CHAPTER 4

RESULTS

4.1 Soil parameter results

Original mean and standard deviation (SD) values are presented by field treatment in Tables 3 and 4. For original mean and SD values of each field in the study, see Appendix A. For the individual parameter results, letter grouping to show significance is demonstrated on the graphs only for those parameters showing significance (N, P, and K) from the interaction of field treatment, sampling location, and depth.

4.1.1 Total carbon and Active carbon

TC and AC were most concentrated in the planting stations of CF4 and CF8 treatments at 0-15 cm. TC(AC) values for CF4 were 0.44% (269.6 mg/kg) and for CF8 were 0.44% (284.4 mg/kg). (Table 3). Though values were not significantly higher (at $p<0.05$) than REF carbon values, TC and AC showed an increase by greater than 45% in 0-15 cm in CF8 and CF4 planting stations compared to REF. Lowest carbon values for all treatments were found in the lower depth, 15-30 cm. TC and AC values follow the same relative trend for all sampling points (Figure 17, 18).

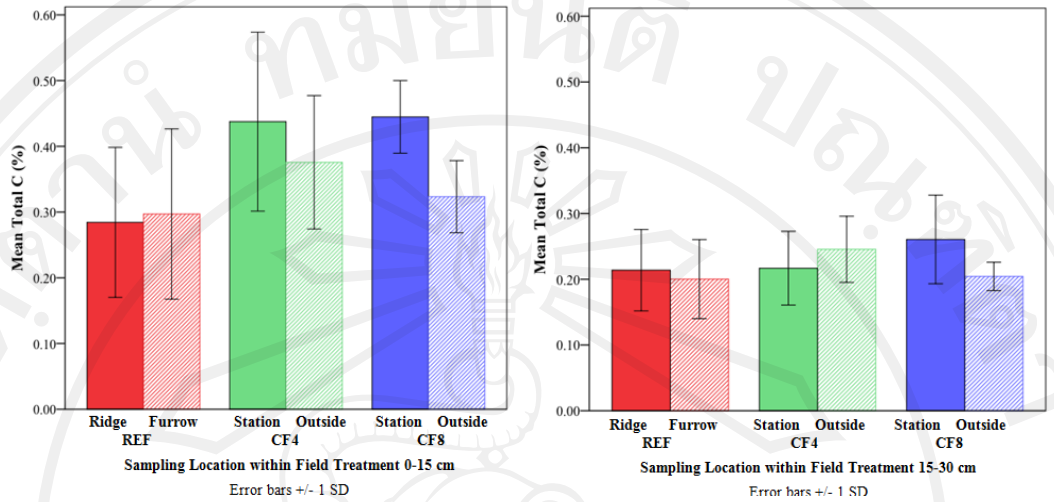

Figure 17: Mean TC by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

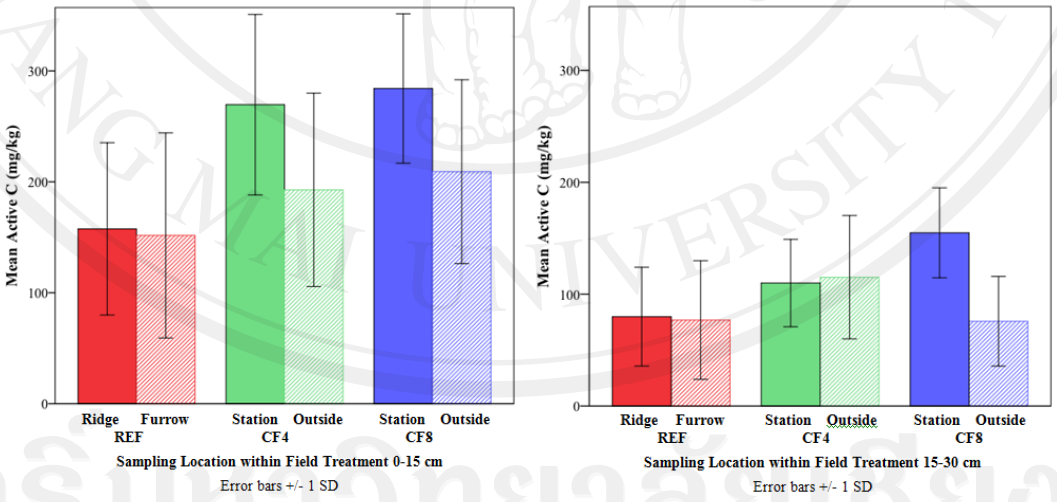

Figure 18: Mean AC by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.2 Nitrogen

Highest N levels occurred in CF4 and CF8 0-15 cm planting stations (0.038% and 0.032%, respectively). N in CF4 0-15 cm planting station was significantly higher than REF ridges and furrows (0.021 and 0.023%, respectively) and CF8 significantly higher than REF ridges. N in both CF4 and CF8 planting stations are significantly higher than outside the station and the lower depth within their respective treatment. N values are similar between ridge and furrow at the respective depths compared to inside and outside CF stations (Figure 19). For mean separation of N by field treatment, sampling location, and depth with letter grouping to show significant differences, see Table 12 and Figure 19.

