

**Supplemental Table S2: chemical and physical parameters of the soils from study sites**

Agro-ecological zone Region, District-village	OC-BlkW	TN- Kjeldah	C/N ratio	Cu	Zn	Mn	Fe	Clay	Silt	Sand	Texture
	(%)	(%)									
<b>Songwe</b>											
Mbozi_Mbimba	2.53±0.006	0.21±0.006	11.85±0.006	2.16±0.006	3.74±0.006	120.00±0.006	55.15±0.006	46.68±0.006	17.64±0.006	35.68±0.006	Clay
Mbozi_Ivwanga	1.95±0.006	0.15±0.006	12.66±0.006	0.05±0.006	4.01±0.006	146.98±0.006	63.59±0.006	42.68±0.006	15.64±0.006	41.68±0.006	clay
Mbozi_Nambala	1.66±0.006	0.13±0.006	13.18±0.006	1.82±0.006	2.22±0.006	127.02±0.006	17.78±0.006	40.68±0.006	7.64±0.006	51.68±0.006	SC
Momba_Impumpila	0.87±0.002	0.10±0.002	9.20±0.002	0.08±0.002	1.59±0.002	119.68±0.002	34.29±0.002	17.18±0.289	8.13±0.283	76.17±0.283	SL
Momba_Isanga	1.21±0.002	0.10±0.002	12.41±0.002	0.11±0.002	1.67±0.002	141.24±0.002	27.90±0.002	22.82±0.461	3.45±0.193	73.49±0.193	SCL
Momba_Kakozi	1.06±0.003	0.09±0.003	12.64±0.003	0.20±0.003	2.17±0.003	155.00±0.003	24.76±0.003	27.32±0.321	7.95±0.307	65.99±0.307	SCL
Ileje_Itumba	0.85±0.000	0.07±0.000	11.56±0.000	1.47±0.000	2.19±0.000	111.57±0.000	76.47±0.000	32.44±0.139	6.40±0.139	60.44±0.139	SCL
Ileje_Namangoni	1.3±0.100	0.22±0.100	10.46±0.100	1.92±0.100	5.88±0.100	106.38±0.100	20.90±0.100	42.78±0.100	6.74±0.100	50.78±0.100	SC
Ileje_Isongole	1.68±0.003	0.18±0.003	9.41±0.003	1.59±0.003	7.89±0.003	84.15±0.003	36.3±0.003	44.38±0.300	6.34±0.300	48.38±0.300	SC
<b>Rukwa</b>											
Nkasi_Milundikwa	2.02±0.03	0.19±0.030	12.66±0.03	3.43±0.030	2.27±0.030	93.42±0.030	83.73±0.030	34.71±0.030	7.67±0.030	57.71±0.030	SCL
Nkasi_Kasu	1.14±0.001	0.10±0.001	10.85±0.001	1.93±0.001	0.95±0.001	117.07±0.001	125.07±0.001	20.27±0.237	1.23±0.237	77.27±0.237	SCL
Nkasi_Kantawa	0.93±0.001	0.08±0.001	11.03±0.001	0.75±0.001	5.51±0.001	84.4±0.001	67.98±0.001	12.67±0.013	0.63±0.013	86.67±0.013	LS
Sumbawanga TC_Chanji	0.98±0.000	0.08±0.000	11.72±0.000	1.09±0.000	2.49±0.000	47.15±0.000	15.66±0.000	18.67±0.007	1.63±0.007	79.67±0.007	SL
Sumbawanga TC_Kizitwe	1.04±0.000	0.08±0.000	12.41±0.000	1.18±0.000	1.17±0.000	33.10±0.000	28.50±0.000	22.62±0.063	0.58±0.063	76.62±0.063	SCL
Sumbawanga TC_Ntendo	1.22±0.007	0.13±0.007	10.23±0.007	0.89±0.007	3.19±0.007	78.94±0.007	74.23±0.007	12.69±0.007	1.65±0.007	85.69±0.007	LS
