
Supplementary materials

Water yam (*Dioscorea alata* L.) growth and tuber yield as affected by rotation and fertilization regimes across an environmental gradient in West Africa

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Figure S1. Map showing the four sites (source: Google Earth, 2022, buildings data layer [SIAO. NOAA. US. Navy. NGA. GEBCO, Image Landsat / Copernicus] Available at: <http://www.google.com/earth/index.html> [Accessed 12 March 2021]).

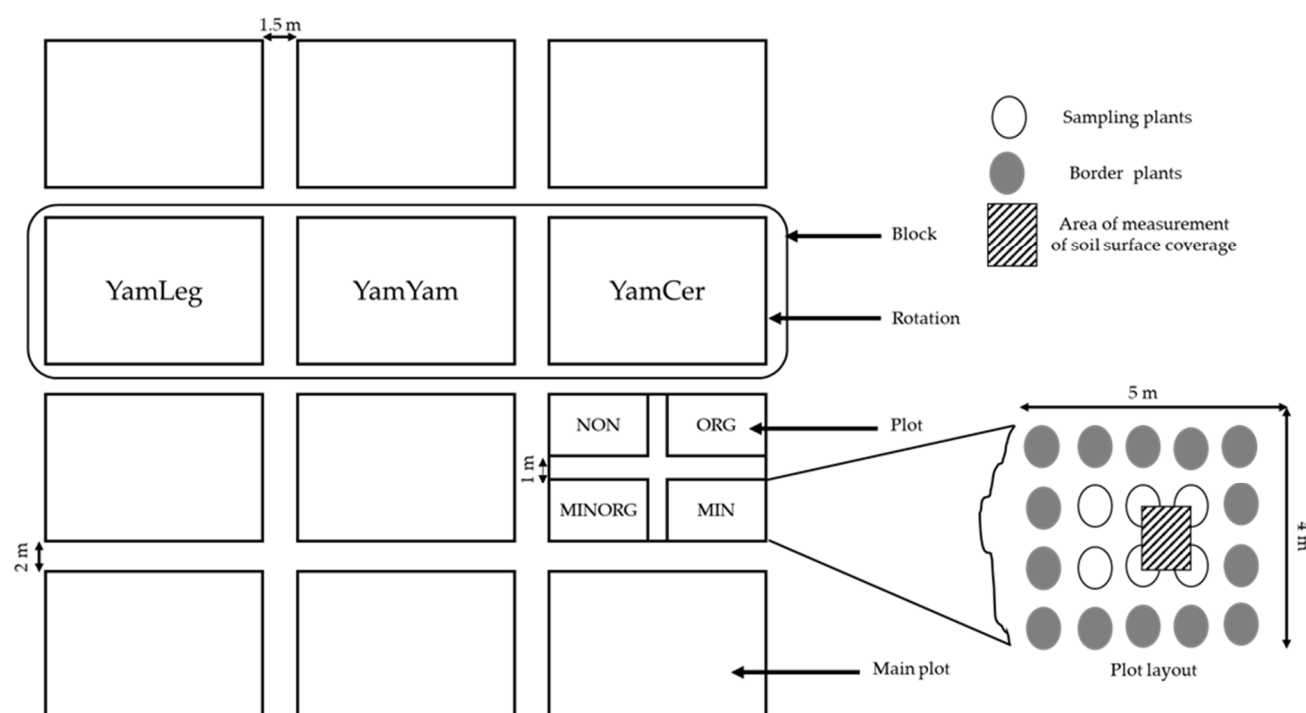


Figure S2. Layout of experiment installed in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) from 2016 to 2018. NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure). YamCer = water yam – cereal – water yam, YamLeg = water yam – legume – water yam and YamYam = water yam – white yam – water yam.

Table S1. Amount of C, N, P and K added by mineral and organic fertilizers in 2017 on white guinea yam (*D. rotundata*) in the four sites, maize (*Zea mays*) in Liliyo, Midebdo and Léo and rice (*Oryza sativa*) in Tiéningboué.

Site	Fertilization	Cereal				White yam			
		C	N	P	K	C	N	P	K
		kg ha ⁻¹							
Liliyo	MIN	66.9	147.8	18.3	49.4	23.4	51.6	2.5	87.2
	MINORG ^a	2867.8	425.9	95.2	150.9	1002.3	148.8	31.3	87.7
	ORG	5668.6	704.0	172.1	252.4	1981.3	246.1	60.1	88.2
Tiéningboué	MIN	38.8	85.6	14.7	96.5	23.4	51.6	2.5	87.2
	MINORG ^a	1226.1	185.3	93.5	154.5	740.1	111.8	53.2	107.7
	ORG	2413.4	284.9	172.3	212.5	1456.8	172.0	104.0	128.2
Midebdo	MIN	66.9	147.8	18.3	49.4	23.4	51.6	2.5	87.2
	MINORG ^a	1996.9	181.6	22.4	139.5	685.8	62.8	5.8	83.0
	ORG	3926.8	215.4	26.6	229.6	1348.2	74.0	9.1	78.8
Léo	MIN	66.9	147.8	18.3	49.4	23.4	51.6	2.5	87.2
	MINORG ^a	1996.9	181.6	22.4	139.5	695.9	63.1	6.4	88.5
	ORG	3926.8	215.4	26.6	229.6	1368.4	74.6	10.4	89.9

NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure); Poultry and cow manures were sampled in each site and analyzed for their N, P and K contents. Total C and N contents were measured using an elemental analyzer (vario PYRO cube, Elementar Analysensysteme GmbH, Germany) and total P and K contents by ICP-OES after digestion with nitric acid (HNO₃) based on Hoenig, (2001). a Cereal cultivated in Tiéningboué was rice while in the tree other sites, it was maize; a MINORG received half of NPK added in MIN as mineral fertilizer and half of manure added in ORG as manure

Table S2. Amount of C, N, P and K added by groundnut (*Arachis hypogaea*) straw incorporated in 2017 at Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso).