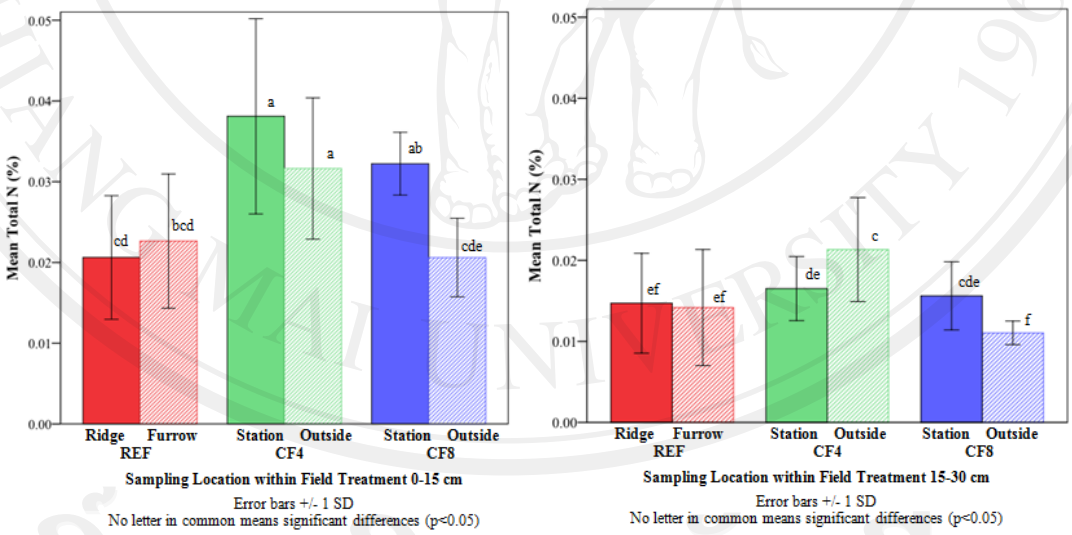

Figure 19: Mean N by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.3 Phosphorous

P values were significantly higher in CF8 and CF4 planting stations (50.48 and 8.51 mg/kg, respectively) compared to 0-15 cm REF ridge and furrow (3.42 and 2.80 mg/kg, respectively) and 0-15 cm outside CF8 and CF4 planting stations (4.52 and 2.19 mg/kg). Within each respective sampling location, P values decreased in the lower depth. For mean separation of P by field treatment, sampling location, and depth with letter grouping to show significant differences, see Figure 12 and Table 20.

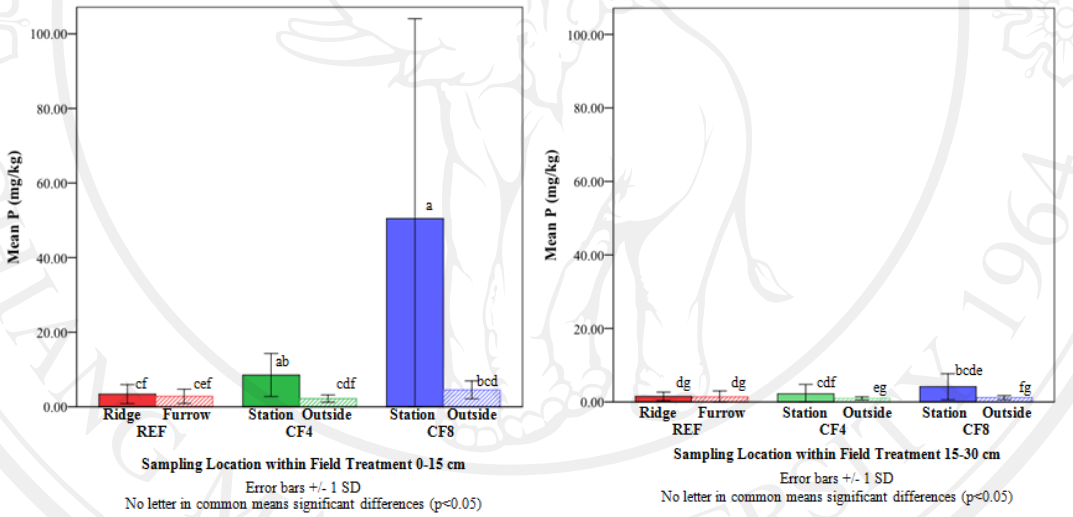

Figure 20: Mean P by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.4 Potassium

An unpaired t-test showed no significant differences between the results of K-bray and K-exchangeable analyses. Therefore, the following potassium results presented here are from the exchangeable cations method only. For results of both potassium methods, refer to Appendix A. CF4 planting station at 0-15 cm showed significantly higher K levels (4.89 mmol/kg) than outside the station (3.55 mmol/kg). Highest value overall was in CF8 planting stations at 0-15 cm (5.85 mmol/kg). No significant differences in K levels were observed at either depth for REF.

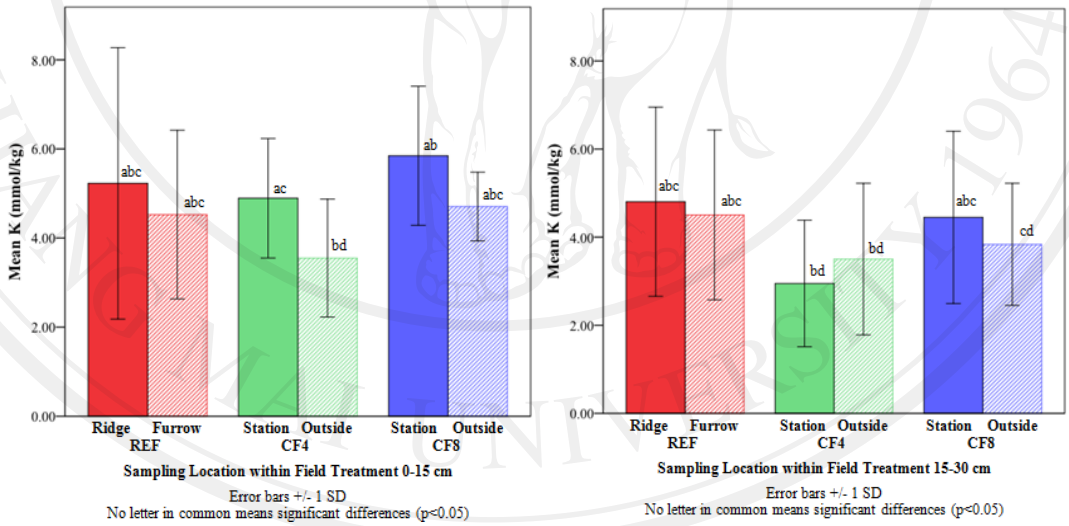

Figure 21: Mean K by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.5 Calcium

Calcium values were highest in CF8 planting stations (41.68 mmol/kg) with no significant differences observed in REF fields at both depths. Significantly higher calcium levels were found in CF8 planting stations (0-30 cm, combining values of both depths) compared to outside CF8 planting stations (0-30 cm) (Table 10).

