40	50	60	70	80	90	100
Percent of lettuce acreage (%) ()											

End of Block: Cover crops

Start of Block: Crop rotation

Q30

Crop Rotation. The following questions ask about the history of crops planted in the field we are sampling. These questions refer to the planting history for this field over the past 5 years.

Please use records of your cropping plan history to answer these questions. If records are not available, please answer to your best recollection.

Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

Page Break

Q31 When (what date) was lettuce planted in this field during this season?

_____

Q32 Will you plant more than one lettuce crop in this field this season?

- ○ Yes (1)
- ○ No (3)

Page Break

Q33 Does your farm operation seasonally rotate other crops or land uses in between lettuce plantings?

- ○ Yes, we currently rotate other crops with our lettuce (3)
- ○ No, not currently, but we have rotated other crops with our lettuce in the past (2)
- ○ No, we do not rotate other crops with our lettuce (1)
- ○ We sublease to another operation that plants crops other than lettuce (4)
- ○ Not sure (5)

Display this question:

If Q33 = Yes, we currently rotate other crops with our lettuce

Or Q33 = We sublease to another operation that plants crops other than lettuce

Q34 How often would you say your farm operation/ or sublease operation rotates other crops in between your lettuce plantings?

- ○ We rotate other crops or land uses in between each lettuce planting (1)
- ○ We rotate other crops or land uses in between every two lettuce plantings (2)
- ○ We rotate other crops or land uses in between every three or more lettuce plantings (3)
- ○ Depends on the prices for different crops (4)
- ○ Don't know (5)

Display this question:

If Q32 != Yes

And Q32 != No

Q35 What crops were planted in this field for the past five years? (*include fallow periods*). *If you grew multiple crops per season, please list them in the order they were planted. An example entry could be: 2019 lettuce to*

broccoli, 2018 lettuce and carrots to celery and onions, 2017 lettuce to strawberry, 2016 lettuce to kale and broccoli, 2015 fallow, etc.).

- ○ 2019 (1) _____
- ○ 2018 (2) _____
- ○ 2017 (3) _____
- ○ 2016 (4) _____
- ○ 2015 (5) _____

Q36 What crops were planted in this field or block for the past five years? If you grew multiple crops in a given year, please list them in the order they were planted. If you grew multiple crops per field at the same time, please list them all in the same box. For example, "lettuce, chard, carrots." If the field/block was not planted with a crop for sale, please describe how it was used, for example, "cover crop" or "fallow."

	1st crop(s) (1)	2nd crop(s) (2)	3rd crop(s) (3)
2019 (6)			
2018 (7)			
2017 (8)			
2016 (9)			
2015 (10)			

Q37 What will likely be planted in this field next, after this lettuce crop has been harvested? *For example, another food crop, a cover crop, or left fallow.*

_____

_____

_____

_____

_____

End of Block: Crop rotation

Start of Block: Tillage

Q38
Tillage. The following questions ask about your tillage management.

Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

Page Break

Q39 Do you till the soil for lettuce production?

- ○ Yes (1)
- ○ No (2)

Skip To: End of Block If Q39 = No

Q40 Do you use deep tillage (greater than 12 inches deep)?

- ○ Yes (1)
- ○ No (2)

Display this question:

If Q40 = Yes

Q41 How often do you use deep tillage?

- ○ More than once per year (1)
- ○ Once per year (2)
- ○ Once every two years (3)
- ○ Once every few years (4)
- ○ Once every five years or less (5)
- ○ Not sure (6)

Display this question:

If Q40 = Yes

Q42 What was the last year deep tillage was used on this field?

- ○ 2019 (4)
- ○ 2018 (5)
- ○ 2017 (6)
- ○ 2016 (7)
- ○ 2015 or before (8)

Display this question:

If Q40 = Yes

Q43 During what month do you typically do deep tillage in this field?

- ○ January (4)
- ○ February (5)
- ○ March (6)
- ○ April (7)
- ○ May (8)
- ○ June (9)
- ○ July (10)
- ○ August (11)
- ○ September (12)
- ○ October (13)
- ○ November (14)
- ○ December (15)

Display this question:

If Q40 = Yes

Q44 How many inches deep is tilled during deep tillage?

_____ inches (4)

Display this question:

If Q40 = Yes

Q45 What percent of the field is tilled during deep tillage?

