

Supplementary material

Property history

Prior to conversion to regenerative practices, in orchards open space between trees was maintained with 3x yearly glyphosate application, as well as annual pesticide and rodenticide applications to control populations of snails and squirrels. Trees were fertilized with surface applied NPK pellets. Pastures were maintained as low-diversity grassland, Bermuda grass was controlled with glyphosate.

Inputs

All fertilization rates and timings were recommended by consultants based on soil test results and tissue analysis. All inputs were approved for organic production under USDA National Organic Program guidelines. After transitioning to organic production, compost, vermicompost, and compost tea comprised the foundation of ALF's fertility management. Compost was applied annually at rates of 6.7-13.5 Mg per Ha in perennial systems and 67-112 Mg per Ha for annual systems. Compost tea was applied to each field 15-25 times throughout the growing season (Feb-Nov) at rates of 168 L per Ha in citrus (J, M), 262 L per Ha in avocados (L, C), and 187 L per Ha in pastures (P, S). From 2015-2017 compost tea rates were increased to 505 L per Ha in avocados and 1497 L per Ha in pastures. Foliar sprays using compost tea were applied to perennial systems at a rate of 935 L per Ha from 2014-2016 and decreased to 281 L per Ha for the subsequent years. From 2020-2021, compost tea application transitioned from injections to soil drenches at rates of 4676 L per Ha in the garen and 1403 L per Ha in the perennial systems. Biodynamic preparations were also prepared on-site and incorporated annually in homeopathic doses according to Demeter's Biodynamic Farm Standard. Numerous other materials have been applied at varying rates to supply maintenance amounts of macro- and micronutrients, address in season deficiencies, and prepare vegetable beds prior to planting. Potash (K_2SO_4) and gypsum ($CaSO_4 \cdot 2H_2O$) supplied the majority of potassium (K), calcium (Ca) and sulfur (S). Other commonly applied materials include kelp, crustacean and fish-based products, azomite, blood and bone meals, greensand, and other organic fertilizers that provided one or more targeted nutrients. For example, a product called Biomin Booster 235 supplied Fe (1%), Mn (1.5%), Zn (2.5%), as well as N (1%), Mg (0.5%), and B (0.025%). In 2015, there was a shift away from

broadcasting amendments in favor of fertigation in perennial systems. This allowed for smaller amounts of nutrients to be applied more regularly, limiting the number of tractor passes and associated compaction issues. Some products/brands were substituted to ensure solubility.

Table S1. Fertilizers and amendments were applied either every season, two-three seasons, or only one season, 2014-2017. Record of inputs from 2012-13 was missing. CCT = Compost + compost tea, BD = biodynamic preparations, kelp = kelp meal and/or seaweed extract, fish = fish meal and/or fish emulsion, 221 = Biomin Booster 221, 235 = Biomin Booster 235, SOBEC = Soluble Organic Biological Extracts and Colloids, 4-4-4 = Perfect Blend Organics Biotic 4-4-4

