Effects of Long-Term Cattle Manure Application on Soil Health

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Introduction

- Application of organic manure is an important agricultural practice for sustainability (Albiach et al., 2000; Peacock et al., 2001).
- Soil is the largest terrestrial organic carbon pool (Stockmann et al., 2013) and most studied parameter for long-term research (Stockmann et al., 2013).
- SOC is the energy source for various soil microbial organisms (Reeves, 1997).

Introduction

- Manure is an excellent source of plant nutrients and improves SOC (Peacock,2001).
- Nutrient inputs to cultivated soils might differentiate structure and activities of microbial community and their environment (Zhang et al., 2012).
- Quantity and quality of manure is important component when it used as a organic fertility source.

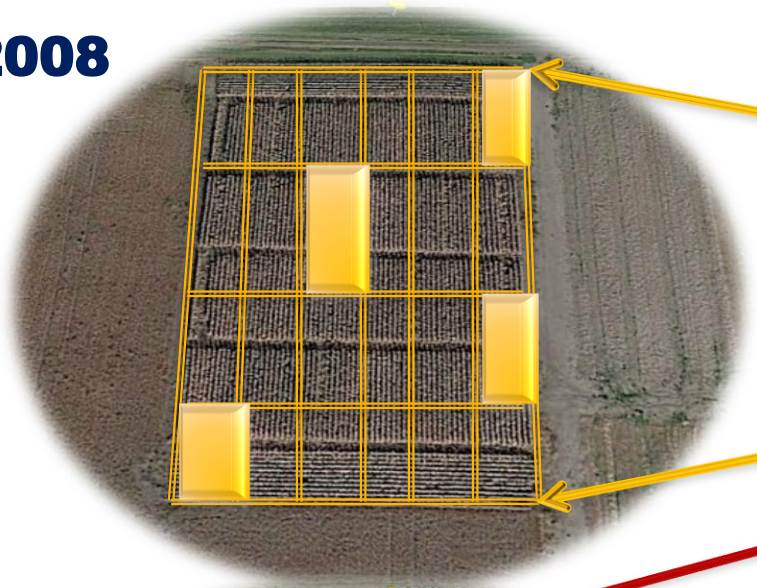
Study Objective and Hypothesis

- Objective; To assess the impacts of manure and inorganic fertilizer applications on selected physical soil quality indicators.

- Hypothesis: Manure application to soils can help to improve SOC and physical soil quality indicators.

Study Locations

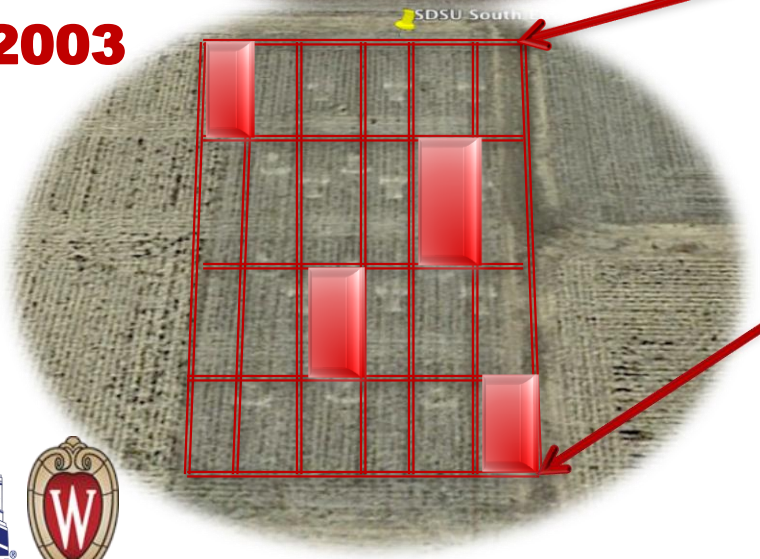
2008



6m (W)
18m (L)