Site	Fertilization regimes	C	N	P	K
		kg ha ⁻¹			
Liliyo	NON	774.4	49.5	3.1	36.4
	MIN	804.8	46.9	2.9	40.4
	MINORG	490.9	26.5	4.1	26.3
	ORG	841.3	49.0	7.6	30.1
Tiéningboué	NON	975.8	62.0	4.1	38.7
	MIN	858.8	54.6	4.3	63.0
	MINORG	1098.0	70.7	6.39	63.9
	ORG	981.8	68.3	6.5	61.7
Midebdo	NON	522.0	20.2	3.0	18.7
	MIN	572.1	25.2	1.7	23.8
	MINORG	633.0	23.2	2.3	33.7
	ORG	598.5	26.2	2.4	27.4
Léo	NON	1040.5	59.8	3.8	51.4
	MIN	1400.6	77.1	5.3	81.6
	MINORG	1584.3	82.5	6.2	93.6
	ORG	1512.9	77.2	7.1	93.6

NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure).; Groundnut straw dry yields were measured at the harvest, and samples taken in each site. These samples were analyzed for their C, N, P and K contents. Total C and N contents were measured using an elemental analyzer (vario PYRO cube, Elementar Analysensysteme GmbH, Germany) and total P and K contents by ICP-OES after digestion with nitric acid (HNO₃) based on Hoenig, (2001);

Table S3. Soil total carbon and pH (average \pm standard error) of the upper layer (0–30 cm) according to the rotations and fertilization regimes in Liliyo and Tiéningboué (Côte d’Ivoire), and Midebdo and Léo (Burkina Faso) measured in December 2017.

Soil properties	Rotation	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
Total C (g kg ⁻¹ sol)	YamCer	NON	6.3 \pm 0.74	8.7 \pm 0.32	3.7 \pm 0.46	4.7 \pm 0.64
	YamCer	MIN	9.0 \pm 1.91	9.6 \pm 1.34	5.24 \pm 1.44	4.8 \pm 0.73
	YamCer	MINORG	7.2 \pm 1.18	10.0 \pm 1.38	4.4 \pm 0.68	5.3 \pm 0.86
	YamCer	ORG	8.3 \pm 0.84	10.7 \pm 1.77	6.5 \pm 0.57	6.4 \pm 1.25
	YamLeg	NON	6.5 \pm 0.79	8.6 \pm 0.40	4.6 \pm 0.58	4.0 \pm 0.76
	YamLeg	MIN	4.7 \pm 0.31	9.3 \pm 0.76	4.6 \pm 0.73	4.7 \pm 0.69
	YamLeg	MINORG	5.8 \pm 0.10	10.1 \pm 2.24	5.6 \pm 0.96	5.5 \pm 1.99
	YamLeg	ORG	5.8 \pm 0.73	10.6 \pm 1.71	5.4 \pm 0.45	4.7 \pm 1.14
	YamYam	NON	8.9 \pm 0.87	9.1 \pm 0.81	2.6 \pm 0.20	4.1 \pm 0.40
	YamYam	MIN	11.9 \pm 2.88	10.7 \pm 1.39	4.1 \pm 0.70	4.6 \pm 1.14
	YamYam	MINORG	13.9 \pm 1.87	12.9 \pm 1.98	3.3 \pm 0.27	4.2 \pm 0.37
	YamYam	ORG	10.3 \pm 1.19	14.0 \pm 2.33	4.3 \pm 0.54	4.9 \pm 0.94
pH, H ₂ O	YamCer	NON	6.1 \pm 0.3	5.7 \pm 0.2	5.6 \pm 0.3	5.2 \pm 0.4
	YamCer	MIN	5.8 \pm 0.2	5.2 \pm 0.1	5.7 \pm 0.4	5.1 \pm 0.4
	YamCer	MINORG	5.6 \pm 0.3	5.8 \pm 0.1	6.4 \pm 0.5	5.5 \pm 0.3
	YamCer	ORG	5.6 \pm 0.4	5.7 \pm 0.2	6.1 \pm 0.3	6.1 \pm 0.5
	YamLeg	NON	5.9 \pm 0.2	5.4 \pm 0.2	5.8 \pm 0.2	5.0 \pm 0.1
	YamLeg	MIN	5.6 \pm 0.3	4.9 \pm 0.2	5.5 \pm 0.1	4.9 \pm 0.1
	YamLeg	MINORG	6.1 \pm 0.2	5.3 \pm 0.2	5.8 \pm 0.3	5.3 \pm 0.1
	YamLeg	ORG	6.0 \pm 0.1	5.5 \pm 0.2	6.0 \pm 0.1	5.4 \pm 0.1
	YamYam	NON	6.5 \pm 0.3	5.3 \pm 0.1	5.8 \pm 0.4	4.4 \pm 0.3
	YamYam	MIN	6.3 \pm 0.2	5.5 \pm 0.2	5.9 \pm 0.5	4.3 \pm 0.1
	YamYam	MINORG	6.1 \pm 0.2	5.5 \pm 0.1	6.1 \pm 0.1	4.8 \pm 0.2
	YamYam	ORG	6.0 \pm 0.1	6.0 \pm 0.2	6.1 \pm 0.2	5.7 \pm 0.3

YamCer = water yam – cereal – water yam, YamLeg = water yam – legume – water yam and YamYam = water yam – white guinea yam – water yam; NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure). Soil chemical properties presented (mean \pm standard errors) correspond of the mean of 4 soil samples taken in December 2017 at each experimental site. Total C was measured using an elemental analyzer (varioPYRO cube, Elementar Analysensysteme GmbH, Germany); pH using a pH electrode (Benchtop pH/ISE meter model 720A, Orion Research Inc., USA) in a soil:water (1:2) solution

Table S4. Soil carbon stocks (t ha⁻¹) of the upper layer (0–30 cm) according to the rotations and fertilizations fertilization regimes in Liliyo and Tiéningboué (Côte d’Ivoire), and Midebdo and Léo (Burkina Faso) measured in May 2016 and December 2017.