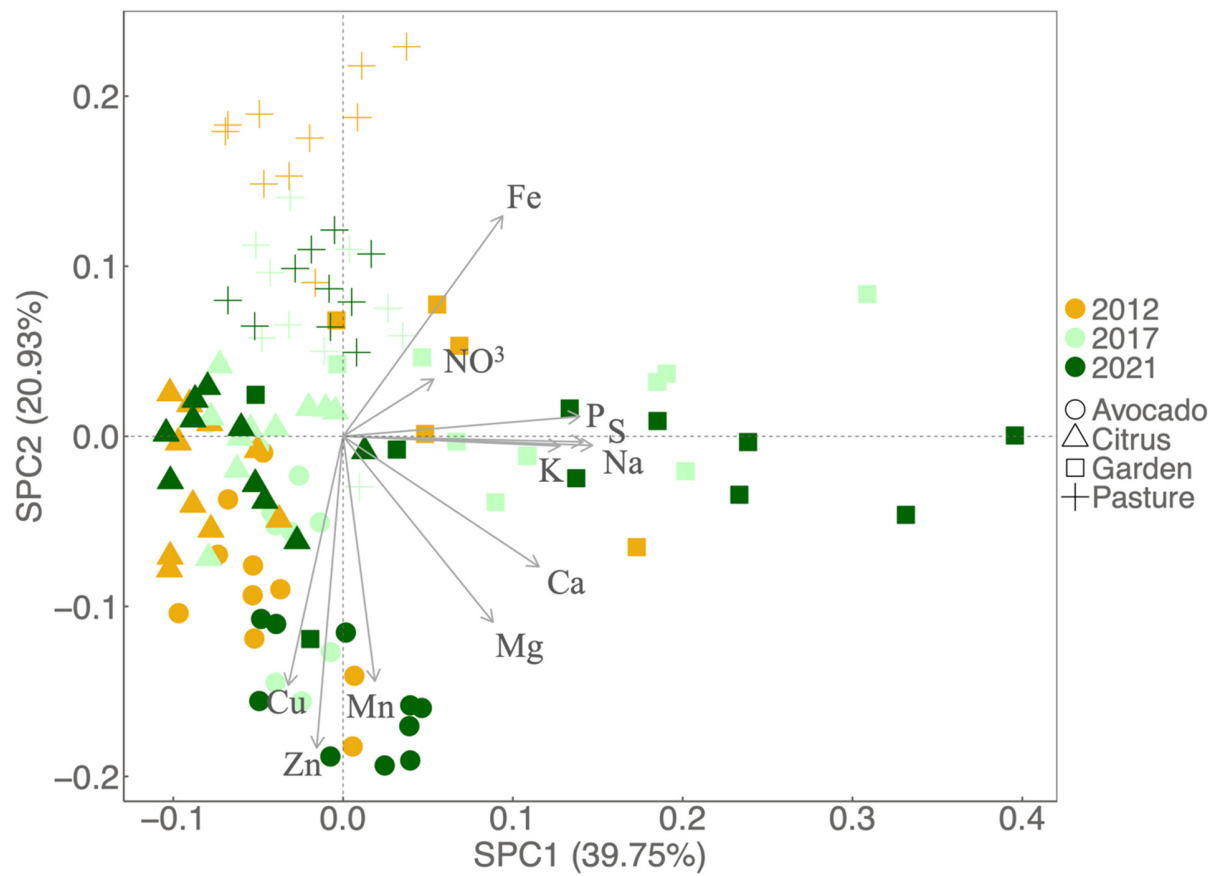
	2012-2013	2014-2017	2018-2021
Overall Farm	Perfect Blend 4-4-4, Organic 440 Spray Oil, American Soils - 100% Organic Compost Soil Amendment	Compost, Compost Tea, Biodynamic Preparations (500-508)	Compost, Compost Tea, Biodynamic Preparations (500-508), Vermicompost, Plant Extracts (Nettle, Comfrey, Horsetail)
Garden	BioFlora Dry Crumbles 6-6-5+8% Ca, Organic Container Potting Mix, Malibu Biodynamic Compost Amendment, Alfalfa Meal	Gypsum, Fish Meal, Fish Emulsion, Kelp Meal, Seaweed Extract, Crustacean Meal, Azomite, Rock Phosphate, SeaCrop, Blood Meal, Bone Meal, Tiger Organic 90CR Sulfur, Biomin Boron, Cal Phos, Bio Link, Green Sand, Iron Sulfate	Sea Crop, Fish Emulsion, Boron Granular, Fish Meal, Gypsum, Liquified Kelp, Fish Hydrolysate, Biomin Manganese, Biomin Boron, GrowMore Seaweed Extract, Biomin Iron, Fertibor, Brandt Manganese, Brandt Ferrous Sulfate, Big Red Bloodmeal 13-0-0, Cenergy (Soluble Potash), Big Foot Mycorrhizal Inoculant, Eden Blue Gold Base Mix, Pure Neem Oil, Biomin Cal-Boro
Orchard	Perfect Blend 4-4-4, True Organic Products 10-5-2, Perfect Blend 7-2-2, Green Cypress Zinc 10%, Green Cypress Manganese 7%, Soft Rock Phosphate, 100% Organic Compost Soil Amendment with Rice Hulls, 50%/50% Organic Topsoil, Fish Meal, Crab Meal, Kelp Meal, Fish Emulsion, Maxicrop 1-0-4, Zinc 8%, Boron 3%, Super Sulfur Potash, Magnesium Sulfate 9.8%	Potash, Fish Meal, Fish Emulsion, Kelp Meal, Seaweed Extract, Perfect Blend 4-4-4, Crustacean meal, Biomin Booster 235, Gypsum, Blood Meal, Humic Acid, Biomin Booster 221, Pacific Gro Oceanic Hydrolysate, Cenergy, Biomin Manganese, Aragonite, Solubor	True 315, Maxicrop, Citric Acid, Biomin Manganese, Biomin Iron, Biomin Boron, Biomin Booster 235, Big Red Bloodmeal 13-0-0, Fish Meal, Pacific Gro Oceanic Hydrolysate, Cenergy, K Plex, Aragonite, Mn Sulfate, Solubor, Zn Sulfate, Mg Sulfate, Fe Sulfate, Fulvic Acid
Pastures		Fish Meal, Fish Emulsion, Kelp Meal, Seaweed Extract, Potash, Biomin Booster 221, Pacific Gro Oceanic Hydrolysate, Biomin Manganese	True 315, Maxicrop, Citric Acid, Biomin Manganese, Biomin Iron, Biomin Boron, Cenergy