Sumbawanga R_Ndelema	1.04±0.013	0.09±0.013	13.30±0.013	1.12±0.013	1.34±0.013	33.84±0.013	36.40±0.013	18.69±0.013	3.65±0.013	77.69±0.013	SL
Sumbawanga R_Laela	0.81±0.004	0.07±0.004	10.53±0.004	0.52±0.004	9.70±0.004	82.33±0.004	11.16±0.004	16.58±0.100	1.54±0.100	81.58±0.100	SL
Sumbawanga R_Lusaka	1.02±0.004	0.09±0.004	10.82±0.004	1.44±0.004	2.39±0.004	29.99±0.004	57.27±0.004	22.62±0.063	7.58±0.063	69.62±0.063	SCL
<b>Mbeya</b>											
Mbeya rural_Mvunwa	1.44±0.007	0.10±0.007	15.13±0.007	0.22±0.007	18.22±0.007	106.96±0.007	29.31±0.007	22.69±0.007	16.65±0.007	60.69±0.007	SCL
Mbeya rural_Njelenje	0.86±0.013	0.15±0.013	6.40±0.013	0.37±0.013	3.38±0.013	154.28±0.013	41.03±0.013	18.69±0.013	11.65±0.013	69.69±0.013	SL
Mbeya rural_Mshewe	1.52±0.003	0.12±0.003	12.81±0.003	2.15±0.003	12.65±0.003	66.16±0.003	67.18±0.003	26.02±0.300	23.7±0.300	49.38±0.300	SCL
Chunya_Chokaa	0.60±0.002	0.09±0.002	6.58±0.002	0.62±0.002	5.29±0.002	122.27±0.002	25.49±0.002	10.34±0.020	7.02±0.020	82.70±0.020	LS
Chunya_Kibaoni	0.73±0.006	0.08±0.006	9.53±0.006	2.75±0.006	4.73±0.006	35.90±0.006	32.47±0.006	17.32±0.006	8.00±0.006	74.68±0.006	SL
Chunya_Mapogoro	1.24±0.000	0.11±0.000	11.39±0.000	1.82±0.000	2.33±0.000	98.29±0.000	20.34±0.000	15.26±0.063	9.94±0.063	74.62±0.063	SL
Mbeya CC_Mponja	2.14±0.013	0.15±0.013	15.98±0.013	0.33±0.013	6.88±0.013	45.38±0.013	107.82±0.013	29.33±0.013	22.01±0.013	48.69±0.013	SCL
Mbeya CC_TARI Uyole	2.13±0.023	0.20±0.023	11.81±0.023	1.74±0.023	10.43±0.023	140.00±0.023	83.86±0.023	22.34±0.023	17.02±0.023	60.70±0.023	SCL
Mbeya CC_Utukuyu	2.68±0.001	0.22±0.001	12.17±0.001	0.17±0.001	10.27±0.001	87.62±0.001	68.59±0.001	27.22±0.100	23.90±0.100	48.58±0.100	SCL
<b>Iringa</b>											
Iringa DC_Mgama	0.82±0.010	0.07±0.010	12.88±0.010	2.86±0.010	0.62±0.010	142.38±0.010	14.40±0.010	15.33±0.010	6.01±0.010	78.69±0.010	SL
ringa DC_Ibumila	1.34±0.003	0.10±0.003	13.6±0.003	0.44±0.003	1.47±0.003	71.78±0.003	49.71±0.003	31.02±0.300	0.70±0.300	67.38±0.300	SCL
Iringa DC_Lyamungwe	1.22±0.000	0.13±0.001	9.14±0.001	2.30±0.001	0.06±0.001	53.23±0.001	27.40±0.001	29.22±0.100	1.90±0.100	68.58±0.100	SCL
Kilolo_Mkoga	0.43±0.002	0.09±0.002	4.67±0.002	0.10±0.002	0.38±0.002	137.94±0.002	11.68±0.002	5.30±0.020	2.98±0.020	91.66±0.020	Sand