	Rotation	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
May 2016	YamCer	NON	28.15	35.48	17.91	16.98
	YamCer	MIN	40.33	34.74	14.56	15.90
	YamCer	MINORG	34.78	37.45	15.29	18.01
	YamCer	ORG	39.85	38.28	21.93	19.68
	YamLeg	NON	34.32	33.85	17.88	15.85
	YamLeg	MIN	26.46	34.20	17.73	16.41
	YamLeg	MINORG	30.36	32.11	17.33	24.39
	YamLeg	ORG	32.92	29.94	18.96	16.68
	YamYam	NON	30.36	27.75	20.13	17.50
	YamYam	MIN	35.06	35.92	17.88	17.35
	YamYam	MINORG	31.92	39.75	16.46	18.66
	YamYam	ORG	39.75	40.81	17.73	18.24
	Average		33.69	35.02	17.82	17.97
	se		1.32	1.11	0.57	0.67
December 2017	YamCer	NON	21.79	26.35	14.25	15.94
	YamCer	MIN	30.93	28.99	19.13	15.98
	YamCer	MINORG	24.87	30.19	16.15	17.54
	YamCer	ORG	28.69	32.44	23.63	20.03
	YamLeg	NON	22.43	25.98	16.94	15.76
	YamLeg	MIN	16.14	28.19	16.95	18.34
	YamLeg	MINORG	20.11	30.48	20.56	21.26
	YamLeg	ORG	19.89	31.91	19.56	18.14
	YamYam	NON	28.03	27.48	9.50	16.04
	YamYam	MIN	31.80	32.45	15.08	17.87
	YamYam	MINORG	47.88	38.85	12.16	16.42
	YamYam	ORG	35.39	42.37	15.74	19.21
	Average		27.33	31.31	16.64	17.71
	se		2.49	1.42	1.10	0.52

SOCs (t ha⁻¹) = SOC (g kg⁻¹) × BD (kg dm⁻³) × SLT (dm) × [1 – (GV/100)] where SOC: Soil carbon Stocks, SOC: Soil carbon content, BD: Bulk density, SLT : Soil layer thickness and GV : gravel volume (%). Soils were sampled in May 2016 and December 2017 and analyzed for C content using an elemental analyzer (varioPYRO cube, Elementar Analysensysteme GmbH, Germany). BD and GV were measured on two pits opened on each block on October 2020 using the cylinder method. YamCer = water yam – cereal – water yam, YamLeg = water yam – legume – water yam and YamYam = water yam – white guinea yam – water yam; NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG. In 2016, the rotations showed correspond to plot names.

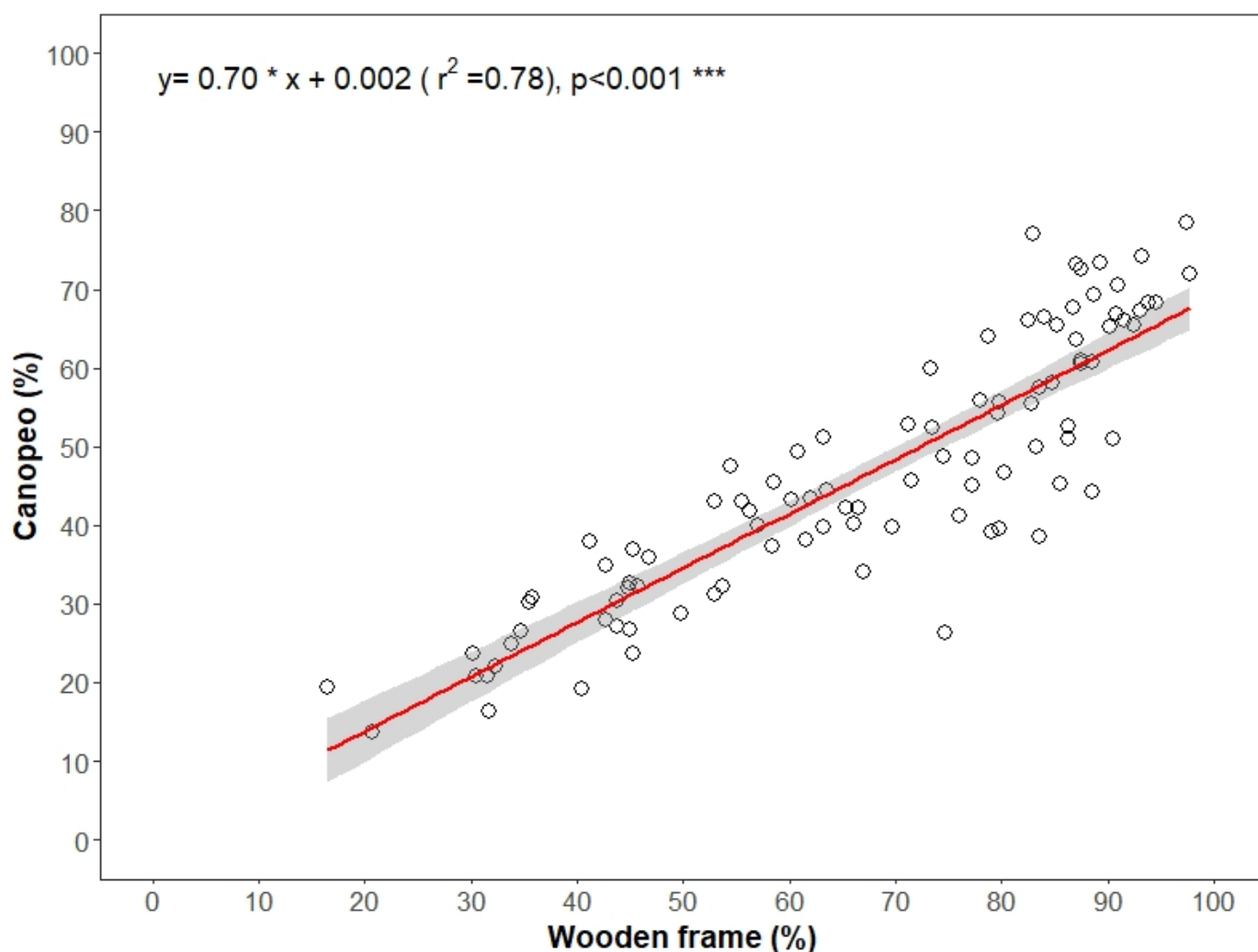


Figure S3. Relationship between soil surface coverage by water yam aboveground organs measured using the wooden frame (Burstall and Harris, 1983 modified by Diby et al., 2011b) and canopeo (Patrignani and Ochsner, 2015) in Tiénigboué in 2018 from 70 to 168 DAP ($n=4$). The yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regimes (NON, MIN, MINORG and ORG). The linear regression, the coefficient of determination (r^2) and the p-value are shown in the graph. The grey band indicates the 95% confidence interval. NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure).

Table S5. Summary of the linear mixed-effects model fitted by REML to assess the effect of site on sprout emergence rate (%) of water yam setts at 49 DAP in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 and 2018. Water yam was cultivated in the presence of different fertilization regimes in 2016 and 2018. In 2018, for each fertilization regime, water yam was cultivated after either a cereal, a legume, or a yam for each fertilization regime.