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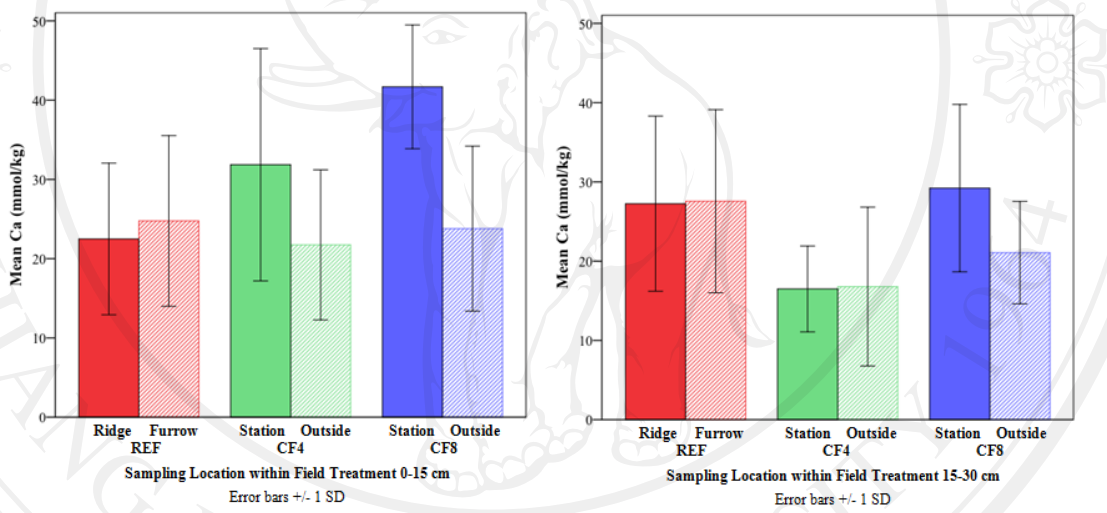

Figure 22: Mean Ca by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.6 Magnesium

Mg content increases with depth for REF and CF8 fields (Figure 23). Highest Mg content occurred in CF8 outside the station at 15-30 cm (11.31 mmol/kg) (Table 4). No statistically significant differences were found in Mg values when looking at the interaction of field treatment, sampling location, and depth

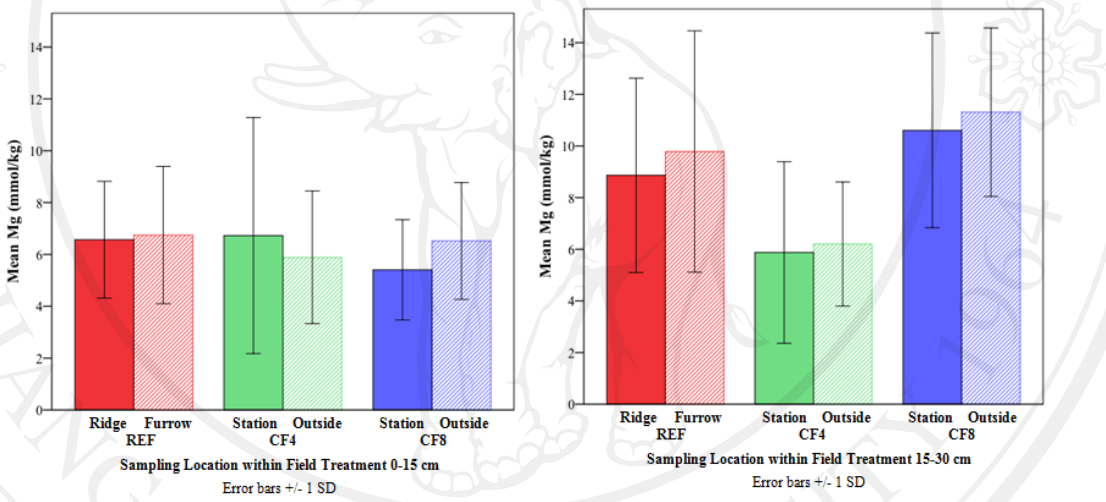

Figure 23: Mean Mg by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.7 Sodium

Sodium values trend consistently between depths within each respective treatment. Values were highest overall in CF8 fields with no significant differences in Sodium content between inside and outside CF stations or ridge and furrow.