Table S2. Means (\pm se) of total microbial, fungal, and bacterial biomass ($\mu\text{g C g soil}^{-1}$), arbuscular mycorrhizal fungal biomass (nmol 16:1 ω 5 NLFA g soil $^{-1}$), fungal:bacterial ratios (F:B), fungal pathogen relative abundance (path ab; number of sequences sample $^{-1}$) and richness (path rich; number of ASVs sample $^{-1}$), fungal saprotroph relative abundance (sap ab) and richness (sap rich), bacterial richness, soil organic matter (SOM%, LOI), water stable aggregate (WSA%), soil macro and micronutrients (mg kg soil $^{-1}$), and soil pH (1:1 water:soil) measured at 0-10 cm depth in 2012, 2017 and 2021 in an avocado orchard, citrus orchard, vegetable garden and pasture following a transition from conventional to regenerative practices in 2012.

Variable	Avocado			Citrus			Garden			Pasture			$P_{\text{Crop Type}}$	P_{Year}	P_{CTxY}
	2012	2017	2021	2012	2017	2021	2012	2017	2021	2012	2017	2021			
Total biomass	142.7 (40.8) ^c	286.1 (29.9) ^b	460.8 (29.9) ^a	88.5 (40.8) ^b	192.8 (29.9) ^{ab}	218.6 (29.9) ^a	155.3 (45.3) ^a	220.2 (29.9) ^a	238.7 (29.9) ^a	168.3 (40.8) ^b	277.9 (29.9) ^{ab}	289.6 (29.9) ^a	<0.001	<0.001	0.005
Fungal biomass	108.0 (35.9) ^c	210.5 (26.2) ^b	358.7 (26.2) ^a	60.6 (35.9) ^a	142.8 (26.2) ^a	158.2 (26.2) ^a	117.8 (39.9) ^a	150.0 (26.2) ^a	165.2 (26.2) ^a	104.5 (36.0) ^b	190.1 (26.2) ^{ab}	204.5 (26.2) ^a	<0.001	<0.001	0.010
AMF biomass	4.05 (0.92) ^c	9.48 (0.66) ^b	12.38 (0.74) ^a	2.89 (0.92) ^b	5.14 (0.66) ^{ab}	6.69 (0.66) ^a	2.96 (1.03) ^a	4.78 (0.66) ^a	4.54 (0.66) ^a	3.78 (0.92) ^b	8.00 (0.66) ^a	7.58 (0.66) ^a	<0.001	<0.001	0.002
Bacteria biomass	35.6 (7.97) ^c	75.5 (5.73) ^b	102.1 (5.73) ^a	28.9 (7.97) ^b	50.0 (5.73) ^{ab}	60.5 (5.73) ^a	36.4 (8.88) ^b	70.2 (5.73) ^a	73.5 (5.73) ^a	63.5 (7.97) ^b	87.8 (5.73) ^a	85.2 (5.73) ^{ab}	<0.001	<0.001	0.020
F:B ratio	3.21 (0.40) ^a	2.75 (0.28) ^a	3.54 (0.28) ^a	2.43 (0.40) ^a	2.83 (0.28) ^a	2.60 (0.28) ^a	3.03 (0.447) ^a	2.12 (0.28) ^a	2.25 (0.28) ^a	1.56 (0.40) ^a	2.13 (0.283) ^a	2.42 (0.28) ^a	<0.001	0.435	0.147
C per OM	6.32 (1.082) ^b	6.25 (0.79) ^b	10.43 (0.79) ^a	5.53 (1.08) ^a	7.23 (0.79) ^a	7.61 (0.79) ^a	5.64 (1.20) ^a	3.69 (0.79) ^a	4.62 (0.79) ^a	4.91 (1.08) ^a	4.87 (0.79) ^a	6.81 (0.79) ^a	<0.001	<0.001	0.042
