Supplementary Materials

Table S1. Weather conditions during the seven crop growing seasons

Crop and year	Growth periods	Time (days)	P (+ irr.) (mm)	ETc (mm)	P-ETc (mm)	Moisture conditions
BW 2005	Ini	31	149	14	135	Wet
	Dev	145	289	160	129	Wet
	Mid	41	65	196	-131	Dry
	Late	31	17	123	-106	Dry
SU 2006	Ini	30	63	24	39	Wet
	Dev	42	81	90	-9	Dry
	Mid	53	23	161	-137	Dry
	Late	30	11	48	-37	Dry
BW 2007	Ini	32	14	23	-9	Dry
	Dev	147	246	159	86	Wet
	Mid	42	15	221	-206	Dry
	Late	31	12	116	-104	Dry
BW 2009	Ini	32	145	16	129	Wet
	Dev	147	320	182	138	Wet
	Mid	42	106	225	-120	Dry
	Late	31	30	117	-87	Dry
SO 2010	Ini	19	51	22	29	Wet
	Dev	35	99	129	-30	Dry
	Mid	45	117	289	-173	Dry
	Late	30	75	117	-42	Dry
MA 2018	Ini	20	9 (+60)	48	21	Wet
	Dev	35	85 (+30)	166	-51	Dry
	Mid	40	135	214	-79	Dry
	Late	4	0	11	-11	Dry
MA 2020	Ini	30	23	34	-11	Dry
	Dev	40	55	152	-97	Dry
	Mid	50	101	359	-258	Dry
	Late	13	37	66	-29	Dry