2016 (Boxcox transformation)				
Random effects:	Std. error			
Block	0.00033			
Block:Rotation	60.95			
Block:Rotation:Fertilization	0.147			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	4692.84	76.15	[4541.79; 4843.88]	< 0.001
Tiéningboué	141.51	105.53	[-67.82; 350.84]	0.18 ^{ns}
Midebdo	-331.13	104.78	[-538.96; -123.30]	0.12 ^{ns}
Léo	154.57	106.35	[-56.38; 365.53]	0.14 ^{ns}
2018 (Boxcox transformation)				
Random effects:	Std. error			
Block	282.93			
Block:Rotation	201.91			
Block:Rotation:Fertilization	0.093			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	4781.00	226.75	[4337.41; 5224.60]	< 0.001
Tiéningboué	-171.51	235.81	[-632.83; -171.51]	0.46 ^{ns}
Midebdo	-1685.59	234.54	[-2144.40; -1226.76]	< 0.001***
Léo	-670.08	235.81	[-1131.40; -208.76]	0.0052 **

Between the parenthesis after the year is indicated the type of transformation used on the data before the analysis if applied. Asterisks indicate the significance of the difference between the sites for each year: ns not significant, ** p<0.01, *** p<0.001.

Table S6. Summary of the linear mixed-effects model fitted by REML to assess the effect of site on soil surface coverage (%) by water yam aboveground organs in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 at 70, 84 and 98 days after planting (DAP). Water yam was cultivated in the presence of different fertilization regimes in 2016.

70 DAP				
Random effects:	Std. error			
Block	1.77			
Block:Rotation	6.89			
Block:Rotation:Fertilization	0.0012			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	70.68	2.43	[65.87; 75.50]	< 0.001
Tiéningboué	-43.66	3.20	[-50.00; -37.31]	< 0.001 ***
Midebdo	-48.92	3.22	[-55.29; -42.54]	< 0.001 ***
Léo	-36.73	3.24	[-43.14; -30.31]	< 0.001 ***
84 DAP				
Random effects:	Std. error			
Block	6.35			
Block:Rotation	3.76			
Block:Rotation:Fertilization	0.0031			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	80.64	2.92	[74.85; 86.43]	< 0.001
Tiéningboué	-12.07	4.14	[-20.26; -3.87]	0.051 ^{ns}
Midebdo	-41.12	4.14	[-49.31; -32.93]	< 0.001 ***
Léo	-30.34	4.18	[-38.62; -22.06]	< 0.001 ***
98 DAP				
Random effects:	Std. error			
Block	2.91			
Block:Rotation	2.57			
Block:Rotation:Fertilization	0.0034			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	94.87	2.52	[89.88; 99.86]	< 0.001
Tiéningboué	-7.59	3.58	[-14.69; -0.50]	0.053 ^{ns}
Midebdo	-46.43	3.56	[-53.49; -46.43]	< 0.001 ***
Léo	-32.72	3.60	[-39.85; -25.58]	< 0.001 ***

Asterisks indicate the significance of the difference between the sites for each year: ns not significant, *** p<0.001.

Table S7. Summary of the linear mixed-effects model fitted by REML to assess the effect of site on soil surface coverage (%) by water yam aboveground organs in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2018 at 70, 84, 98 and 126 days after planting (DAP). Water yam was cultivated in the presence of different fertilization regimes after either a cereal, a legume, or a yam within each fertilization regime.

70 DAP				
Random effects:	Std. error			
Block	3.21			
Block:Rotation	3.09			
Block:Rotation:Fertilization	1.56			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	59.39	2.63	[54.18; 64.59]	< 0.001
Tiéningboué	-36.25	2.64	[-41.49; -31.01]	< 0.001 ***
Midebdo	-49.37	2.64	[-54.60; -44.13]	< 0.001 ***
Léo	-31.76	2.66	[-37.02; -26.49]	< 0.001 ***
84 DAP				
Random effects:	Std. error			
Block	4.22			
Block:Rotation	0.0015			
Block:Rotation:Fertilization	2.90			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	68.52	3.06	[62.46; 74.58]	< 0.001
Tiéningboué	-30.17	3.08	[-36.27; -24.07]	< 0.001 ***
Midebdo	-47.48	3.07	[-53.58; -41.38]	< 0.001 ***
Léo	-30.07	3.08	[-36.17; -23.97]	< 0.001 ***
98 DAP				
Random effects:	Std. error			
Block	4.92			
Block:Rotation	0.0019			
Block:Rotation:Fertilization	5.35			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	73.21	3.42	[77.90; 89.91]	< 0.001
Tiéningboué	-26.77	3.17	[-21.20; -7.63]	< 0.001 ***
Midebdo	-21.53	3.14	[-32.89; -19.32]	< 0.001 ***
Léo	-16.51	3.16	[-32.12; -18.55]	< 0.001 ***
126 DAP				
Random effects:	Std. error			
Block	2.94			
Block:Rotation	0.0011			
Block:Rotation:Fertilization	6.94			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	90.54	2.75	[85.09; 95.99]	< 0.001
Tiéningboué	-29.40	2.97	[-35.29; -23.52]	< 0.001 ***
Midebdo	-25.94	2.97	[-31.82; -20.05]	< 0.001 ***
Léo	-25.58	2.99	[-31.50; -19.6]	< 0.001 ***

Asterisks indicate the significance of the difference between the sites for each year: *** $p < 0.001$.

Table S8. Summary of the linear mixed-effects model fitted by REML to assess the effect of site on soil surface coverage (%) by water yam organs in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2018 at 140, 154 and 168 days after planting (DAP). Water yam was cultivated in the presence of different fertilization regimes after either a cereal, a legume, or a yam for each fertilization regime.

140 DAP				
Random effects:	Std. error			
Block	0.0013			
Block:Rotation	2.95			
Block:Rotation:Fertilization	8.45			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	95.24	2.40	[90.47; 100.00]	< 0.001
Tiéningboué	-37.04	2.93	[-42.85; -31.24]	< 0.001 ***
Midebdo	-20.34	2.92	[-26.15; -14.53]	< 0.001 ***
Léo	-30.20	2.97	[36.08; -24.32]	< 0.001 ***
154 DAP				
Random effects:	Std. error			
Block	0.0019			
Block:Rotation	0.0066			
Block:Rotation:Fertilization	7.03			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	95.62	2.36	[90.93; 100.00]	< 0.001
Tiéningboué	-53.61	3.02	[-59.59; -47.62]	< 0.001 ***
Midebdo	-33.18	3.02	[-39.17; -27.19]	< 0.001 ***
Léo	-52.59	3.06	[-58.65; -46.53]	< 0.001 ***
168 DAP				
Random effects:	Std. error			
Block	2.77			
Block:Rotation	2.18			
Block:Rotation:Fertilization	0.0034			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	64.66	2.55	[59.60; 69.71]	< 0.001
Tiéningboué	-31.51	3.50	[-38.44; -24.58]	< 0.001 ***
Midebdo	-8.92	3.51	[-15.86; -1.99]	0.012 **
Léo	-52.86	0.54	[-59.87; -45.85]	< 0.001 ***

Asterisks indicate the significance of the difference between the sites for each year: ** p<0.001, *** p<0.001.