Kilolo_Mfyome	0.53±0.013	0.07±0.013	9.94±0.013	0.12±0.013	0.57±0.013	33.03±0.013	13.29±0.013	5.33±0.013	4.01±0.013	90.69±0.013	Sand
Kilolo_Mtitu	1.34±0.007	0.12±0.007	12.28±0.007	1.70±0.007	0.61±0.007	31.64±0.007	37.19±0.007	33.33±0.007	4.01±0.007	62.69±0.007	SCL
Mufindi_Ikovano	0.93±0.001	0.08±0.001	11.51±0.001	0.74±0.001	2.18±0.001	91.45±0.001	7.84±0.001	9.22±0.103	0.00±0.000	90.58±0.103	Sand
Mufindi_Igoma	0.83±0.000	0.07±0.000	11.30±0.000	0.68±0.000	7.61±0.000	23.75±0.000	21.55±0.000	13.26±0.063	2.94±0.063	83.62±0.063	LS
Mufindi_Ikweha	1.04±0.013	0.12±0.013	9.44±0.013	1.01±0.013	3.03±0.013	30.76±0.013	101.25±0.013	11.33±0.013	2.01±0.013	86.69±0.013	LS
<b>Njombe</b>											
Wanging'ombe_Mngate	1.43±0.023	0.11±0.023	16.13±0.023	0.56±0.023	1.53±0.023	62.05±0.023	14.41±0.023	16.30±0.023	7.98±0.023	75.66±0.023	SL
Wanging'ombe_Mlevela	2.11±0.007	0.19±0.007	11.57±0.007	0.29±0.007	0.97±0.007	137.59±0.007	61.50±0.007	38.33±0.007	7.01±0.007	54.69±0.007	SC
Wanging'ombe_Ndandu	1.09±0.010	0.10±0.010	11.89±0.010	0.65±0.010	3.32±0.010	94.26±0.010	54.56±0.010	15.22±0.100	8.90±0.100	75.58±0.100	SL
Njombe DC_Tagamenda	1.56±0.003	0.15±0.003	10.39±0.003	0.32±0.003	0.90±0.003	119.68±0.003	77.11±0.003	35.02±0.300	4.70±0.300	59.38±0.300	SC
Njombe DC_Itipingi	1.01±0.020	0.23±0.020	4.68±0.020	1.63±0.020	1.32±0.020	131.52±0.020	42.47±0.020	16.34±0.020	5.02±0.020	78.70±0.020	SL
Njombe DC_Kichiwa	1.56±0.003	0.15±0.003	9.90±0.003	0.30±0.003	1.79±0.003	77.60±0.003	83.75±0.003	36.02±0.300	1.70±0.300	61.38±0.300	SC
Ludewa_Njelela	4.99±0.007	0.38±0.007	12.98±0.007	1.19±0.007	0.58±0.007	61.45±0.007	41.00±0.007	27.25±0.067	7.93±0.067	64.61±0.067	SCL
Ludewa_Mtumamo	1.91±0.020	0.18±0.020	12.03±0.020	0.38±0.020	1.14±0.020	34.80±0.020	39.85±0.020	24.34±0.020	9.02±0.020	66.70±0.020	SCL
Ludewa_Amani	2.10±0.006	0.19±0.006	10.74±0.006	1.52±0.006	1.20±0.006	53.24±0.006	28.91±0.006	45.26±0.063	7.94±0.063	46.62±0.063	SC
<b>Ruvuma</b>											
Madaba Lituta	1.74±0.000	0.16±0.000	10.78±0.000	1.34±0.000	0.51±0.000	172.54±0.000	26.14±0.000	31.28±0.043	3.96±0.043	64.64±0.043	SCL

Madaba_Kipingo	1.58±0.003	0.12±0.003	13.68±0.003	2.99±0.003	2.30±0.003	75.29±0.003	134.9±0.003	21.32±0.003	6.00±0.003	72.68±0.003	SCL
Madaba_Ndelenyuma	1.34±0.001	0.13±0.001	10.39±0.001	3.36±0.001	8.11±0.001	74.43±0.001	526.73±0.001	21.19±0.133	3.87±0.133	74.55±0.133	SCL