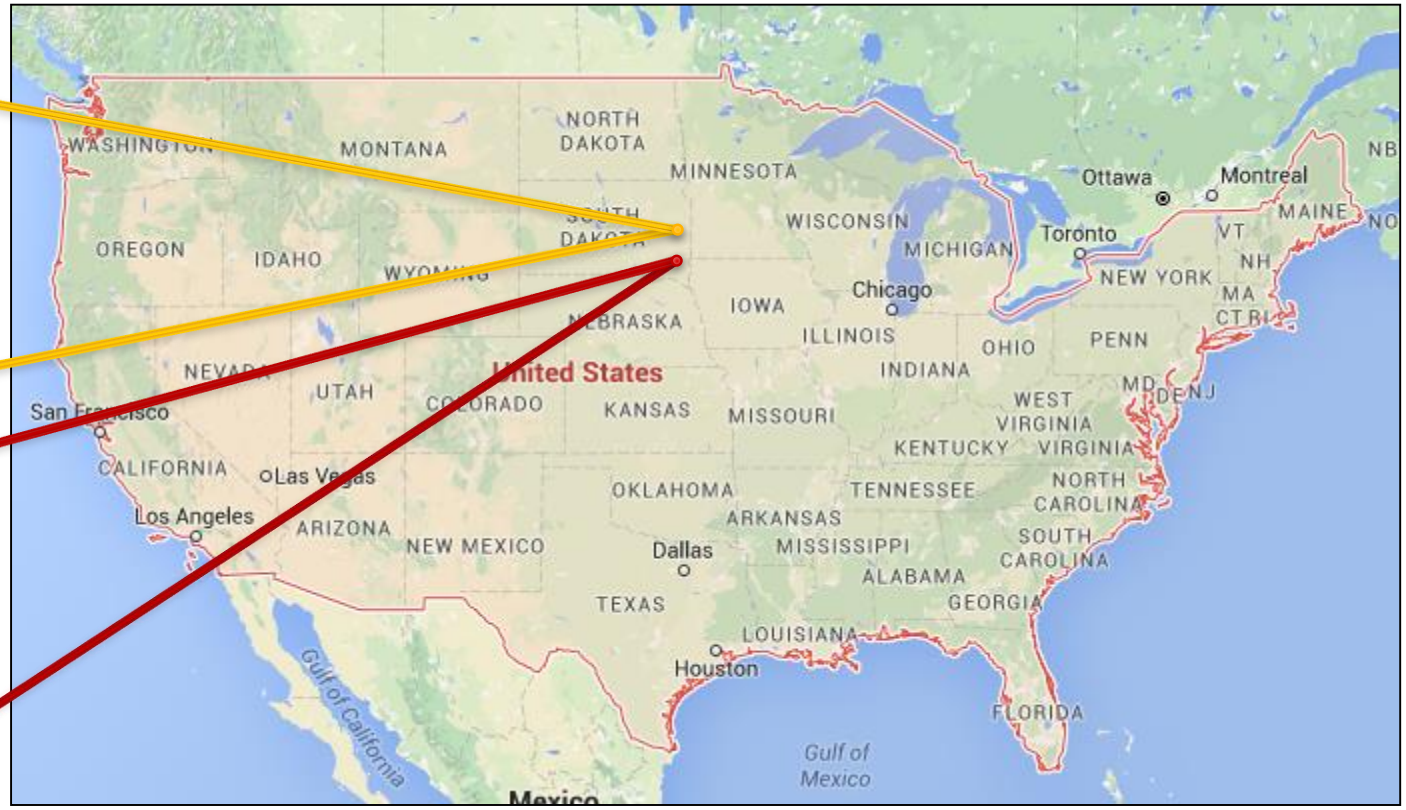
Vienna

2003



4.6m (W)
20m (L)