Table S9. Mean soil surface coverage (expressed in % of soil surface covered) by water yam aboveground organs according to the rotations and fertilization regimes in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) measured in 2016 and 2018. The values in parenthesis represent the coefficients of variation.

Year	Rotation	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
2016	YamCer YamLeg YamYam	NON	78.7 (23.2)	54.9 (55.1)	36.8 (62.7)	44.0 (47.0)
		MIN	80.3 (24.5)	58.8 (51.0)	53.5 (48.7)	64.5 (36.0)
		MINORG	83.8 (22.2)	63.6 (47.2)	46.5 (50.7)	49.8 (42.7)
		ORG	85.5 (20.6)	65.6 (49.0)	41.8 (45.9)	53.7 (46.5)
2018	YamCer	NON	77.6 (18.3)	42.3 (47.4)	30.0 (67.6)	30.0 (73.1)
	YamCer	MIN	81.5 (21.9)	41.4 (51.9)	57.6 (54.5)	45.9 (58.2)
	YamCer	MINORG	82.9 (21.1)	49.3 (40.2)	60.8 (47.0)	54.0 (56.9)
	YamCer	ORG	83.4 (21.1)	48.4 (42.4)	62.0 (46.2)	37.4 (53.0)
	YamLeg	NON	70.4 (23.1)	42.3 (41.5)	40.2 (52.8)	42.7 (56.6)
	YamLeg	MIN	80.2 (21.0)	48.1 (42.4)	62.3 (41.8)	52.4 (50.9)
	YamLeg	MINORG	80.9 (27.5)	53.9 (32.9)	52.4 (49.6)	50.1 (60.7)
	YamLeg	ORG	83.1 (20.4)	50.4 (35.9)	47.7 (64.7)	51.1 (47.9)
	YamYam	NON	69.5 (31.1)	34.3 (42.0)	39.4 (64.1)	34.8 (49.7)
	YamYam	MIN	75.8 (28.4)	55.6 (33.4)	48.2 (53.2)	45.7 (54.7)
	YamYam	MINORG	82.8 (17.4)	51.2 (39.3)	38.9 (62.3)	50.8 (49.7)
	YamYam	ORG	78.5 (29.5)	40.7 (51.9)	57.8 (47.5)	54.6 (48.2)

In 2016, the varieties cultivated were C18 for Liliyo, Woroba for Tiéningboué and Florido for Midebdo and Léo. In 2018, yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regime. The fertilization regimes are: NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG. In 2018, yam variety C18 was cultivated in the four sites after either a cereal (YamCer), a legume (YamLeg) or a yam (YamYam) for each fertilization regime. In 2016, the rotations showed correspond to plot names.