Songea_DC_Mlete	0.67±0.010	0.10±0.010	7.59±0.010	33.47±0.01	5.52±0.010	122.17±0.010	77.96±0.010	7.33±0.010	1.29±0.010	91.41±0.010	Sand
Songea_DC_Mang'ua	0.91±0.003	0.10±0.003	9.35±0.003	2.27±0.003	1.41±0.003	30.34±0.003	56.03±0.003	11.29±0.027	2.97±0.027	85.65±0.027	LS
Songea_DC_Seed farm	1.08±0.003	0.08±0.003	13.93±0.003	0.71±0.003	0.83±0.003	89.13±0.003	169.31±0.003	23.32±0.003	2.00±0.003	74.68±0.003	SCL
Songea_DC_Nambehe	1.17±0.000	0.10±0.000	11.53±0.000	1.14±0.000	0.98±0.000	57.01±0.000	80.48±0.000	20.27±0.050	1.95±0.050	77.63±0.050	SCL
Namtumbo_Msindo	0.97±0.003	0.08±0.003	12.11±0.003	2.53±0.003	0.79±0.003	13.23±0.003	50.29±0.003	35.02±0.300	0.28±0.000	64.10±0.300	SC
Namtumbo_Ruvuma	0.98±0.007	0.09±0.007	12.12±0.007	0.18±0.007	1.00±0.007	48.34±0.007	99.92±0.007	38.25±0.067	0.21±0.067	61.33±0.067	SC
<b>Morogoro</b>											
Kilosa_TARI Ilonga	1.19±0.001	0.10±0.001	11.33±0.001	6.23±0.001	0.69±0.001	113.93±0.001	77.78±0.001	21.19±0.133	3.15±0.133	75.27±0.133	SCL
Kilosa_Msowero	0.56±0.017	0.11±0.017	6.02±0.017	1.35±0.017	1.97±0.017	142.48±0.017	134.52±0.017	11.34±0.017	0.30±0.017	88.42±0.017	LS
Kilosa_Mvumi	1.38±0.000	0.07±0.000	19.78±0.000	0.42±0.000	4.00±0.000	119.87±0.000	51.16±0.000	19.25±0.067	5.21±0.067	75.33±0.067	SL
Mvomero_Kipera	1.42±0.020	0.26±0.020	5.92±0.020	1.38±0.020	1.72±0.020	24.69±0.020	58.81±0.020	40.34±0.020	2.30±0.020	57.42±0.020	SC
Mvomero_Chanagalawe	1.56±0.003	0.14±0.003	11.14±0.003	2.44±0.003	1.06±0.003	75.93±0.003	33.36±0.003	53.29±0.027	4.25±0.027	42.37±0.027	Clay
Mvomero_Kinyenze	1.10±0.003	0.11±0.003	10.07±0.003	2.04±0.003	1.86±0.003	65.98±0.003	52.76±0.003	23.32±0.003	5.28±0.003	71.40±0.003	SCL
Morogoro_R-Muhungamkola	2.30±0.004	0.17±0.004	12.89±0.004	2.55±0.004	2.65±0.004	31.20±0.004	47.63±0.004	23.28±0.043	4.24±0.043	72.36±0.043	SCL
Morogoro_R-Lukonde	1.85±0.000	0.15±0.000	12.6±0.000	1.11±0.000	1.63±0.000	39.79±0.000	35.64±0.000	23.26±0.063	2.22±0.063	74.34±0.063	SCL
Morogoro_R-Maleta	4.57±0.013	0.38±0.013	12.54±0.013	0.61±0.013	0.63±0.013	65.50±0.013	122.46±0.013	19.33±0.013	3.29±0.013	77.41±0.013	SL
<b>Arusha</b>											
Meru_Seliani Kisongo	3.20±0.001	0.29±0.001	11.02±0.001	1.22±0.001	11.19±0.001	15.12±0.001	63.42±0.001	27.19±0.133	15.15±0.133	57.27±0.133	SCL
Meru_Kikatiti	2.86±0.023	0.24±0.023	12.9±0.023	6.47±0.023	4.45±0.023	20.23±0.023	80.56±0.023	26.34±0.023	18.30±0.023	55.42±0.023	SCL