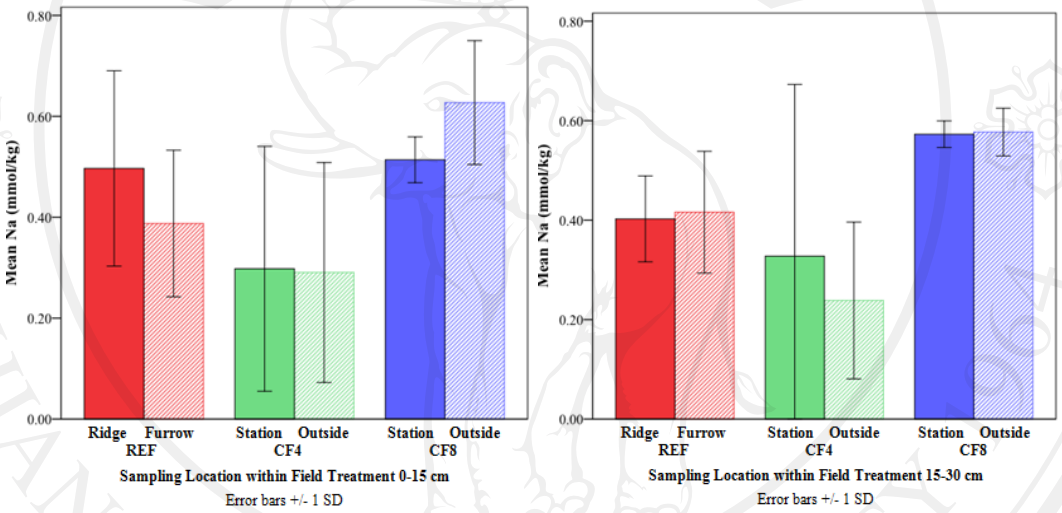

Figure 24: Mean Na by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.8 pH

Large ph ranges existed in CF fields treatments (Figure 25). pH values in CF4 and CF8 stations were 6.18 and 6.17, respectively while outside the CF4 and CF8 station at 15-30 cm, 4.54 and 4.94, respectively. REF pH at all sampling locations and depth ranged 5.58 to 5.90.

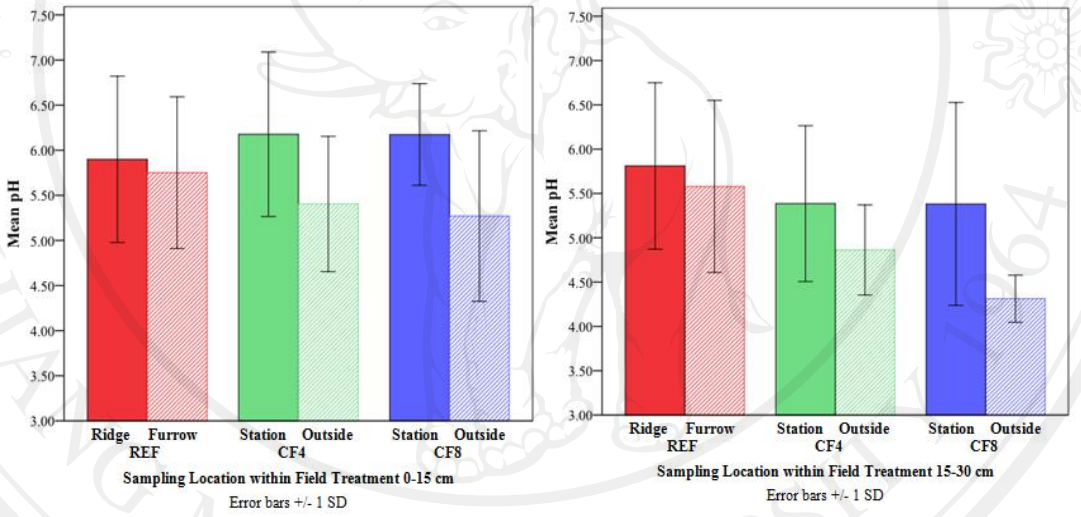

Figure 25: Mean pH by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.9 Bulk Density

BD was lowest in CF8 (1.48 g/cm^3) and CF4 (1.50 g/cm^3) stations compared to ridge (1.55 g/cm-3) and furrow (1.52 g/cm-3). BD was higher outside the planting station at 0-15 cm for both CF8 (1.57 g/cm-3) and CF4 (1.54 g/cm-3) than ridge or furrow. (Table 3, 4, Figure 26). There were significantly lower BD values inside planting stations of CF4 and CF8 then outside (the effect of field treatment and sampling location only, Table 10).

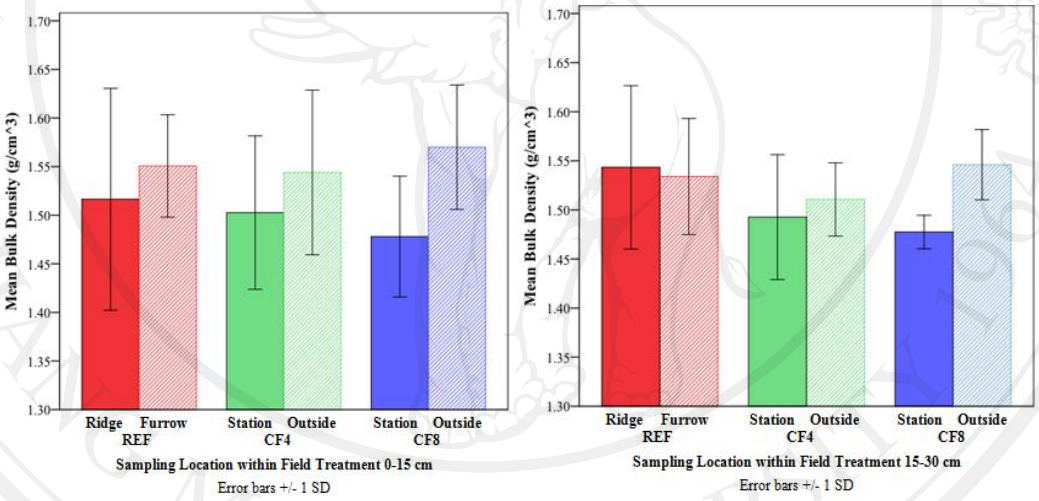

Figure 26: Mean BD by field treatment, sampling location and depth: 0-15 cm (left) and 15-30 cm (right)

4.1.10 Infiltration

Infiltration results are for 0-15 cm only (Figure 27). No significant differences were observed for the interaction of field treatment, sampling location, and age. Infiltration rates from highest to lowest (mm/hr) were: CF4 outside (405.4 mm/hr) >

CF4 inside (381.8) > CF8 inside (298.7) > CF8 outside (258.7) > REF ridge (249.7) > REF furrow (170.4). (Table 3).