0 10 20 30 40 50 60 70 80 90 100

Percent (%) of the field tilled ()	

Q46 Please use the text box below to describe how you till (other than deep ripping).
Please include: How often, how deep, and when you till, and also describe how you prepare the beds.

_____

_____

_____

_____

_____

Page Break

Q47 What are the main goals of the tillage?

- ☐ Weed control (1)
- ☐ Bed preparation (2)
- ☐ Other (please specify) (3) _____

Q48 How long do you keep the beds in place once they are formed?

- ○ Only one season (1)
- ○ 2-3 seasons (2)
- ○ 4-5 seasons (3)
- ○ 6 or more seasons (4)

Page Break

End of Block: Tillage

Start of Block: Irrigation

Q49
Irrigation. The following questions ask about your irrigation management.

Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

Page Break

Q50 How many inches of water did you apply before planting lettuce in this field (in total)? *Please refer to your Fall 2019 - Summer 2020 irrigation.*

_____ inches of irrigation water (4)

Page Break

Q51 What type of **preseason/transplant** irrigation system do you use? *Select all that apply.*

- ▢ Furrow (1)
- ▢ Sprinkler (2)
- ▢ Surface drip (3)
- ▢ Sub-surface drip (4)

Q52 What type of **growing season** irrigation system do you use? *Select all that apply.*

- ▢ Furrow (1)
- ▢ Sprinkler (2)
- ▢ Surface drip (3)
- ▢ Sub-surface drip (4)

Page Break

Display this question:

If Q52 = Sub-surface drip

Q53 For sub-surface drip irrigation, how deep are the lines in inches?

_____ inches (4)

Display this question:

If Q52 = Surface drip

Or Q52 = Sub-surface drip

Q54 For drip irrigation, how many lines are there per bed?

- ○ 1 (4)
- ○ 2 (7)
- ○ 3 (8)
- ○ 4 or more (9)

Page Break

Q55 How many inches of water do you apply during the growing season (after planting) in total?

_____ inches (4)

Q56 How often did you (or will you) irrigate during the growing season this year?

- ○ Daily (1)
- ○ Every few days (2)
- ○ Weekly (3)
- ○ Every few weeks (4)

Page Break

Q57 Do you add chlorine to the irrigation water?

- ○ Yes, both preseason and during growing season (1)
- ○ Yes, during preseason only (2)
- ○ Yes, during production only (3)
- ○ No (4)

Display this question:

If Q57 != No

Q58 Why do you add chlorine to the irrigation water? *Select all that apply.*

- ☐ Concern for food safety (1)
- ☐ Mandated by buyers (2)
- ☐ Neighboring farms do this (3)
- ☐ Extension staff recommend it (4)
- ☐ Other (please specify) (5) _____

Display this question:

If Q57 != No

Q59 For how many years have you been adding chlorine to the irrigation water?

_____ years (4)

End of Block: Irrigation

Start of Block: Other Fields

Q60 If you have multiple blocks or fields of lettuce, do you manage them similarly? *For example, do you use similar practices (e.g. cover cropping, crop rotations) and similar levels of inputs (e.g. water, fertilizer) for all of your lettuce blocks or fields?*

- ○ Yes (1)
- ○ No (2)
- ○ Not sure (3)
- ○ Don't have multiple fields/blocks of lettuce (4)

Display this question:

If Q60 != Yes

Or Q60 != Don't have multiple fields/blocks of lettuce

Q61 Could you please indicate the degree to which your management practices for this field differ from your management practices for other fields that you operate?

	No difference (1)	Small difference (2)	Large difference (3)
Soil amendments or fertilizers (4)	○	○	○
Cover crops (5)	○	○	○
Crop rotation (6)	○	○	○
Tillage (7)	○	○	○
Irrigation (8)	○	○	○
Other (9)	○	○	○

End of Block: Other Fields

Start of Block: Compost Social Qs

Q62 **Incentives and Barriers.** In this section, we will ask about the incentives and barriers that you consider when deciding if and how to use these management practices.

Note: You may close the survey at any time and your progress and responses will be saved. You can later return to where you left off by using the same URL link.

Page Break

Display this question:

If If Have you or will you use compost in this field for the current lettuce crop (Fall 2019 - Summer 2... No compost used Is Selected

Q63 You previously responded that your farm does not currently use compost. Has your farm operation ever used compost in the past?