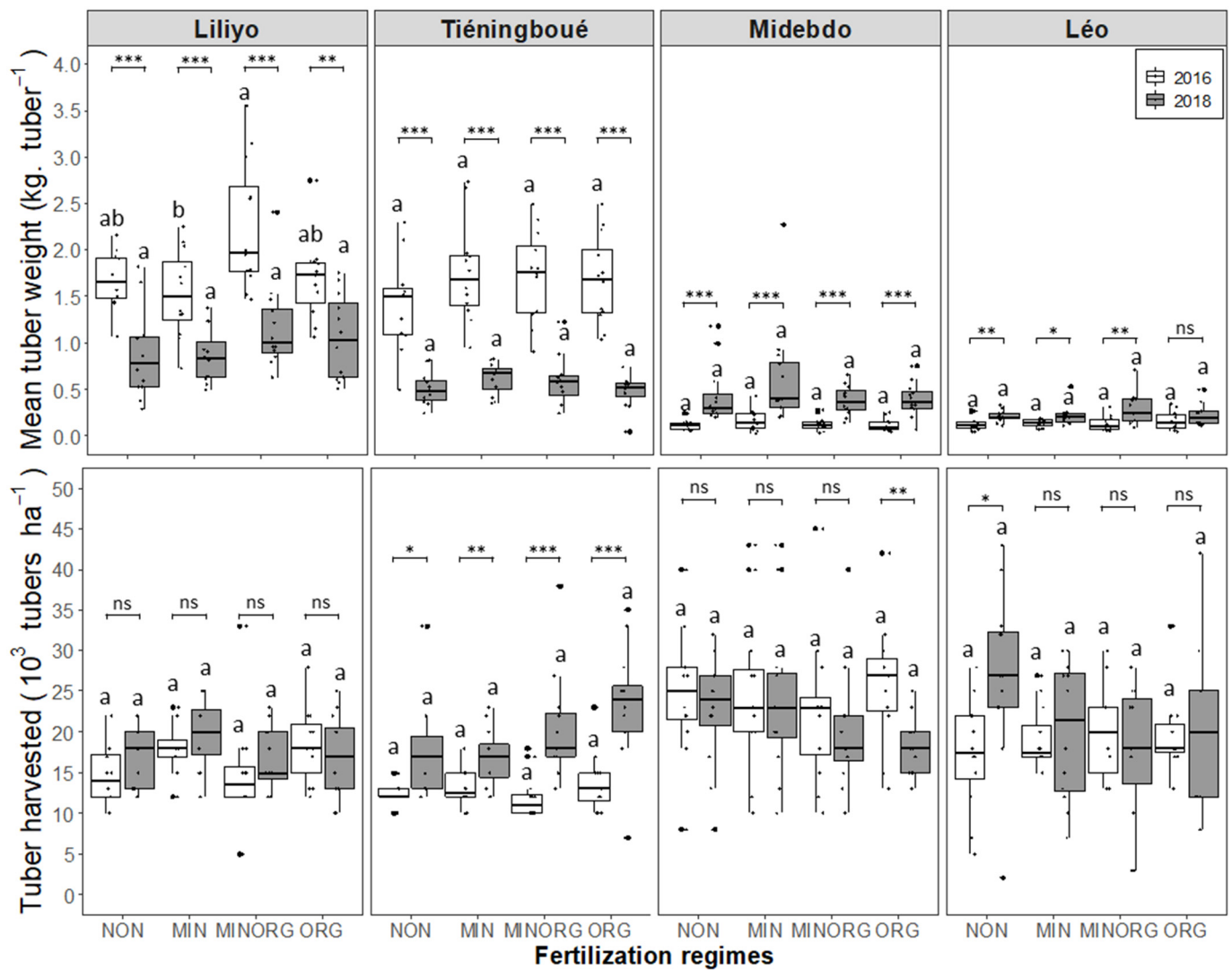


Figure S4. Effect of years and fertilization regimes on water yam mean tuber weights and tuber number in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 and 2018. In 2016, the varieties cultivated were C18 for Liliyo, Woroba for Tiéningboué and Florido for Midebdo and Léo. In 2018, yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regime. For each site and each year, different letters denote significant differences between fertilization regimes calculated by Tukey test at $p\text{-level} \leq 0.05$ ($n = 12$ replicates per fertilization). Asterisks indicate the results of the t-test assessing the significance of the difference between the years for each site and fertilization regimes: ns not significant, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. The fertilization regimes are: NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG.

Table S10. Summary of the linear mixed-effects model fitted by REML to assess the effect of site on water yam fresh tuber yields (t ha⁻¹) in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 and 2018. Water yam was cultivated in the presence of different fertilization regimes in 2016 and 2018. In 2018, for each fertilization regime, water yam was cultivated after either a cereal, a legume, or a yam for each fertilization regime.

2016 (log transformation)				
Random effects:	Std. error			
Block	7.67			
Block:Rotation	3.82			
Block:Rotation:Fertilization	0.14			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	3.40	0.05	[3.29; 3.51]	< 0.001
Tiéningboué	-0.43	0.07	[-0.57; -0.28]	< 0.001 ***
Midebdo	-2.51	0.07	[-2.66; -2.37]	< 0.001 ***
Léo	-2.61	0.07	[-2.75; -2.46]	< 0.001 ***
2018				
Random effects:	Std. error			
Block	5.54			
Block:Rotation	1.12			
Block:Rotation:Fertilization	0.0007			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (Liliyo)	16.44	0.71	[15.03; 17.85]	< 0.001
Tiéningboué	-5.83	0.90	[-7.62; -4.04]	< 0.001 ***
Midebdo	-7.47	0.89	[-9.25; -5.70]	< 0.001 ***
Léo	-11.24	0.90	[-13.04; -9.44]	< 0.001 ***

Between the parenthesis after the year is indicated the type of transformation used on the data before the analysis if applied. Asterisks indicate the significance of the difference between the sites for each year: *** p<0.001.

Table S11. Summary of the linear mixed-effects model fitted by REML to assess the effect of fertilization regime on water yam fresh tuber yields (t ha⁻¹) in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 cultivated in the presence of different fertilization regimes.

Liliyo				
Random effects:	Std. error			
Block	0.00057			
Block:Rotation	0.00033			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (NON)	27.32	3.05	[21.36; 33.28]	< 0.001
MIN	4.18	4.32	[-4.24; 12.61]	0.34 ^{ns}
MINORG	8.20	4.32	[-0.22; 16.63]	0.06 ^{ns}
ORG	6.29	4.42	[-2.32; 14.91]	0.16 ^{ns}
Tiéningboué				
Random effects:	Std. error			
Block	2.08			
Block:Rotation	0.00055			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (NON)	17.19	1.72	[13.83; 20.55]	< 0.001
MIN	4.63	1.84	[1.03; 8.23]	0.05 ^{ns}
MINORG	2.48	1.84	[-1.11; 6.08]	0.18 ^{ns}
ORG	5.30	1.84	[1.70; 8.91]	0.007 ^{**}
Midebdo (log transformation)				
Random effects:	Std. error			
Block	1.86			
Block:Rotation	0.16			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (NON)	0.82	0.12	[0.57; 1.07]	< 0.001
MIN	0.25	0.16	[-0.07; 0.58]	0.14 ^{ns}
MINORG	0.02	0.16	[-0.30; 0.35]	0.87 ^{ns}
ORG	-0.01	0.16	[-0.34; 0.31]	0.94 ^{ns}
Léo (log transformation)				
Random effects:	Std. error			
Block	1.39			
Block:Rotation	0.19			
Fixed effects:	Estimate	Std. error	CI-95%	p-value
Intercept (NON)	0.57	0.12	[0.32; 0.83]	< 0.001
MIN	0.33	0.15	[0.01; 0.66]	0.05 ^{ns}
MINORG	0.17	0.16	[-0.15; 0.51]	0.28 ^{ns}
ORG	0.37	0.16	[0.04; 0.71]	0.02 [*]

Between the parenthesis after the site name is indicated the type of transformation used on the data before the analysis if applied. Asterisks indicate the significance of the difference between the sites for each year: ns not significant, * p<0.05, ** p<0.01.

Table S12. Fresh tuber yield (t ha⁻¹) of water yam according to the rotations and fertilizations fertilization regimes in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) measured in 2016 and 2018. The values in parenthesis represent the coefficients of variation expressed in % of the mean yield.

Year	Rotation	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
2016	YamCer, YamLeg, YamYam	NON	27.3 (25.4)	17.0 (31.2)	2.5 (38.2)	1.9 (38.2)
		MIN	31.5 (35.2)	21.8 (17.0)	3.3 (47.3)	2.6 (23.6)
		MINORG	35.5 (34.6)	19.7 (18.1)	2.5 (35.3)	2.4 (47.7)
		ORG	33.6 (33.8)	22.5 (29.1)	2.5 (49.6)	2.9 (49.4)
2018	YamCer	NON	16.1 (52.5)	10.9 (30.9)	7.3 (14.9)	4.7 (41.6)
	YamCer	MIN	15.4 (38.0)	7.4 (42.0)	11.1 (31.9)	3.8 (59.1)
	YamCer	MINORG	18.7 (23.3)	14.0 (35.8)	12.2 (16.8)	9.3 (79.2)
	YamCer	ORG	19.1 (28.7)	12.3 (31.6)	8.8 (32.1)	2.8 (66.8)
	YamLeg	NON	15.4 (28.1)	8.5 (20.3)	8.6 (40.6)	6.1 (66.7)
	YamLeg	MIN	20.8 (27.3)	11.3 (18.0)	12.1 (58.8)	7.3 (79.7)
	YamLeg	MINORG	17.3 (15.3)	11.5 (24.2)	7.9 (31.7)	4.4 (100.9)
	YamLeg	ORG	17.6 (22.9)	12.5 (37.3)	5.8 (80.6)	5.4 (42.4)
	YamYam	NON	11.0 (60.3)	7.2 (53.8)	9.6 (54.5)	5.8 (11.9)
	YamYam	MIN	13.8 (39.9)	12.5 (17.1)	13.7 (62.4)	3.1 (21.2)
	YamYam	MINORG	18.9 (34.2)	8.2 (34.7)	3.4 (39.9)	4.9 (87.7)
	YamYam	ORG	13.3 (34.5)	10.5 (66.4)	7.0 (28.4)	4.6 (82.5)