Meru_NM-AIST	3.16±0.000	0.25±0.000	12.37±0.000	2.21±0.000	8.07±0.000	11.59±0.000	101.61±0.000	25.31±0.007	24.27±0.007	50.39±0.007	SCL
Karatu_Marera	1.05±0.002	0.11±0.002	9.12±0.002	1.95±0.002	2.01±0.002	93.25±0.002	31.90±0.002	54.15±0.167	12.11±0.167	33.23±0.167	Clay
Karatu_Kilimatambo	1.93±0.017	0.16±0.017	13.02±0.017	3.53±0.017	0.88±0.017	102.65±0.017	100.93±0.017	63.34±0.017	16.30±0.017	20.42±0.017	Clay
Karatu_Rhotia Juu	3.40±0.001	0.21±0.001	16.46±0.001	4.87±0.001	40.78±0.001	99.74±0.001	108.80±0.001	55.31±0.010	21.27±0.010	23.39±0.010	Clay
Monduli_Ngarashi	2.14±0.013	0.16±0.013	14.47±0.013	7.84±0.013	4.96±0.013	65.20±0.013	80.14±0.013	43.33±0.013	22.29±0.013	34.41±0.013	Clay
Monduli_Sepeko	2.26±0.000	0.20±0.000	11.34±0.000	1.74±0.000	4.74±0.000	32.67±0.000	90.23±0.000	35.26±0.063	23.22±0.063	41.34±0.063	CL
Monduli_Rasharasha	2.39±0.030	0.26±0.030	10.09±0.030	3.53±0.030	2.53±0.030	70.65±0.030	101.52±0.030	25.35±0.030	25.31±0.030	49.43±0.030	SCL
<b>Kilimanjaro</b>											
Siha_Njaru	3.61±0.007	0.26±0.007	14.49±0.007	3.77±0.007	1.07±0.007	62.52±0.007	79.05±0.007	32.31±0.007	24.27±0.007	43.39±0.007	CL
Siha_Fuka-Sanya Juu	2.59±0.002	0.15±0.002	17.23±0.002	0.27±0.002	3.99±0.002	15.02±0.002	147.10±0.002	36.30±0.023	21.26±0.023	42.38±0.023	CL
Siha_Koboko Kusini	2.14±0.010	0.21±0.010	10.66±0.010	3.20±0.010	6.94±0.010	68.49±0.010	108.36±0.010	52.33±0.010	20.29±0.010	27.41±0.010	clay
Hai_Lambo mferejini	1.69±0.003	0.17±0.003	9.89±0.003	44.23±0.003	11.8±0.003	156.1±0.003	47.33±0.003	53.29±0.030	21.25±0.030	25.37±0.030	clay
Hai_Kia	2.52±0.003	0.28±0.003	9.22±0.003	6.91±0.003	1.30±0.003	7.92±0.003	51.29±0.003	15.32±0.003	15.28±0.003	69.40±0.003	SL
Hai_Narumu - Machame	1.73±0.000	0.18±0.000	9.36±0.000	3.00±0.000	6.79±0.000	1.60±0.000	69.67±0.000	55.25±0.067	19.21±0.067	25.33±0.067	clay
Moshi_R_Boro Masoka	2.55±0.010	0.28±0.010	9.30±0.010	49.18±0.010	6.28±0.010	95.96±0.010	162.11±0.010	57.33±0.010	18.29±0.010	24.41±0.010	clay
Moshi_R_Longuo A	3.21±0.050	0.28±0.050	13.53±0.050	1.61±0.050	16.54±0.050	123.75±0.050	32.95±0.050	54.27±0.050	18.23±0.050	27.35±0.050	clay
Moshi_R_Kidachini	2.99±0.033	0.32±0.033	10.22±0.033	7.86±0.033	21.47±0.033	155.80±0.033	36.82±0.033	52.35±0.033	18.31±0.033	29.43±0.033	clay