- ▢ Yes, we have used compost within the last 5 years (1)
- ▢ Yes, but not within the last 5 years (2)
- ▢ No, we have never used any type of compost (3)
- ▢ Don't know (4)

Page Break

Display this question:

If If Have you or will you use compost in this field for the current lettuce crop (Fall 2019 - Summer 2... No compost used Is Selected

Q64 Would your farm operation ever consider adopting compost as a regular practice?

- ○ Yes (1)
- ○ No (2)
- ○ Don't know (4)

Page Break

Display this question:

If If Have you or will you use compost in this field for the current lettuce crop (Fall 2019 - Summer 2... No compost used Is Not Selected

Q65 Which of the following statements best captures your farm operation's current attitude toward compost?

- ○ We would use more compost if we could (1)
- ○ We are satisfied with the amount of compost we use, and would neither increase nor decrease use (2)
- ○ We are planning to scale back our use of compost next season (3)
- ○ Decline to answer (4)
- ○ Don't know (5)

Page Break

Q66 To what extent do each of the following pose a challenge to using compost on your farm?

	Major challenge (1)	Minor challenge (2)	Not a challenge (3)
Cost to purchase (1)	○	○	○
Cost to haul and/or spread (2)	○	○	○
Nutrients release too slowly (3)	○	○	○
Nutrient concentration is too low or imprecise (4)	○	○	○
Food safety concerns (5)	○	○	○
Difficulty storing before spreading (6)	○	○	○
Compost quality is too unpredictable (7)	○	○	○
Heavy metal or phosphorous accumulation in soils (8)	○	○	○
Can spread contaminants to farm (pesticides, herbicides, weed seeds, diseases) (9)	○	○	○
Cannot recoup long-term benefits because lease tenure is too short or uncertain (10)	○	○	○
Product is not consistently available (11)	○	○	○
Nutrient leaching into surrounding waterways (12)	○	○	○
Buyers won't allow it (13)	○	○	○
Benefits are unclear (14)	○	○	○
Other (please specify) (15)	○	○	○

Page Break

Q67 To what extent would each of the following factors motivate your farm operation to adopt or expand compost use?

	Major motivator (1)	Minor motivator (2)	Not a motivator (3)
Increased crop yield (1)	○	○	○
Improved crop quality (2)	○	○	○
Reduced impact from floods (3)	○	○	○
Improved consistency in production (i.e. reduced adverse effects of extreme weather). (16)	○	○	○
Reduced disease (4)	○	○	○
Reduced pests (5)	○	○	○
Healthier soil (6)	○	○	○
Water conservation (7)	○	○	○
Protect biodiversity (8)	○	○	○
Attract pollinators (9)	○	○	○
Attract natural pest predators (10)	○	○	○
Carbon storage (11)	○	○	○
Incentive payments from government (12)	○	○	○
Buyer demand (13)	○	○	○
Increased crop prices (14)	○	○	○
Other (15)	○	○	○

Q68 Are there any challenges you would like to tell us more about pertaining to compost use?

_____

_____

_____

_____

_____

Q69 Are there any innovations you have developed to facilitate the use of compost?

_____

_____

_____

_____

_____

End of Block: Compost Social Qs

Start of Block: Cover cropping social Qs

Display this question:

If Q20 = No, not currently, but we have practiced cover cropping in the past

Or Q20 = No, we have never practiced cover cropping

Q70 You previously responded that your farm does not currently use cover crops. Would your farm operation ever consider adopting cover cropping as a regular practice?

- ○ Yes (1)
- ○ No (2)
- ○ Decline to answer (3)
- ○ Don't know (4)

Page Break

Q71 Which of the following statements best captures your farm operation's current attitude toward cover crops?

- ○ We would like to plant more cover crops than we are currently planting (1)
- ○ We are satisfied with our current cover cropping practices, and would neither increase nor decrease the amount of cover cropping that we practice (2)
- ○ We are planning to scale back the amount of cover cropping that we practice (3)

Page Break

Q72 Has the percent of acreage to which you plant a cover crop changed since you began farming?

- ○ Yes, we have decreased cover cropping. (Please describe why in the text box). (1)
  _____
- ○ Yes, we have increased cover cropping. (Please describe why in the text box). (2)
  _____
- ○ No, it has stayed the same. (3)

Page Break

Q73 To what extent do each of the following factors pose a challenge to cover cropping on your farm?