In 2016, the varieties cultivated were C18 for Liliyo, Woroba for Tiéningboué and Florido for Midebdo and Léo. In 2018, yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization re-gime. The fertilization regimes are: NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure). In 2018, yam variety C18 was cultivated in the four sites after either a cereal (YamCer), a legume (YamLeg) or a yam (YamYam) for each fertilization regime. In 2016, the rotations showed correspond to plot names.

Table S13. Rainfall use efficiency (kg ha⁻¹ mm⁻¹) according to fertilization regimes in Liliyo and Tiéningboué (Côte d'Ivoire), Midebdo and Léo (Burkina Faso) in 2016 and 2018. In 2018, yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regime. The values following \pm after the means are standard errors.

Year	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
2016	NON	6.8 \pm 0.51	5.0 \pm 0.52	1.3 \pm 0.14	0.7 \pm 0.08
	MIN	8.5 \pm 0.93	5.9 \pm 0.39	1.7 \pm 0.23	0.9 \pm 0.06
	MINORG	8.5 \pm 0.91	5.4 \pm 0.33	1.2 \pm 0.13	0.8 \pm 0.12
	ORG	8.2 \pm 0.90	6.0 \pm 0.56	1.2 \pm 0.18	1.1 \pm 0.16
2018	NON	2.3 \pm 0.31	2.5 \pm 0.30	2.3 \pm 0.26	2.2 \pm 0.27
	MIN	2.7 \pm 0.31	2.7 \pm 0.26	3.1 \pm 0.47	1.7 \pm 0.39
	MINORG	2.7 \pm 0.22	2.7 \pm 0.32	1.9 \pm 0.34	2.0 \pm 0.54
	ORG	2.5 \pm 0.21	3.0 \pm 0.38	1.7 \pm 0.25	1.6 \pm 0.33

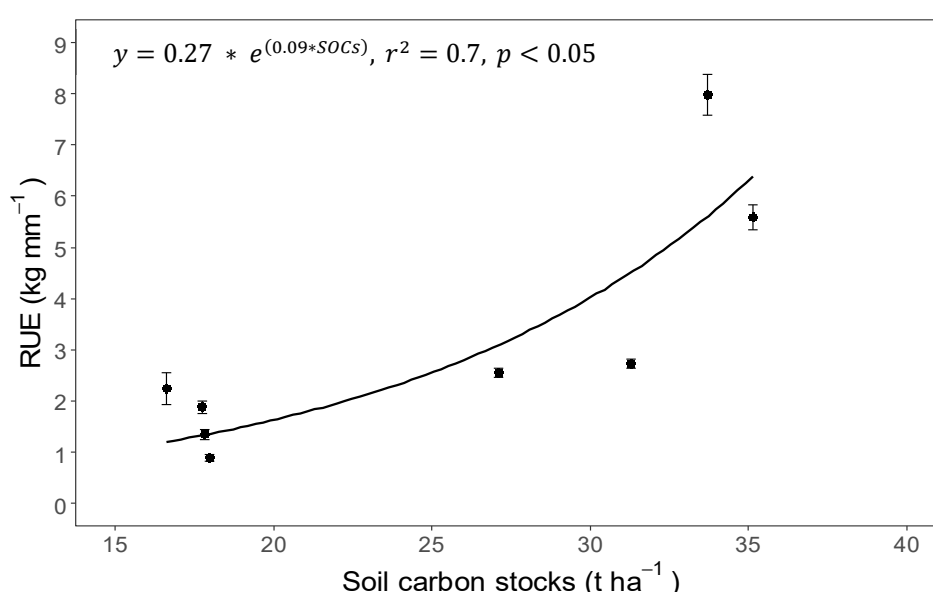


Figure S5. Relationship between rainfall use efficiency (RUE) by water yam cultivated under various fertilization regimes (NON, MIN, MINORG and ORG) and soil carbon stocks in Liliyo and Tiéningboué (Côte d’Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 and 2018. In 2018, yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regime. The regression equation, the coefficient of determination and the p value are shown on the graphs. Each point of RUE and soil carbon stock represents a mean of 48 replicates. The fertilization regimes are: NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure).

Table S14. Summary of variables significantly associated to each cluster identified by the hierarchical clustering on principal components performed on data of water yam cultivated under various fertilization regimes (NON, MIN, MINORG and ORG) in Liliyo, Tiéningboué, Midebdo and Léo in 2016.

Cluster	Variables	Mean within cluster	Over all mean	p.value
(1)	SSC_70 (%)	70.7	38.2	***
	Yield (t ha ⁻¹)	32.0	14.3	***
	SSC_98 (%)	94.9	73.1	*
	SOCs (t ha ⁻¹)	33.7	26.1	*
(2)	SOCs (t ha ⁻¹)	35.1	26.1	*
(3)	Yield (t ha ⁻¹)	2.4	14.34	*
	SOCs (t ha ⁻¹)	17.9	26.1	*
	pH (water)	5.3	6.0	*
(4)	pH (water)	7.1	6.0	***
	Yield (t ha ⁻¹)	2.7	14.3	*
	SOCs (t ha ⁻¹)	17.8	26.1	*
	SSC_98 (%)	48.4	73.1	**
	Final_Em (%)	93.2	96.6	***

Mean within cluster represent the mean of each variable for all individuals belonging to the cluster. Overall mean represents the means of each variable for all the data set using for the analysis (mean of 192 observations). Clusters 1, 2, 3 and 4 correspond respectively to Lilio, Tiéningboué, Midebdo and Léo. SOC_s = Soil carbon stocks; pH = pH (H₂O); Final_EM = final yam emergence rate; SSC₇₀ = Soil surface coverage by water yam above-ground organs at 70 days after planting; Yield = Yam fresh tubers yields in t ha⁻¹.