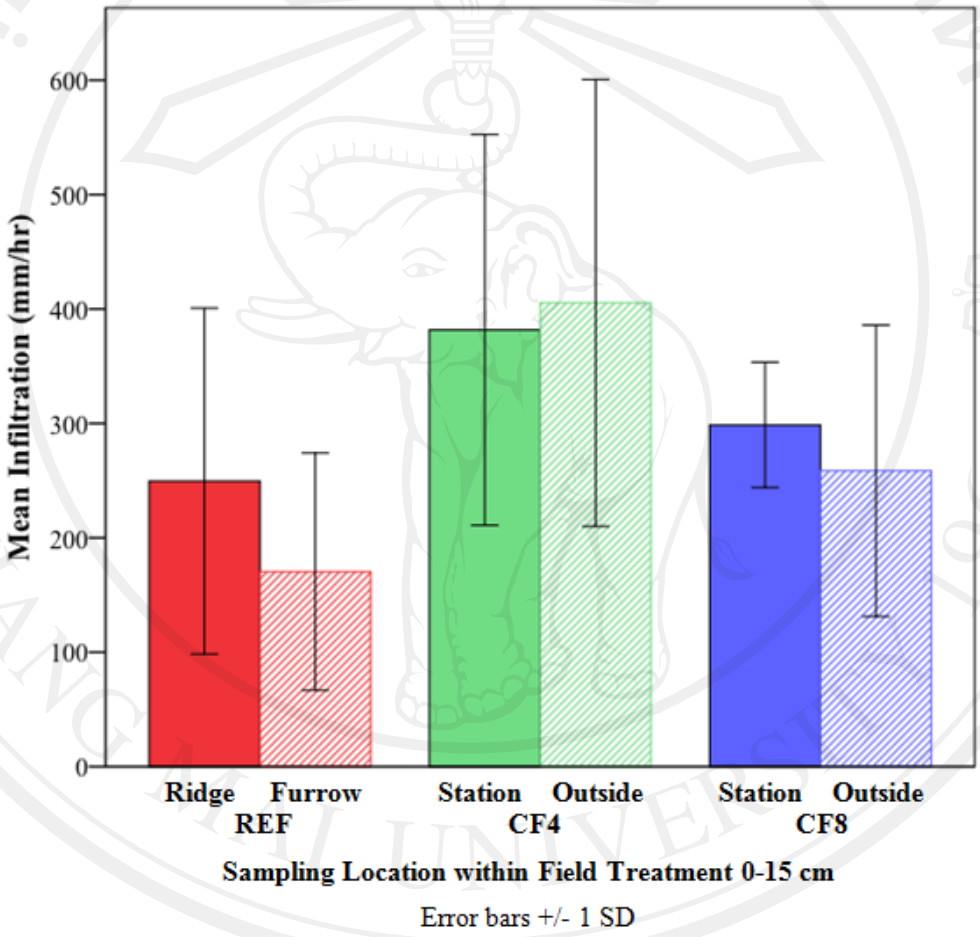

Figure 27: Mean IN by field treatment and sampling location at 0-15 cm

Table 3: Soil parameter mean and standard deviation by field treatment, sampling location, and 0-15 cm depth

Fixed Variable		Reference 0-15 cm				CF4 0-15 cm				CF8 0-15 cm			
		Ridge		Furrow		Inside station		Outside station		Inside station		Outside station	
	(Unit)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
TC	%	0.284	0.114	0.297	0.130	0.437	0.136	0.376	0.101	0.445	0.055	0.323	0.055
AC	mg/kg	157.58	77.65	151.73	92.51	269.62	81.37	192.80	87.22	284.16	67.34	209.18	82.91
N	%	0.0206	0.0077	0.0226	0.0083	0.0381	0.0121	0.0316	0.0088	0.0322	0.0039	0.0206	0.0049
P	mg/kg	3.42	2.55	2.80	1.92	8.51	5.76	2.19	0.99	50.48	53.58	4.52	2.40
K	mmol/kg	5.23	3.05	4.53	1.89	4.89	1.34	3.55	1.32	5.85	1.56	4.71	0.77
Ca	mmol/kg	22.48	9.57	24.76	10.77	31.85	14.65	21.74	9.47	41.68	7.81	23.78	10.41
Mg	mmol/kg	6.57	2.25	6.75	2.65	6.73	4.55	5.89	2.56	5.41	1.93	6.52	2.25
Na	mmol/kg	0.50	0.19	0.39	0.15	0.30	0.24	0.29	0.22	0.51	0.05	0.63	0.12
pH	Unit	5.90	0.92	5.75	0.84	6.18	0.91	5.40	0.75	6.17	0.56	5.27	0.95
BD	gcm-3	1.52	0.11	1.55	0.05	1.50	0.08	1.54	0.08	1.48	0.06	1.57	0.06
IN	mm/hr	249.68	151.17	170.39	103.64	381.76	170.85	405.40	195.24	298.70	54.77	258.65	127.34

Table 4: Soil parameter mean and standard deviation by field treatment, sampling location, and 15-30 cm depth

Fixed Variable		Reference 15-30 cm				CF4 15-30 cm				CF8 15-30 cm			
		Ridge		Furrow		Inside station		Outside station		Inside station		Outside station	
	(Unit)	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
TC	%	0.214	0.062	0.200	0.060	0.233	0.083	0.249	0.050	0.250	0.045	0.204	0.022
AC	mg/kg	79.89	44.14	76.86	53.04	109.95	39.11	115.14	55.15	154.89	40.23	75.83	40.08
N	%	0.0147	0.0062	0.0142	0.0072	0.0165	0.0040	0.0213	0.0064	0.0156	0.0042	0.0110	0.0015
P	mg/kg	1.53	1.15	1.39	1.61	2.23	2.57	0.96	0.42	4.15	3.53	1.18	0.57
K	mmol/kg	4.80	2.15	4.50	1.93	2.95	1.44	3.50	1.72	4.45	1.96	3.84	1.39
Ca	mmol/kg	27.25	11.05	27.56	11.55	16.49	5.42	16.79	10.02	29.21	10.56	21.08	6.47
Mg	mmol/kg	8.87	3.76	9.79	4.67	5.87	3.52	6.20	2.40	10.61	3.77	11.31	3.26
Na	mmol/kg	0.40	0.09	0.42	0.12	0.33	0.35	0.24	0.16	0.57	0.03	0.58	0.05
pH	Unit	5.81	0.94	5.58	0.97	5.38	0.88	4.86	0.51	5.38	1.15	4.31	0.27
BD	gcm-3	1.54	0.08	1.53	0.06	1.49	0.06	1.51	0.04	1.48	0.02	1.55	0.04
IN	mm/hr	no infiltration at 15-30cm											