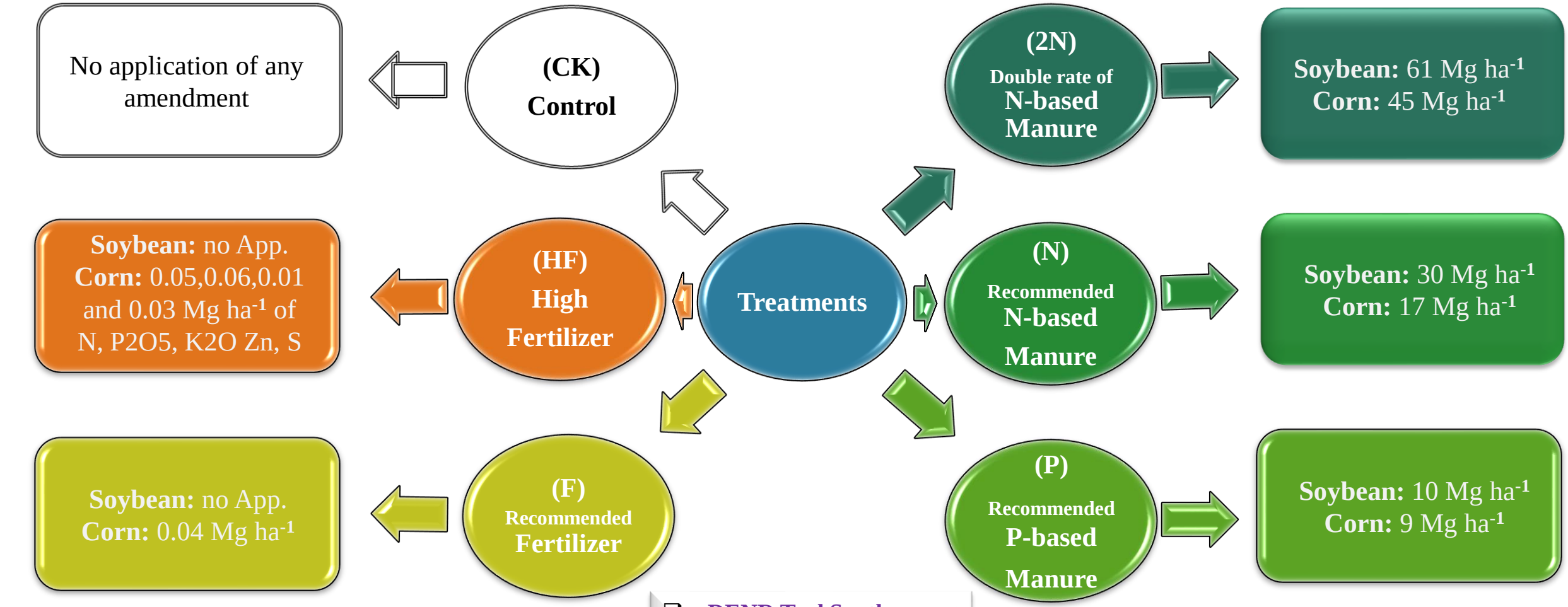
Egan



Source; (Google Map)

- Felt Research Farm, Brookings (44° 22’ 07.15” N, 96° 47’ 26.45” W)
- Southeast Research Farm, Clay (43° 02’ 33.46” N, 96° 53’ 55.78” W)
- Corn (*Zea mays* L.)-Soybean (*Glycine max* L.) rotation.
- 24 plots- randomized complete block design with 4 replications.

Study Treatments



- [DENR Tool South Dakota Department of Environment & Natural Resources]

Urea | Map | Potash | Zinc sulfate | Ammonium sulfate

Dairy Manure | Beef Manure

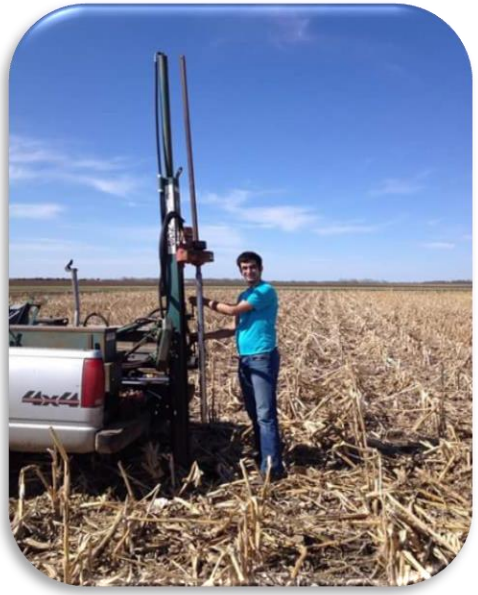
Treatments Application





- ✓ Manure was incorporated with a disc one to three days after application.