Path ab	150.9 (36.7) ^a	34.1 (8.3) ^b	88.2 (19.1) ^a	636.1 (154.9) ^a	414.6 (101.0) ^{ab}	256.3 (55.7) ^b	1047.2 (364.7) ^a	546.3 (133.0) ^a	451.2 (103.5) ^a	637.0 (155.1) ^a	292.6 (71.2) ^b	417.3 (90.6) ^{ab}	<0.001	<0.001	0.072
Path rich	9.13 (0.99) ^a	5.63 (0.99) ^b	6.40 (0.88) ^{ab}	11.00 (0.99) ^b	18.37 (0.99) ^a	12.20 (0.88) ^b	13.94 (1.4) ^a	12.88 (0.99) ^a	9.33 (0.93) ^b	14.25 (0.99) ^a	15.75 (0.99) ^a	13.00 (0.88) ^a	<0.001	<0.001	<0.001
Sap ab	998 (104.8) ^a	1172 (104.8) ^a	1191 (93.5) ^a	958 (104.8) ^b	1262 (104.8) ^b	1698 (93.5) ^a	528 (149.2) ^b	1299 (104.8) ^a	1082 (98.7) ^a	1288 (104.8) ^a	1434 (104.8) ^a	1261 (93.5) ^a	<0.001	<0.001	<0.001
Sap rich	37.0 (2.59) ^b	36.2 (2.59) ^b	45.1 (2.32) ^a	38.1 (2.59) ^b	45.2 (2.59) ^{ab}	51.7 (2.32) ^a	30.8 (3.64) ^b	41.0 (2.59) ^{ab}	44.8 (2.44) ^a	39.8 (2.59) ^b	50.2 (2.59) ^a	45.3 (2.32) ^{ab}	0.001	<0.001	0.045
Fungal rich	107.4 (6.84) ^a	116.8 (6.84) ^a	123.3 (6.84) ^a	103.6 (6.84) ^b	127.4 (6.84) ^a	118.1 (6.13) ^{ab}	92.9 (9.60) ^a	110.7 (6.84) ^a	110.5 (6.84) ^a	112.3 (6.84) ^b	144.7 (6.84) ^a	126.0 (6.13) ^b	0.001	<0.001	0.497
Bacteria rich	563 (26.5) ^{ab}	543 (26.5) ^b	632 (23.6) ^a	528 (26.4) ^a	554 (26.4) ^a	522 (23.6) ^a	601 (33.4) ^a	634 (26.5) ^a	558 (23.6) ^a	503 (26.5) ^a	548 (26.5) ^a	536 (23.6) ^a	0.002	0.527	0.045
SOM (%)	2.4 (0.19) ^b	4.42 (0.35) ^a	4.53 (0.36) ^a	1.50 (0.12) ^b	2.67 (0.21) ^a	2.83 (0.23) ^a	2.57 (0.29) ^b	5.86 (0.47) ^a	5.23 (0.42) ^a	3.84 (0.31) ^b	5.71 (0.46) ^a	4.35 (0.35) ^b	<0.001	<0.001	0.010
WSA (%)	24.2 (3.38) ^b	45.4 (2.36) ^a	48.2 (2.36) ^a	20.1 (3.38) ^b	25.3 (2.36) ^{ab}	31.3 (2.36) ^a	12.2 (4.38) ^b	26.5 (2.36) ^a	29.2 (2.36) ^a	35.2 (3.38) ^{ab}	34.4 (2.36) ^b	44.8 (2.36) ^a	<0.001	<0.001	0.012
CEC	13.8 (0.7) ^b	14.7 (0.7) ^{ab}	16.8 (0.7) ^a	11.3 (0.7) ^a	12.7 (0.7) ^a	11.9 (0.7) ^a	15.8 (0.9) ^b	17.0 (0.7) ^{ab}	19.2 (0.7) ^a	11.7 (0.7) ^b	14.4 (0.7) ^a	13.8 (0.7) ^{ab}	<0.001	<0.001	0.126
pH	7.78 (0.05) ^a	7.88 (0.05) ^a	7.75 (0.05) ^a	7.94 (0.05) ^a	7.81 (0.05) ^a	7.93 (0.05) ^a	8.20 (0.07) ^a	7.67 (0.05) ^b	7.64 (0.05) ^b	7.63 (0.05) ^b	7.82 (0.05) ^a	7.68 (0.05) ^{ab}	<0.001	0.061	<0.001