BW, bread wheat; SU, sunflower; SO, sorghum; MA, maize; P, total precipitation; irr., irrigation; ETc, crop evapotranspiration; Ini, initial; Dev, crop development; Mid, mid-season; Late, late-season.
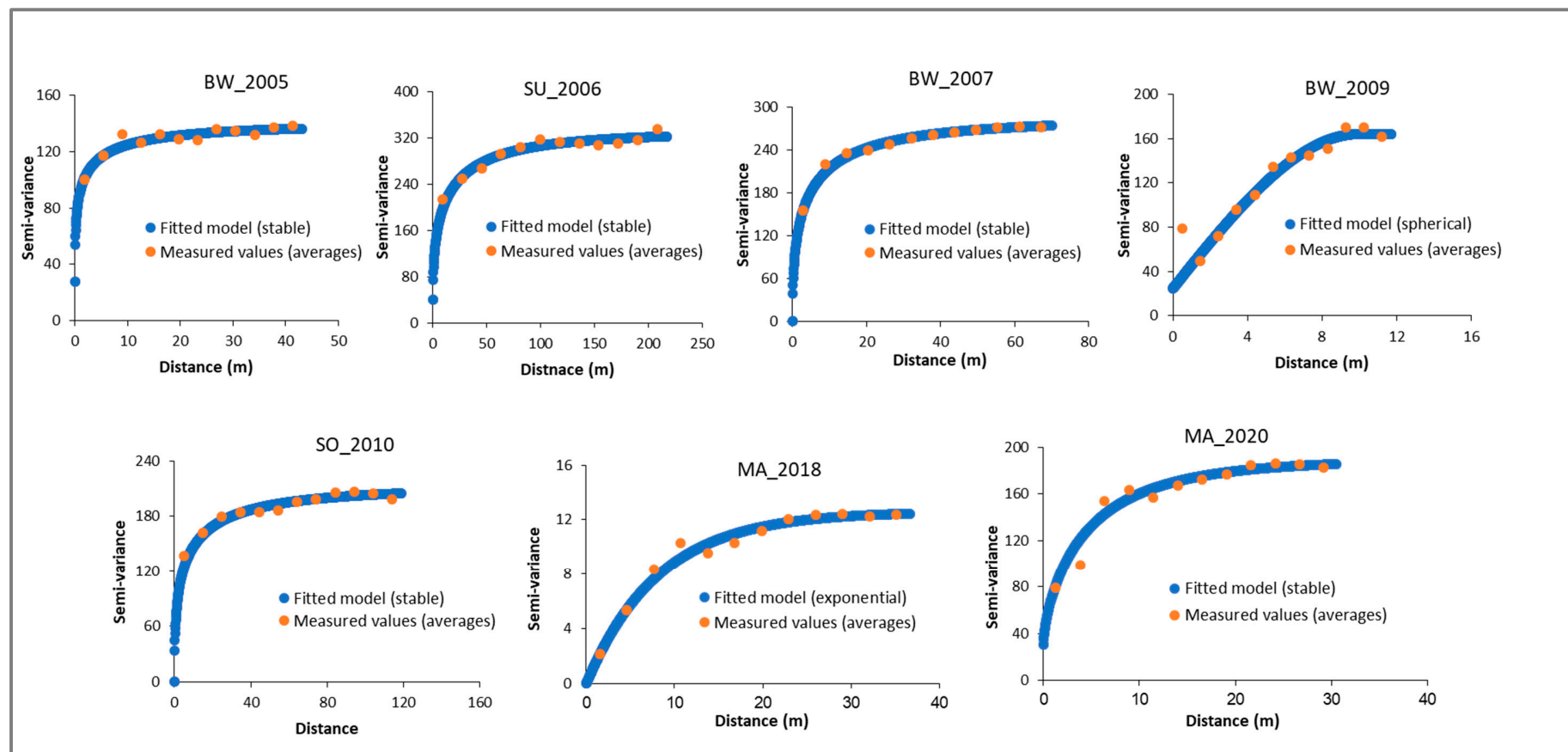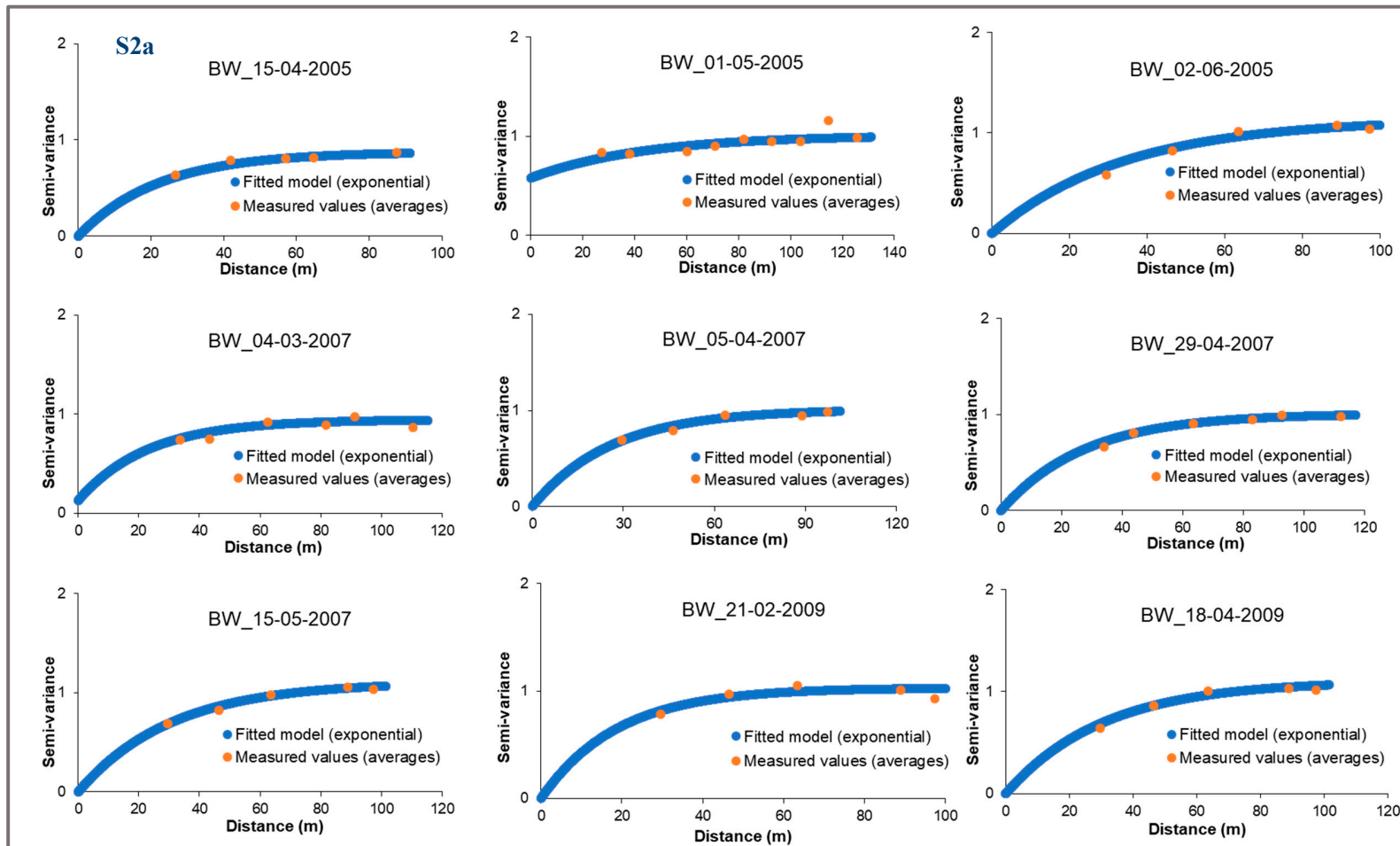
Figure S1. Semi-variogram model of standardized crop yields