4.2 Statistical Analysis

4.2.1 Introduction to the model

Soil parameters were analyzed as a function of the fixed effects of: 1) *field treatment*, represented by Reference, CF-4, and CF-8 fields; 2) *sampling depth*, represented by 0-15 cm and 15-30 cm; 3) *sampling location nested in field treatment*, represented by four positions—inside station and outside station for CF fields and ridge and furrow for reference fields; and 4) the interaction of *sampling location nested in field treatment and depth*. In the statistical model, sampling location is always nested in field treatment because sampling locations are contingent upon field treatments, where CF sampling locations are station inside and station outside and REF sampling locations are ridge and furrow.

4.2.2 Effect of Field Treatment

For all parameters, no significant difference ($p<0.05$) existed between field treatments (mean of all sampling points within each treatment) with the exception of nitrogen (Table 5, Table 6). N was significantly higher overall in CF4 fields (0.027%) than in CF8 and in REF fields (0.020 and 0.018%, respectively). The following range (original means) of each parameter is expressed with field treatment order listed by decreasing value:

TC (0.248 to 0.319%):	CF4>CF8>REF
AC (116.52 to 181.02 mg/kg):	CF8>CF4>REF
N (0.18 to 0.27%):	CF4>CF8>REF
P (2.27 to 15.08 mg/kg):	CF8>CF4>REF
K (3.73 to 4.77 mmol/kg):	REF>CF8>CF4
Ca (28.94 to 22.51 mmol/kg):	CF8>REF>CF4
Mg (6.17 to 8.46 mmol/kg)	CF8>REF>CF4
Na (0.27 to 0.57 mmol/kg)	CF8>REF>CF4
pH (5.34 to 5.76)	REF>CF4>CF8
BD (1.51 to 1.54 g/cm-3)	CF4>CF8>REF
IN (210 to 393 mm/hr)	CF4>CF8>REF

Table 5: F and P-values from Analysis of Variance for each dependent variable as a function of field treatment.

	ANOVA	
Fixed variable	F-Value	P-Value
Total Carbon	2.46	0.1799
Active Carbon	1.69	0.2985
Nitrogen	10.42	0.0004
Phosphorous	1.50	0.3529
Potassium	0.57	0.6080
Calcium	0.40	0.6954
Magnesium	1.11	0.4126
Sodium	3.09	0.1487
pH	0.20	0.8296
Bulk Density	0.29	0.7596
Infiltration	1.60	0.2092

Table 6: Mean separation for each dependent variable as a function of field treatment.

Fixed variable	(unit)	REF	CF4	CF8
Total Carbon	(%)	0.248	0.319	0.308
Active Carbon	(mg/kg)	10.17	12.70	12.95
Nitrogen	(%)	0.018b	0.027a	0.020b
Phosphorous	(mg/kg)	2.27	3.47	6.79
Potassium	(mmol/kg)	4.77	3.73	4.71
Calcium	(mmol/kg)	25.50	22.51	28.94
Magnesium	(mmol/kg)	7.99	6.17	8.46
Sodium	(mmol/kg)	0.43	0.27	0.57
pH	(unit)	5.76	5.48	5.34
Bulk Density	(gcm-3)	1.54	1.51	1.52
Infiltration	(mm/hr)	210.04	393.58	278.68

[a] Mean separation within dependent variables indicated by letters, by Fisher's LSD, with alpha = 0.05, using PDMIX800.

[b] Only values where significance occurred are lettered.

[c] Means presented as LS Means. Refer to Table 3 and 4 for original mean values.

4.2.3 Effect of Sampling Depth

All measured parameters changed significantly with sampling depth (y-Test, P< 0.05) except for BD and Na (Table 7). Highest mean values occurred in 0-15 cm for all parameters, except Mg. In contrast to all other parameters, Mg content increased with depth from 6.31 to 8.77 mmol/kg (Table 8).

Table 7: F and P-values from Analysis of Variance for each dependent variable as a function of sampling depth.

	ANOVA	
Fixed variable	F-Value	P-Value
Total Carbon	112.06	<.0001
Active Carbon	125.98	<.0001
Nitrogen	85.66	<.0001
Phosphorous	133.05	<.0001
Potassium	11.46	0.0012
Calcium	8.51	0.0049
Magnesium	23.16	<.0001
Sodium	0.83	0.3666
pH	33.75	<.0001
Bulk Density	0.47	0.4940

[a] Infiltration not included because only measured at 0-15 cm

Table 8: Mean separation for each dependent variable as a function of sampling depth.

Fixed variable	(unit)	0-15 cm	15-30 cm
TC	%	0.36a	0.22b
AC	mg/kg	14.15a	9.73b
N	%	0.028a	0.016b
P	mg/kg	6.45a	1.91b
K	mmol/kg	4.80a	4.01b
Ca	mmol/kg	27.70a	23.60b
Mg	mmol/kg	6.31b	8.77a
Na	mmol/kg	0.44	0.41
pH	Unit	5.78a	5.27b
BD	gcm-3	1.53	1.52

[a] Mean separation within dependent variables, indicated by letters, by Fisher's LSD, with alpha = 0.05, using PDMIX800.

[b] Only values where significance occurred are lettered.