NO3	2.05 (0.42) ^b	5.64 (1.16) ^a	2.37 (0.49) ^b	4.28 (0.89) ^b	24.71 (5.11) ^a	4.08 (0.85) ^b	3.15 (0.92) ^b	12.79 (2.65) ^a	20.47 (4.23) ^a	7.87 (1.63) ^a	6.27 (1.30) ^a	5.62 (1.16) ^a	<0.001	<0.001	<0.001
P	50.0 (7.4) ^a	34.1 (5.1) ^a	34.2 (5.1) ^a	60.8 (9.0) ^a	64.7 (9.6) ^a	56.9 (8.4) ^a	264.4 (55.7) ^a	312.6 (46.3) ^a	291.6 (43.2) ^a	34.7 (5.1) ^b	59.1 (8.8) ^a	56.0 (8.3) ^{ab}	<0.001	0.696	0.059
K	161 (19.1) ^b	316 (37.4) ^a	198 (23.4) ^b	160 (18.9) ^b	297 (35.2) ^a	270 (31.9) ^a	535 (90.3) ^a	460 (54.4) ^a	577 (68.2) ^a	138 (16.3) ^b	258 (30.5) ^a	173 (20.5) ^{ab}	<0.001	<0.001	0.011
S	18.7 (2.8) ^{ab}	18.0 (2.7) ^b	29.8 (4.5) ^a	15.5 (2.4) ^a	18.0 (2.7) ^a	16.6 (2.5) ^a	29.9 (6.5) ^b	63.8 (9.7) ^a	68.4 (10.4) ^a	22.0 (3.4) ^a	19.0 (2.9) ^a	29.5 (4.5) ^a	<0.001	0.004	0.069
Ca	2068 (109) ^b	2192 (109) ^{ab}	2538 (109) ^a	1742 (109) ^a	1977 (109) ^a	1841 (109) ^a	2347 (154) ^b	2488 (109) ^{ab}	2819 (109) ^a	1795 (109) ^b	2194 (109) ^a	2127 (109) ^{ab}	<0.001	<0.001	0.138
Mg	327 (14.7) ^{ab}	317 (14.3) ^b	369 (16.6) ^a	228 (10.2) ^a	212 (9.5) ^a	200 (9.0) ^a	287 (18.5) ^a	314 (14.1) ^a	337 (15.2) ^a	237 (10.7) ^b	292 (13.1) ^a	272 (12.3) ^{ab}	<0.001	0.151	<0.002
Zn	16.40 (0.89) ^a	15.70 (0.89) ^a	15.68 (0.89) ^a	12.10 (0.89) ^a	10.59 (0.89) ^a	11.04 (0.89) ^a	4.25 (1.25) ^b	10.19 (0.89) ^a	8.93 (0.89) ^a	2.45 (0.89) ^b	6.49 (0.89) ^a	5.33 (0.89) ^a	<0.001	0.048	0.001
Fe	8.67 (0.69) ^a	6.19 (0.49) ^b	8.10 (0.64) ^a	7.68 (0.61) ^{ab}	6.49 (0.51) ^b	8.66 (0.69) ^a	22.49 (2.55) ^a	22.72 (1.81) ^a	21.89 (1.75) ^a	24.79 (1.98) ^a	18.38 (1.47) ^b	14.18 (1.13) ^b	<0.001	0.001	<0.001
Mn	7.08 (0.50) ^b	4.45 (0.32) ^c	10.14 (0.72) ^a	5.04 (0.36) ^b	4.69 (0.33) ^b	6.93 (0.49) ^a	9.15 (0.92) ^a	4.14 (0.29) ^c	6.68 (0.47) ^b	3.40 (0.24) ^a	2.39 (0.17) ^b	3.02 (0.21) ^{ab}	<0.001	<0.001	<0.001
Cu	2.41 (0.24) ^a	2.34 (0.24) ^a	2.70 (0.28) ^a	3.19 (0.33) ^a	3.02 (0.31) ^a	2.50 (0.25) ^a	1.68 (0.24) ^a	2.45 (0.25) ^a	2.07 (0.21) ^a	0.55 (0.06) ^c	1.77 (0.18) ^a	1.13 (0.12) ^b	<0.001	<0.001	<0.001
Na	54.2 (5.39) ^b	66.5 (6.62) ^{ab}	90.1 (8.97) ^a	50.7 (5.04) ^a	57.6 (5.7) ^a	55.0 (5.47) ^a	82.4 (11.71) ^b	126.0 (12.5) ^a	93.4 (9.3) ^{ab}	69.0 (6.87) ^a	68.7 (6.8) ^a	79.0 (7.8) ^a	<0.001	0.013	0.038