Table S2. Descriptive statistics of soil traits

Soil variables	Mean	Median	Min	Max	SD	Skewness	Kurtosis
Depth 0-30 cm							
Sand (g/kg)	558	523	338	824	152	0.14	-1.35
Silt (g/kg)	363	400	141	540	122	-0.21	-1.33
Clay (g/kg)	79	84.5	31	135	33	0.09	-1.31
pH	7.92	7.88	7.62	8.22	0.16	0.27	-0.47
$CaCO_3$ (g/kg)	145	147	125	166	10	-0.08	-0.4
C (g/kg)	15	15.5	9.44	19.7	2.79	-0.25	-0.61
N (g/kg)	1.8	1.87	1.22	2.37	0.35	-0.15	-0.9
C:N	8.39	8.33	7.65	9.15	0.42	0.09	-0.9
ECe (dS/m)	0.38	0.39	0.26	0.52	0.08	0.17	-0.91
Depth 30-60 cm							
Sand (g/kg)	540	492	331	789	148	0.33	-1.33
Silt (g/kg)	345	373	165	518	112	-0.1	-1.26
Clay (g/kg)	115	125	32	221	48	0.08	-0.42
pH	7.94	7.90	7.6	8.29	0.17	0.27	-0.35
$CaCO_3$ (g/kg)	143	146	84	165	18.4	-1.84	4.41
C (g/kg)	12	11.8	7.98	16	2.15	0	-0.6
N (g/kg)	1.44	1.46	0.94	1.75	0.24	-0.33	-0.68
C:N	8.29	8.33	7.74	9.21	0.37	0.64	0.48
ECe (dS/m)	0.46	0.41	0.26	0.76	0.14	0.88	0.08

Min, minimum; Max, maximum; SD, standard deviation.