[c] Means presented as LS Means. Refer to Table 3 and 4 for original mean values

[d] Infiltration not included because only measured at 0-15 cm

4.2.4 Effect of sampling location within field treatment

The effect of sampling location within each field treatment was analyzed against all dependent variables. Values reflect the mean between the two depths at each of the four sampling locations—ridge, furrow, inside station, and outside station. Within ploughed fields, the effect of ridges and furrows showed no significant differences ($p<0.05$) for each tested parameter (TC, AC, N, P, K, Ca, Mg, Na, pH, BD, and IN). For CF4 and CF8, P, AC, Ca, and pH were significantly higher inside the station than outside the station within their respective field treatment ($p<0.05$, Table 7). Within CF4 and CF8, bulk density was significantly lower inside the station than outside the station within their respective treatment. No significant differences existed when comparing sampling locations from CF4 to sampling locations in CF8. Comparing sampling locations between CF and REF, P is highest inside the planting stations of CF8 (27.31 mg/kg original untransformed mean) and significantly higher than REF ridge or furrow, (2.47 and 2.07 mg/kg, respectively).

Highest mean values measured for each soil parameter by sampling location within each treatment were are as follows: 1) ridge REF—pH (5.86), 2) inside station CF4—nitrogen (0.028%); 3) outside station CF4—infiltration (405.4 mm/hr), 4) inside station CF8 —TC (0.35%), AC (14.57 mg/kg for LS means or original means of 246.67 mg/kg), P (27.31 mg/kg), K (5.15 mmol/kg), Ca (35.45 mmol/kg) and lowest BD (1.48 g/cm^3) mean; and 5) outside station CF8—Mg (8.91 mmol/kg) and Na (0.60 mmol/kg). See Table 10 for mean separation using least squares (LS) mean values.

Table 9: F and P-values from Analysis of Variance for each dependent variable as a function of sampling location nested in field treatment.

	ANOVA	
Fixed variable	F-Value	P-Value
Total Carbon	2.10	0.1191
Active Carbon	5.71	0.0028
Nitrogen	2.84	0.0503
Phosphorous	28.06	<.0001
Potassium	1.20	0.3277
Calcium	8.11	0.0004
Magnesium	0.47	0.7081
Sodium	0.88	0.4580
pH	7.87	0.0004
Bulk Density	4.99	0.0055
Infiltration	1.60	0.2092

Table 10: Mean separation for each dependent variable as a function of sampling location nested in field treatment

Fixed Variable		Reference		CF4		CF8	
	(unit)	Ridge	Furrow	Inside station	Outside station	Inside station	Outside station
TC	%	0.25	0.25	0.33	0.31	0.35	0.26
AC	mg/kg	10.42abc	9.92abc	13.36ac	12.03bd	14.57ab	11.33cd
N	%	0.018	0.018	0.028	0.026	0.024	0.016
P	mg/kg	2.47bc	2.07bc	5.36ab	1.58c	[f]10.73a	2.85bc
K	mmol/kg	5.02	4.52	3.94	3.53	5.15	4.27
Ca	mmol/kg	24.85abc	26.16abc	25.91ac	19.11bd	35.45ab	22.43cd
Mg	mmol/kg	7.72	8.27	6.30	6.04	8.01	8.91
Na	mmol/kg	0.45	0.40	0.28	0.27	0.54	0.60
pH	Unit	5.86abc	5.67abc	5.78ac	5.17bd	5.78ab	4.90cd
BD	gcm-3	1.53abc	1.54abc	1.50bd	1.53ac	1.48cd	1.56ab
IN	mm/hr	249.68	170.39	381.76	405.4	298.7	258.65

Table 10 (continued):

[a] Mean separation within dependent variables indicated by letters, by Fisher's LSD, with alpha = 0.05, using PDMIX800.

[b] Only values where significance occurred are lettered.

[c] Original mean value 27.31 mg/kg for P as values over 21 mg/kg were removed to normalize data

[d] Means presented as LS Means. Refer to Table 3 and 4 for original mean values

4.2.5 Interaction of field treatment, sampling location, and depth

These results are presented in Figures 17-27 and Tables 3,4, and 12. Significant differences in parameter values for the interaction of field treatment, sampling location and depth exist mainly between CF planting stations at 0-15 cm and other sampling locations and depths. N was significantly higher at 0-15 cm inside and outside the station than all other sampling points, with the exception of 0-15 cm CF8 planting station. P was significantly higher inside 0-15 CF8 station than any other sampling point with the exception of 0-15 cm CF4 station. Within CF4 and CF8 basins at 0-15 cm, K was significantly higher than outside the station at 0-15 cm and 15-30 cm inside and outside the station within their respective field treatment. For every chemical parameter, CF stations at 0-15 cm (for both CF4 and CF8) were higher than outside the planting station at 0-15 cm with the exception of Mg and higher than 0-15 cm ridge and furrow, with the exception of CF4 for K and Mg (Table 11, Table 12).

Values within reference fields were relatively homogenous with no significant differences demonstrated within REF fields except for N and P between ridge and furrow at 0-15 cm and ridge and furrow at 15-30 cm. Greater variation existed within CF fields (See Figures 17-27). For CF8, ph ranged from 4.54 to 6.17 (outside the station at 15-30 cm to inside station at 0-15 cm, respectively). REF ph ranged from 5.58 to 5.90 (in the furrow at 15-30 to on the ridge 0-15 cm, respectively). From inside to outside the planting station at 0-15 cm, BD ranged for CF8 1.48 to 1.57 g/cm^3, respectively and for CF4 1.50 to 1.54 g/cm^3, respectively

Table 11: F and P-values from Analysis of Variance for each dependent variable as a function of the interaction of field treatment, sampling location and depth.