Table S3. ACOMB (run 2/6/24) was run within each crop type separately. Only taxa present in at least 33% of samples within each crop type were included in the analysis. All analyses were performed on unrarefied data collapsed at genus. The lfc indicates the log-fold change between the year listed relative to 2012. True means significantly ($P < 0.05$) different between years compared and all p-values were adjusted for multiple comparisons using the Holm adjustment. N/A refers to no guild assignment could be made with FungalTraits.

Crop	Genus	Rel abundance	Primary lifestyle	Secondary lifestyle	lfc_year2017	lfc_year2021	2012-2017	2012-2021	2017-2021
Citrus	Pyrenochaetopsis		foliar_endophyte	litter_saprotroph	3.55	5.52	TRUE	TRUE	FALSE
Avocado	Pyrenochaetopsis		foliar_endophyte	litter_saprotroph	-1.61	3.53	FALSE	TRUE	TRUE
Pasture	Pyrenochaetopsis	7273	foliar_endophyte	litter_saprotroph	2.63	3.66	TRUE	TRUE	FALSE
Citrus	Pleurophoma	503	plant_pathogen	wood_saprotroph	0.11	2.91	FALSE	TRUE	FALSE
Citrus	Setophaeosphaeria	691	plant_pathogen	litter_saprotroph	-2.09	-2.77	FALSE	TRUE	FALSE
Citrus	Alternaria	8359	plant_pathogen	litter_saprotroph	-0.22	-2.38	FALSE	TRUE	FALSE
Pasture	Sporormiella	2028	litter_saprotroph	N/A	-3.50	-4.07	TRUE	TRUE	FALSE
Avocado	Wiesneriomyces	3087	foliar_endophyte	litter_saprotroph	5.58	3.69	TRUE	TRUE	FALSE
Citrus	Knufia	331	soil_saprotroph	rock-inhabiting	-1.76	-2.39	FALSE	TRUE	FALSE
Pasture	Talaromyces	1147	unspecified_saprotroph	N/A	0.45	2.47	FALSE	TRUE	FALSE
Pasture	Keratinophyton	488	N/A	N/A	0.80	2.51	FALSE	TRUE	FALSE
Pasture	Plectosphaerella		plant_pathogen	litter_saprotroph	2.16	2.94	FALSE	TRUE	FALSE
Avocado	Pseudoacrodictys	1998	foliar_endophyte	litter_saprotroph	1.51	3.66	FALSE	TRUE	FALSE
Citrus	Acremonium	646	unspecified_saprotroph	foliar_endophyte	0.57	3.14	FALSE	TRUE	FALSE
Citrus	Pleurophragmium	958	unspecified_saprotroph	N/A	1.78	3.87	FALSE	TRUE	FALSE
Garden	Idriella	3000	litter_saprotroph	root_endophyte	-3.05	-3.43	TRUE	TRUE	FALSE
Citrus	Naganishia	1089	unspecified_saprotroph	N/A	-3.76	-3.13	TRUE	TRUE	FALSE
Avocado	Solicocozyma	5158	soil_saprotroph	epiphyte	-2.28	-4.15	FALSE	TRUE	FALSE
Citrus	Apiotrichum	11501	soil_saprotroph	N/A	0.30	5.89	FALSE	TRUE	TRUE
Avocado	Apiotrichum		soil_saprotroph	N/A	-0.66	4.80	FALSE	TRUE	TRUE



Model	<i>Df (num,dem)</i>	<i>F-value</i>	R^2	<i>P-value</i>
Abiotic ~ Crop Type	3,103	37.81	0.454	0.001
Abiotic ~ Year	2,103	6.56	0.052	0.001
Abiotic ~ Crop Type * Year	6, 103	3.32	0.079	0.001

Table SXX : Permutational multivariate ANOVA results of standardized soil macro and micro nutrient availability.