S2a

BW_15-04-2005

BW_01-05-2005

BW_02-06-2005

BW_04-03-2007

BW_05-04-2007

BW_29-04-2007

BW_15-05-2007

BW_21-02-2009

BW_18-04-2009

Fitted model (exponential)
Measured values (averages)

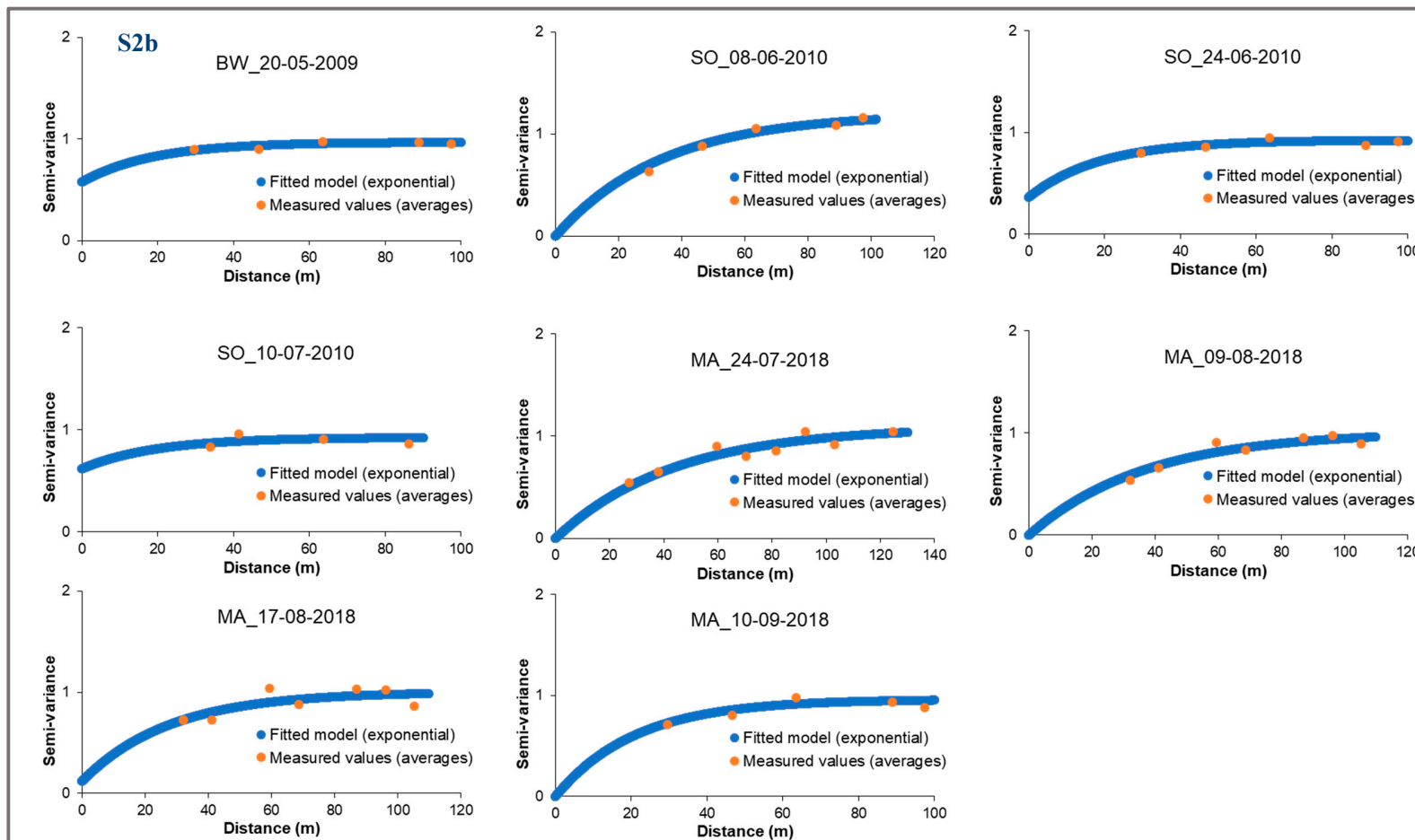Semi-variance

Distance (m)