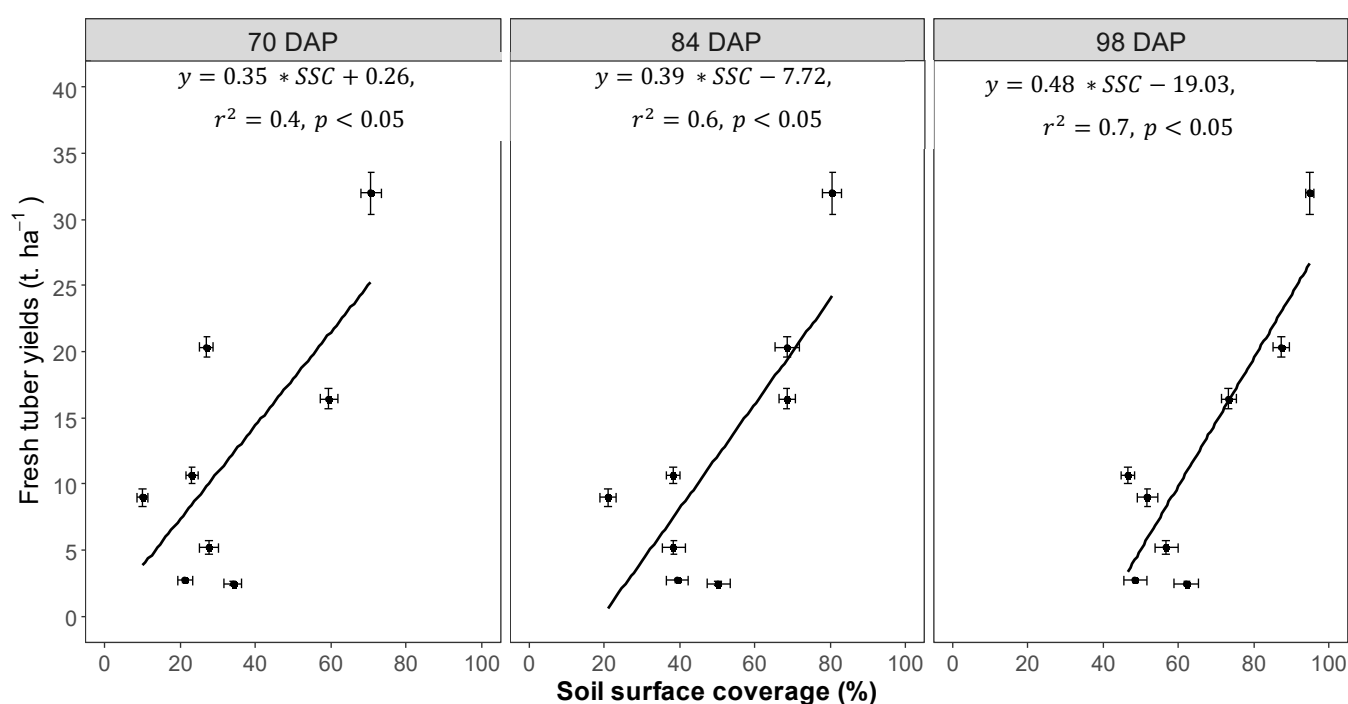


Figure S6. Relationships between yam fresh tuber yields and soil surface coverage by water yam aboveground organs measured in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2016 and 2018 at 70, 84 and 98 DAP (n=4). The yam variety C18 was cultivated in the four sites after either a cereal, a legume or a yam for each fertilization regimes (NON, MIN, MINORG and ORG). The linear regressions, the coefficients of determination (r^2) and the p-values are shown in the graph. Each point represents a mean of 192 observations both for fresh tuber yield and soil surface coverage. DAP =days after planting; NON (no fertilization), MIN (sole mineral fertilization as NPK), MINORG combined organic and mineral fertilization) and ORG (sole organic fertilization as manure).

Table S15. Summary of variables significantly associated to each cluster identified by the hierarchical clustering on principal components performed on data of water yam cultivated in Liliyo, Tiéningboué, Midebdo and Léo after either a cereal, a legume or a yam under various fertilization regimes (NON, MIN, MINORG and ORG) in 2018.

Cluster	Variables	Mean within cluster	Over all mean	p.value
(1)	SSC_70 (%)	59.4	30.1	***
	SSC_154 (%)	95.6	60.8	***
	Yield (t ha ⁻¹)	16.5	10.3	***
	SSC_126 (%)	90.5	70.4	***
	SSC_98 (%)	73.2	57.0	***
	Final_Em (%)	97.6	89.2	***
	SOCs (t ha ⁻¹)	27.3	21.7	**
(2)	Final_Em (%)	94.1	89.2	***
	SSC_98 (%)	51.8	57.0	***
	Yield (t ha ⁻¹)	8.4	10.3	***
	SSC_126 (%)	63.7	70.4	***
	SSC_154 (%)	44.0	60.8	***
	pH (water)	5.4	5.8	***
(3)	pH (water)	6.4	5.8	***
	Yield (t ha ⁻¹)	8.0	10.3	**
	SOCs (t ha ⁻¹)	15.5	21.7	***
	SSC_70 (%)	12.6	30.1	***
	Final_Em (%)	72.9	89.2	***

Mean within cluster represent the mean of each variable for all individuals belonging to the cluster. Over all mean represents the means of each variable for all the data set using for the analysis (mean of 192 observations). SOC_s = Soil carbon stocks; pH = pH (H₂O); Final_EM = final yam emergence rate; SC₇₀, SC₉₈, SC₁₂₆, and 154 = Soil surface coverage by water yam aboveground organs at 70, 98, 126, and 154 days after planting; Yield = Yam fresh tubers yields in t ha⁻¹.

Table S16. Amount of N (kg ha⁻¹) fixed by groundnut in Liliyo and Tiéningboué (Côte d'Ivoire), and Midebdo and Léo (Burkina Faso) in 2017.

Year	Fertilization regimes	Liliyo	Tiéningboué	Midebdo	Léo
2016	NON	32.6	37.9	28.0	53.5
	MIN	20.3	54.0	20.6	63.0
	MINORG	30.2	37.8	15.3	36.5
	ORG	37.3	52.1	24.1	58.9

N fixation was measured using the ¹⁵N natural abundance method (Unkovich, 2008).