Figure S1. PCA of macro and micronutrients in soils collected in 2012 (orange), 2017 (light green) and 2021 (dark green) from an avocado orchard (circles), citrus orchard (triangles), vegetable garden (squares), and a pasture (crosses) following a transition from conventional to regenerative practices in 2011.

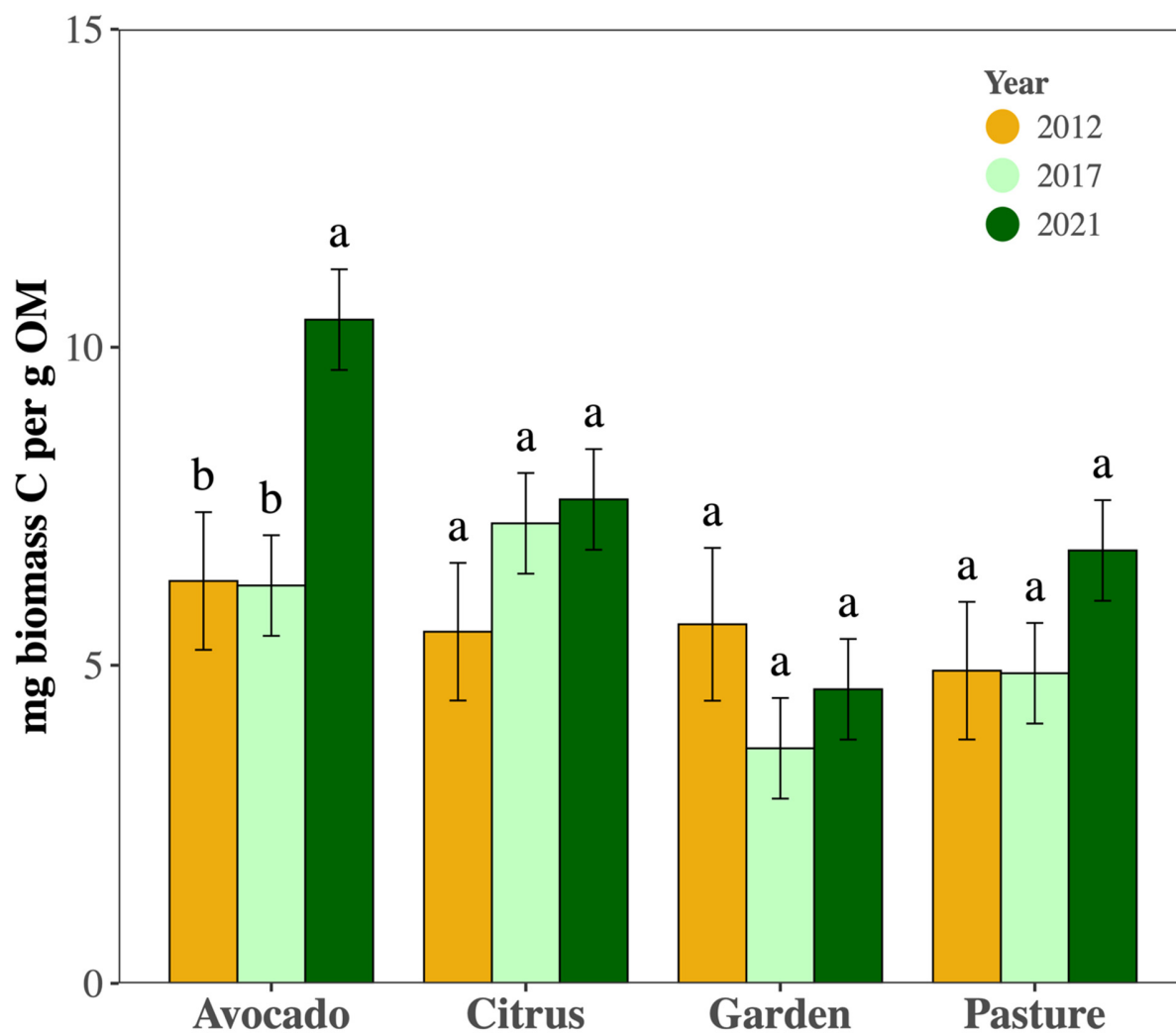


Figure S2. Shift in soil organic matter quality, estimated by the microbial biomass per g organic matter in the avocado and citrus orchard, as well as garden prior to shifts management practices from conventional to regenerative in 2012 (orange), as well as five (light green) and nine years (dark green) post transitioning.