	Major challenge (1)	Minor challenge (2)	Not a challenge (3)
Lack of labor (1)	○	○	○
Uses too much water (2)	○	○	○
Disrupts planting schedule (i.e. hinders spring vegetable planting). (3)	○	○	○
Too costly (4)	○	○	○
Too much planning involved (5)	○	○	○
No benefit to yields (6)	○	○	○
Leads to weed problems (7)	○	○	○
I don't know how to cover crop (8)	○	○	○
I don't have access to cover crop seeds (9)	○	○	○
Buyers don't want it (10)	○	○	○
Other (please specify) (11)	○	○	○

Page Break

Q74 To what extent would each of the following factors motivate your farm operation to adopt or expand cover cropping?

	Major motivator (1)	Minor motivator (2)	Not a motivator (3)
Increased crop yield (1)	○	○	○
Improved crop quality (2)	○	○	○
Reduced impact from floods (3)	○	○	○
Reduced disease (4)	○	○	○
Reduced pests (5)	○	○	○
Healthier soil (6)	○	○	○
Water conservation (7)	○	○	○
Protect biodiversity (8)	○	○	○
Attract pollinators (9)	○	○	○
Attract natural pest predators (10)	○	○	○
Carbon storage (11)	○	○	○
Incentive payments from government (12)	○	○	○
Buyer demand (13)	○	○	○
Increased crop prices (14)	○	○	○
Other (15)	○	○	○

Page Break

Q75 Are there any challenges you would like to tell us more about pertaining to cover cropping?

_____

_____

_____

_____

_____

Q76 Are there any innovations or changes to your operation that you have developed to facilitate cover cropping?

_____

_____

_____

_____

_____

End of Block: Cover cropping social Qs

Start of Block: Crop rotation social qs

Q77 Which of the following statements best captures your farm operation's current attitude toward the **frequency** of your crop rotation schedule?

- ◯ We would like to increase the frequency with which we rotate other crops or land uses with our lettuce plantings if we could (1)
- ◯ We are satisfied with the frequency with which we rotate other crops or land uses with our lettuce plantings (2)
- ◯ We plan to reduce the frequency with which we rotate other crops or land uses with our lettuce plantings (3)
- ◯ Don't know (4)

Page Break

Q78 Which of the following statements best captures your farm operation's current attitude toward the **diversity** of your crop rotation schedule?

- ◯ We would like to increase the diversity of other crops or land uses that we rotate with our lettuce if we could (1)
- ◯ We are satisfied with the current diversity of other crops or land uses that we rotate with our lettuce (2)
- ◯ We plan to reduce the diversity of other crops or land uses that we rotate with our lettuce (3)
- ◯ Don't know (4)

Page Break

Q79 To what extent do each of the following factors pose a challenge to rotating other crops or land uses with lettuce?

	Major challenge (1)	Minor challenge (2)	No challenge (3)
Lack of market for other crops or products (1)	○	○	○
Labor costs (2)	○	○	○
Labor shortages (3)	○	○	○
Lack of knowledge on other crops or land uses (4)	○	○	○
Land rents are too high, so need high-value crops (5)	○	○	○
Difficulty finding a sub-letter to plant other crops (6)	○	○	○
Lack of technical support (7)	○	○	○
Food safety causing decreased acreage available for lettuce planting because of proximity to CAFOS (9)	○	○	○
Soil conditions are not conducive to other crops (10)	○	○	○
Water limitations for other crops (11)	○	○	○
Rotations causing disruptions to production schedule (12)	○	○	○
Other (8)	○	○	○

Page Break

Q80 To what extent would each of the following factors motivate your farm operation to adopt or expand crop rotations?

	Major motivator (1)	Minor motivator (2)	Not a motivator (3)
Increased crop yield (1)	○	○	○
Improved crop quality (2)	○	○	○
Reduced impact from floods (3)	○	○	○
Reduced disease (4)	○	○	○
Reduced pests (5)	○	○	○
Healthier soil (6)	○	○	○
Water conservation (7)	○	○	○
Protect biodiversity (8)	○	○	○
Attract pollinators (9)	○	○	○
Attract natural pest predators (10)	○	○	○
Carbon storage (11)	○	○	○
Incentive payments from government (12)	○	○	○
Buyer demand (13)	○	○	○
Increased crop prices (14)	○	○	○
Efficient use of nutrient (16)	○	○	○
Other (15)	○	○	○

Page Break

Q81 Are there any challenges you would like to tell us more about pertaining to crop rotations?