4

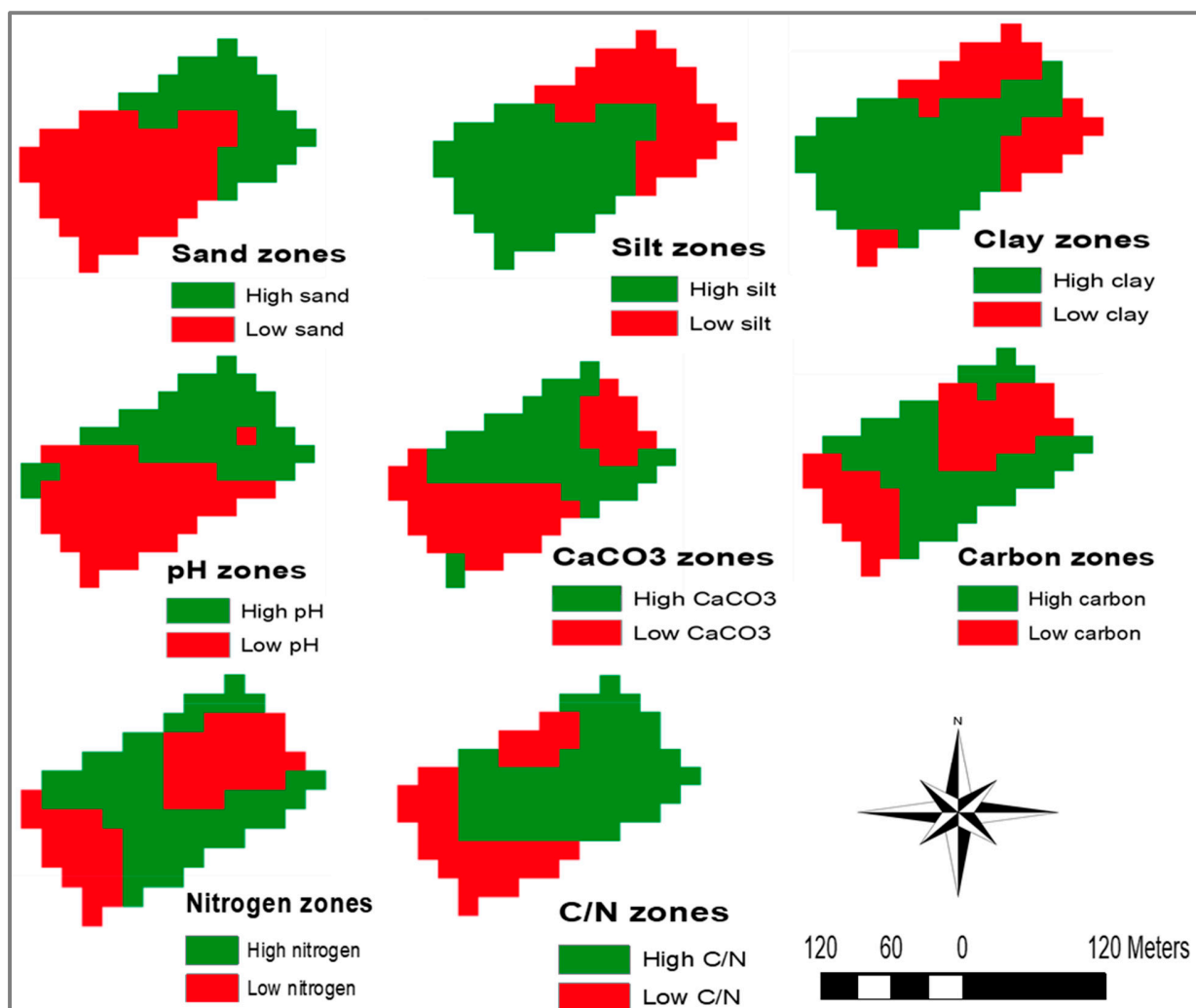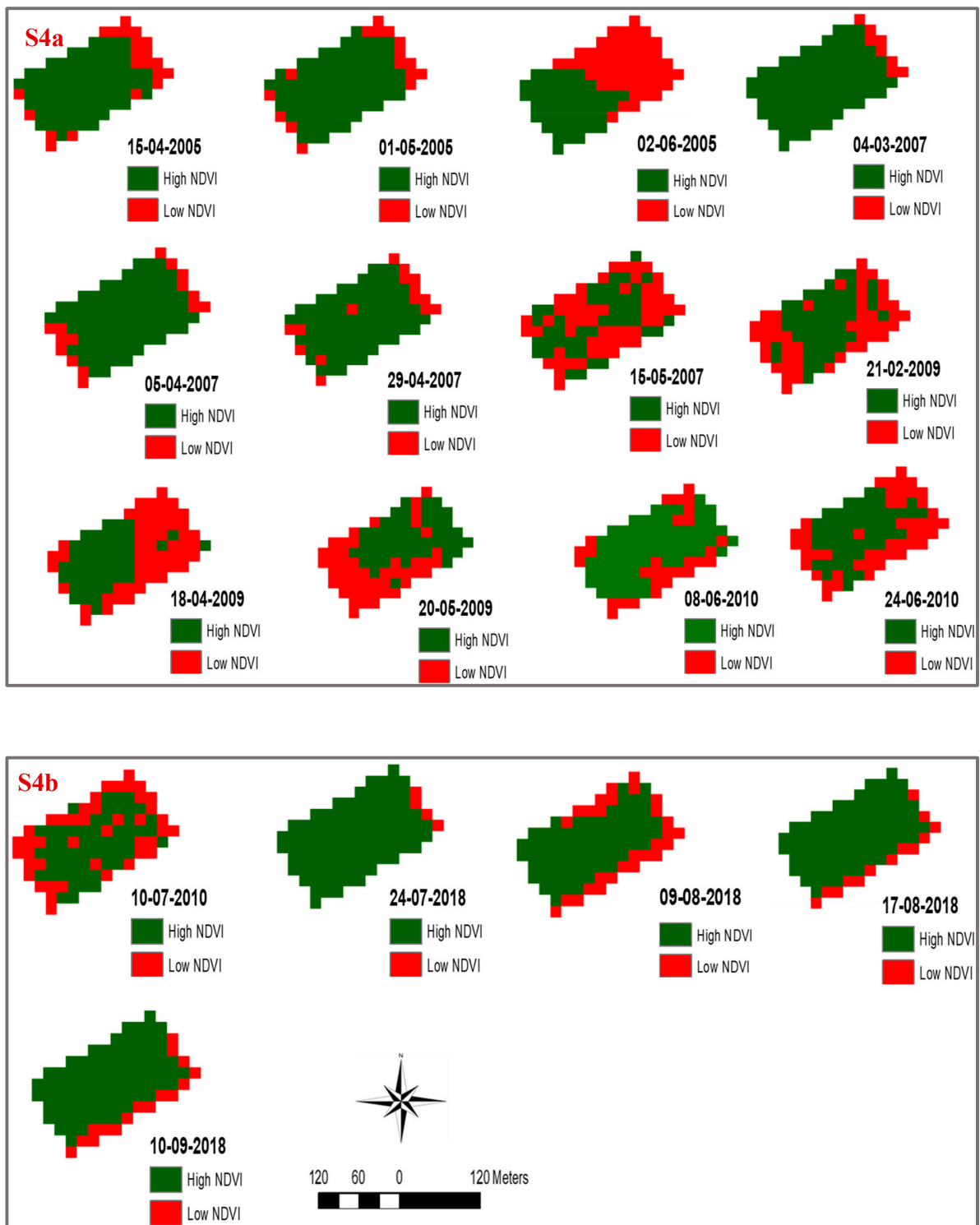**Figure S2.** Semi-variogram models of NDVI data