	ANOVA	
Fixed variable	F-Value	P-Value
Total Carbon	2.56	0.0631
Active Carbon	2.31	0.0848
Nitrogen	3.77	0.0148
Phosphorous	5.59	0.0019
Potassium	3.56	0.0192
Calcium	1.45	0.2361
Magnesium	0.50	0.6806
Sodium	1.40	0.2505
pH	0.74	0.5324
Bulk Density	0.93	0.4332

[a] Infiltration not included because only measured at 0-15 cm

Table 12: Mean separation for each dependent variable for interaction of field treatment, sampling location, and depth.

Fixed Variable (unit)		Reference				CF4				CF8			
		Ridge		Furrow		Inside station		Out. station		Inside station		Out. station	
		0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30	0-15	15-30
TC	%	0.28	0.21	0.30	0.20	0.44	0.22	0.38	0.25	0.44	0.26	0.32	0.20
AC	mg/kg	12.22	8.63	11.80	8.04	16.26	10.46	13.60	10.46	16.77	12.38	14.25	8.40
N	%	0.021cd	0.015ef	0.023bcd	0.014ef	0.038a	0.017de	0.032a	0.021c	0.032ab	0.016cde	0.021cde	0.011f
P	mg/kg	3.42cf	1.53dg	2.75cef	1.39dg	8.51ab	2.22cdf	2.19cdf	0.96eg	[f]17.30a	4.15bcde	4.52bcd	1.18fg
K	mmol/kg	5.23abc	4.8abc	4.53abc	4.50abc	4.93ac	2.95bd	3.55bd	3.50bd	5.85ab	4.45abc	4.71abc	3.84cd
Ca	mmol/kg	22.44	27.25	24.76	27.56	31.81	20.02	21.75	16.48	41.68	29.21	23.78	21.07
Mg	mmol/kg	6.57	8.87	6.75	9.79	6.73	5.87	5.89	6.20	5.41	10.61	6.52	11.31
Na	mmol/kg	0.50	0.40	0.39	0.42	0.30	0.27	0.29	0.24	0.51	0.57	0.63	0.58
pH	Unit	5.90	5.81	5.75	5.58	6.18	5.38	5.40	4.94	6.17	5.38	5.27	4.54
BD	gcm-3	1.51	1.54	1.55	1.54	1.50	1.49	1.54	1.51	1.48	1.48	1.57	1.55
IN	mm/hr	249.68	*	170.39	*	381.76	*	405.40	*	298.7	*	258.65	*

Table 12 (continued)

[a]Mean separation within dependent variables, indicated by letters, by Fisher's LSD, with alpha = 0.05, using PDMIX800.

[b]Only values where significance occurred are lettered.

[c] Original mean value 50.48 mg/kg for P as values over 21 mg/kg were removed to normalize data.

[d] Means presented as LS Means. Refer to Table 3 and 4 for original mean values.

4.3 Active Carbon Correlation

Correlation analysis results using untransformed data between AC and TC, N, and BD were (0.859, 0.796, and 0.273, respectively (Table 13).

Table 13: Active Carbon Correlations

Variable correlated with AC	Pearson Correlation Coefficient
TC	0.859
TN	0.796
BD	0.273

4.4 Interview Results

4.4.1 Fertility management by field

Based off interviews, both REF and CF farmers used a combination of manure and ant heap (termite mound soil) in their fields though REF-1 used only fertilizer and no manure in 2010-11 season. REF farmers spread manure and ant heap separately in lines across the field which is then spread manually just before ploughing. All CF farmers applied one coffee mug mixture of ant heap and manure to each planting station. Farmers could not verify consistent ratio of manure and ant heap.

All farmers have a history of using fertilizer in their fields. Compound D (7-14-7) is used as a basal fertilizer and ammonium nitrate (AN, 34-0-0) for top dressing one to two times during the cropping season. CF4 and CF8 farmers applied Compound D fertilizer consistently to planting stations, usually at 5 ml/station. In 2010 season, CF4-2, CF4-3, and CF8-1 farmers used 5 ml of compound D per station and CF4-2 an 8 ml cup/station. CF4-1 and CF-2 farmers top dressed twice with ammonium nitrate at 5ml/station while CF4-3 and CF8-1 top-dressed one time with a 5 ml cup. Quantifying compound D fertilizer history by REF farmers was more difficult since patterns change annually based on economic factors and rate/area calculations were difficult with much larger fields. For application, compound D fertilizer is spread in the furrow opened for seeding. AN is applied similarly to CF farmers as a top dress 1-2 times around individual seedlings or groupings of maize plant. AN rates differed more with REF farmers— for 2010-11 season, REF-1 used a

beer bottle cap two times, REF-2 used a 5 ml cup, but only for weak plants, and REF-3 used a “pinch” of AN per plant.

4.4.2 Field size and Estimated Maize Yield

The average size of each field treatment was: 1) REF at 0.58 ha, 2) CF4 at 0.10 ha, and 3) CF8 at 0.19 ha. The average estimated yield for: 1) REF was 0.66 t/ha, 2) CF4, 4.50 t/ha, and 3) CF8, 2.68 t/ha (Table 14). The reference farmers in the study also had CF fields near their homestead which were also measured and estimated for yield. The CF fields around the homesteads of REF farmers averaged 0.18 ha with a maize yield estimate of 1.57 t/ha. Estimates were based on actual harvest reported by farmer and did not account for green maize harvest around homestead. The yield reported in Table 14 for CF8-1 accounted for the reported 50% harvest used as green maize.

Table 14: Study field size and estimated maize yield

Field	Field Size in study (ha)	Estimated yield of field in study (kg)	Estimated yield by ha (t/ha)
Ref-1	0.60	500	0.83
Ref-2	0.44	350	0.80
Ref-3	0.70	250	0.34
REF AVG	**0.58**	**400**	**0.69 t/ha**
CF4-1	0.10	400	4.00
CF4-2	0.10	400	4.00
CF4-3	0.10	550	5.50
CF4 AVG	**0.10**	**450**	**4.50 t/ha**
CF8 AVG	**0.19**	**250**	**[a] 2.68 t/ha**

[a] Adjusted yield due to 50% harvested as green