_____

_____

_____

_____

_____

Q82 Are there any innovations or changes to your operation that you have developed to facilitate crop rotations?

_____

_____

_____

_____

_____

End of Block: Crop rotation social qs

Start of Block: Irrigation Social Qs

Q83 How satisfied are you with the efficiency of your farm operation's **irrigation system**?

- ○ Very satisfied (1)
- ○ Satisfied (2)
- ○ Neither satisfied nor dissatisfied (3)
- ○ Dissatisfied (4)
- ○ Very dissatisfied (5)

Q84 To what extent do each of the following pose a challenge to improving the efficiency of your irrigation system?

	Major challenge (1)	Minor challenge (2)	No challenge (3)
Better technology does not exist (1)	○	○	○
Cost to purchase better technology (2)	○	○	○
Not enough water savings to justify expense (3)	○	○	○
Farm terrain is not suitable for more efficient irrigation technology (4)	○	○	○
Crops are not suitable for more efficient irrigation technology (5)	○	○	○
Not enough technical assistance (6)	○	○	○
Crop rotation schedule is too variable (7)	○	○	○
Heavy metal or phosphorous accumulation in soils (8)	○	○	○
Lease is too short or insecure to justify expense (9)	○	○	○
Too much plastic waste (i.e. from used drip tape) (10)	○	○	○
Other (11)	○	○	○

Q85 Are there any challenges you would like to tell us more about pertaining to your irrigation system?

_____

_____

_____

_____

_____

Q86 Are there any innovations or changes to your operation that you have developed to improve your irrigation system that you would like to share with us?

_____

_____

_____

_____

_____

End of Block: Irrigation Social Qs

Start of Block: Conclusions

Q87 These next questions ask about some of the pressures you are facing as a grower. We are interested in these answers so that we can help create research and policy priorities that meet your needs.

Page Break

Q88 How much **influence** do buyers and contracts have **over your decisions** about what practices to use in the field?

	A great deal (1)	A lot (2)	A moderate amount (3)	A little (4)	None at all (5)
Do buyers have influence over your practices? (1)	○	○	○	○	○
Do contract specifications have influence over your practices? (2)	○	○	○	○	○

Display this question:

If Q88 != Do buyers have influence over your practices? [None at all]

And Q88 != Do contract specifications have influence over your practices? [None at all]

Q89 Please describe how and from which buyers you experience influence over practices. This could be regarding food safety, sustainability, or other management decisions.

_____

_____

_____

_____

_____

Page Break

Q90 To what extent has your farming operation experienced any of the following changes as a result of COVID-19?

	No change (1)	Small change (2)	Large change (3)
Decreased demand (1)	○	○	○
Increased demand (2)	○	○	○
Interrupted market access (3)	○	○	○
Increased new market access (for example, online or direct sales) (4)	○	○	○
Labor shortages due to illness (5)	○	○	○
Labor shortages due to worker protection policies (6)	○	○	○
Labor shortages due to increased demand (7)	○	○	○
Uncertainty about food safety and COVID-19 (8)	○	○	○
Unavailability of protective equipment (masks, gloves, etc.) (9)	○	○	○
Decreased access to credit (10)	○	○	○

Page Break

Q91 Please describe how your farm operation been impacted by COVID-19, including anything not covered in the previous question.

_____

_____

_____

_____

_____

Q92 Please describe any steps that your farm operation has taken in response to COVID-19.

_____

_____

_____

_____

_____

Page Break

Q93 What type of soil health research would you like to learn more about? Check all the things you are interested in. If you don't see something you are interested in, please add it in.

- ☐ Soil microbes (2)
- ☐ Role of soil for climate change mitigation (3)
- ☐ Biodiversity and soil health (4)
- ☐ Soil borne diseases (5)
- ☐ Cover cropping and soil health (6)
- ☐ Crop rotations and soil health (7)
- ☐ Compost applications and soil health (8)
- ☐ Food safety and soil health (9)
- ☐ Relationship between human health and soil health (10)
- ☐ Other (please specify) (11) _____

Q96 Please enter your mailing address where we can send a $100 gift in recognition of your participation.

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End of Block: Conclusions