Figure S3. Single soil property zones

Figure S4. Single NDVI zones

Table S3. Statistical differences between 2-zone single soil property maps and their pixel agreements with yield zones

Soil traits	Zones	Data points	Mean ± LSD	Agreement (%)
Sand (g/kg)	High sand	36	626 ± 43.2 a	63
	Low sand	63	483 ± 34.3 b	
Silt (g/kg)	High silt	63	404 ± 27.8 a	90
	Low silt	36	292 ± 32.1 b	
Clay (g/kg)	High clay	67	112 ± 7.39 a	94
	Low clay	32	79.3 ± 10.42 b	
pH	High pH	45	7.95 ± 0.01 a	72
	Low pH	54	7.92 ± 0.01 b	
CaCO3 (g/kg)	High CaCO3	49	146 ± 1.31 a	76
	Low CaCO3	50	142 ±1.05 b	
Carbon (g/kg)	High Carbon	53	14.1 ± 0.62 a	80
	Low Carbon	46	12.4 ± 0.63 b	
Nitrogen (g/kg)	High Nitrogen	54	1.69 ± 0.08 a	81
	Low Nitrogen	45	1.48 ± 0.07 b	
C/N	High C/N	62	8.42 ± 0.06 a	89
	Low C/N	37	8.23 ± 0.05 b	

Statistical differences between 2-zones of single soil property and their pixel agreement (%) with crop yields. Means bearing different letters are significantly different within 2-zone classes at p = 0.05 level according to the least-significant difference (LSD) test.

Table S4. Statistical differences between 2-zone single NDVI maps and their pixel agreements with yield zones

Crop & year	Date	Zones	Data points	Mean ± LSD	Agreement (%)
BW 2005	15-Apr	High NDVI	78	0.70 ± 0.012 a	95
		Low NDVI	21	0.65 ± 0.032 b	
	1-May	High NDVI	83	0.77 ± 0.01 a	90
		Low NDVI	16	0.72 ± 0.014 b	
	2-Jun	High NDVI	47	53 ± 0.01 a	74
		Low NDVI	52	48 ± 0.02 b	
BW 2007	4-Mar	High NDVI	91	0.72 ± 0.015 a	83
		Low NDVI	9	0.63 ± 0.027 b	
	5-Apr	High NDVI	84	0.84 ± 0.008 a	89
		Low NDVI	15	0.80 ± 0.014 b	
	29-Apr	High NDVI	84	0.67 ± 0.006 a	89
		Low NDVI	15	0.64 ± 0.013 b	
	15-May	High NDVI	44	0.62 ± 0.006 a	71
		Low NDVI	55	0.60 ± 0.009 b	
BW 2009	21-Feb	High NDVI	50	0.57 ± 0.014 a	77
		Low NDVI	49	0.52 ± 0.021 b	
	18-Apr	High NDVI	45	0.70 ± 0.013 a	72
		Low NDVI	54	0.66 ± 0.021 b	
	20-May	High NDVI	51	0.62 ± 0.005 a	78
		Low NDVI	48	0.60 ± 0.001 b	
SO 2010	8-Jun	High NDVI	70	0.50 ± 0.02 a	97
		Low NDVI	29	0.43 ± 0.033 b	
	24-Jun	High NDVI	51	0.73 ± 0.004 a	78
		Low NDVI	48	0.71 ± 0.013 b	
	10-Jul	High NDVI	56	0.73 ± 0.002 a	83
		Low NDVI	43	0.72 ± 0.009 b	
MA 2018	24-Jul	High NDVI	95	0.60 ± 0.033 a	78
		Low NDVI	4	0.38 ± 0.068 b	
	9-Aug	High NDVI	71	0.66 ± 0.022 a	98
		Low NDVI	28	0.56 ± 0.042 b	
	17-Aug	High NDVI	86	0.81 ± 0.023 a	87
		Low NDVI	13	0.62 ± 0.074 b	
	10-Sep	High NDVI	83	0.59 ± 0.028 a	90
		Low NDVI	16	0.42 ± 0.057 b	

Statistical differences between 2-zones of NDVI data and their pixel agreement (%) with crop yields. Means bearing different letters are significantly different within 2-zone classes at p = 0.05 level according to the least-significant difference (LSD) test
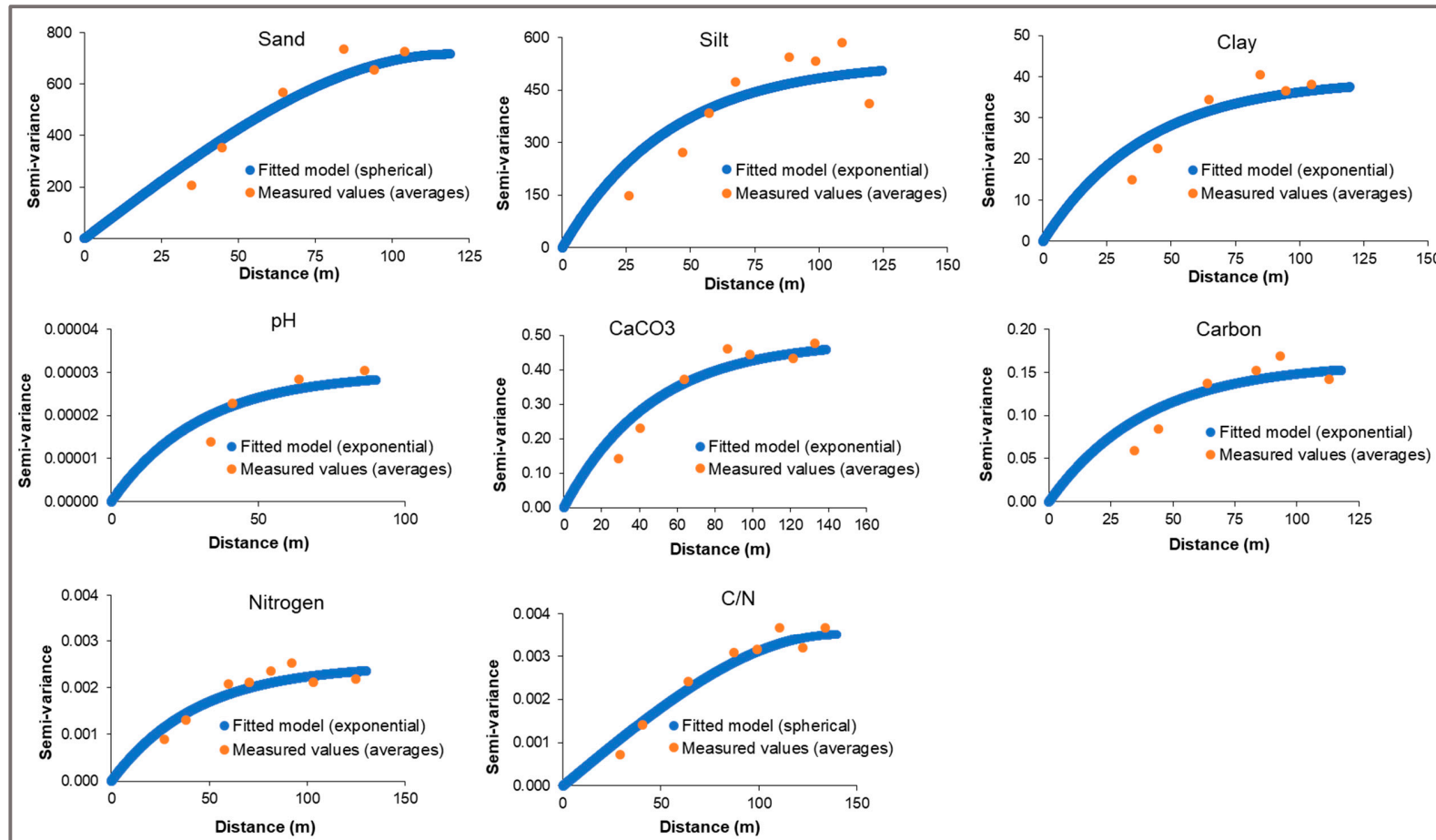
Figure S5. Semi-variogram graph of soil traits