Site Analysis and Sampling



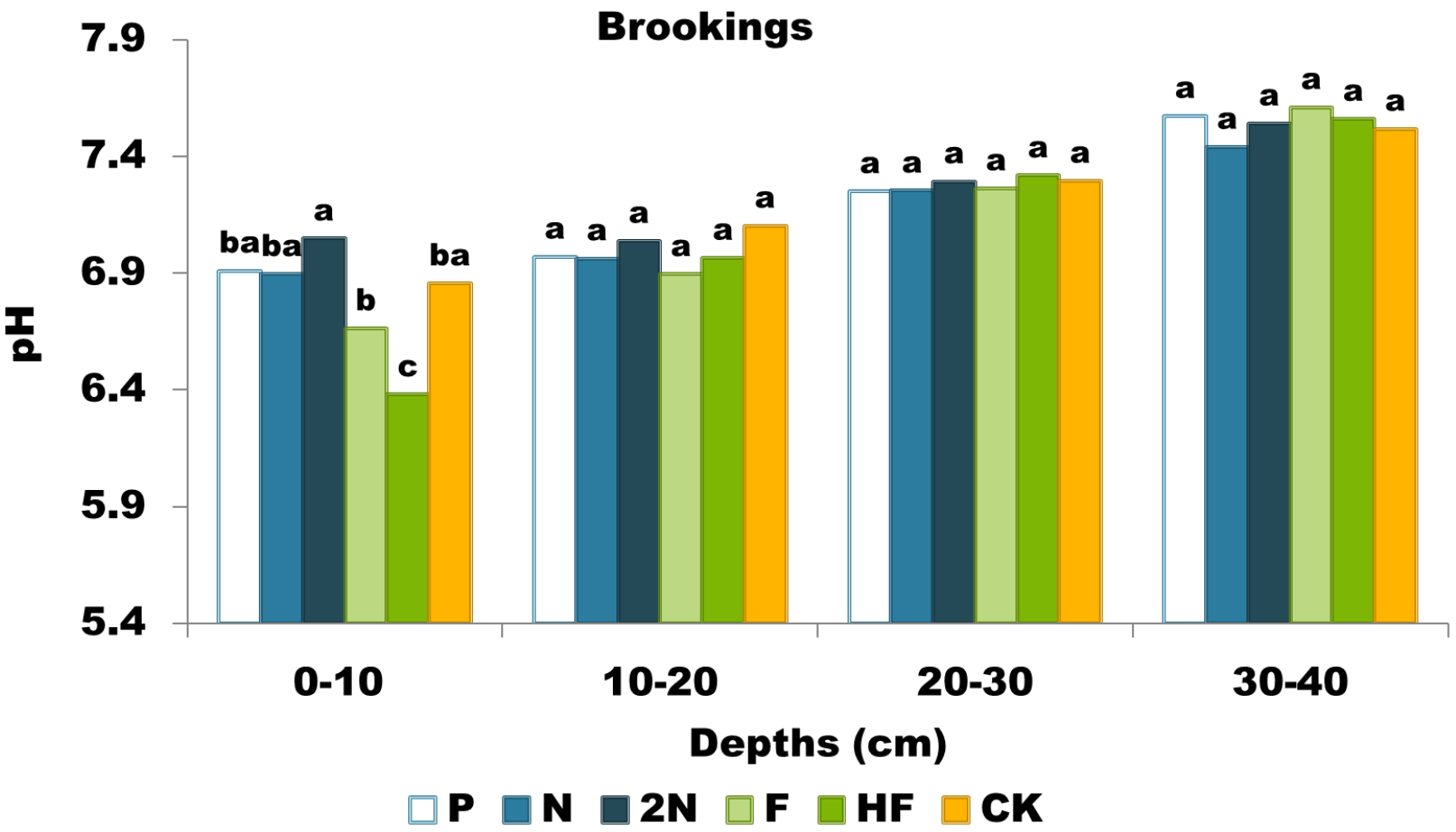
Soil Analysis

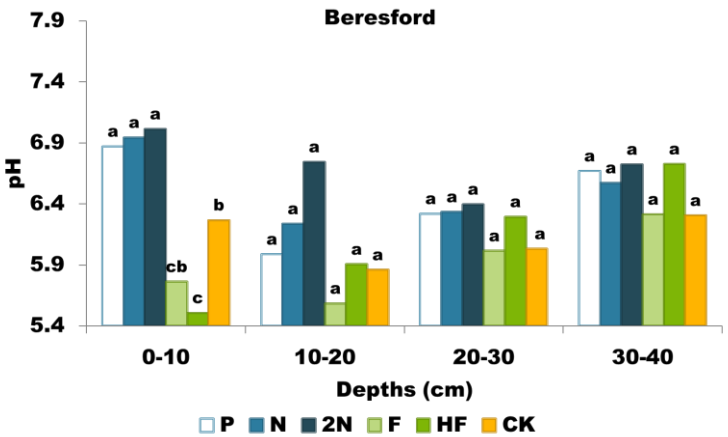
- pH (1:1)
- EC (1:2.5)
- Aggregate stability (Kemper and Rosenau, 1986)
- SOC/TN (Combustion; Stetson et al., 2012)
- Bulk density (Core method; Grossman and Reinsch., 2002)
- Water infiltration rate (Double-Ring method; Reynolds et al., 2002)

Data Analysis

- The estimating for the significant distinction (LSD) among treatments was obtained exploitation the ‘Mixed procedure in SAS 9.3 (Institute, 2012).
- Discriminant analysis was performed by using JMP software and groups was indicating as treatments.
- Significance was tested at 5% level.

Soil pH

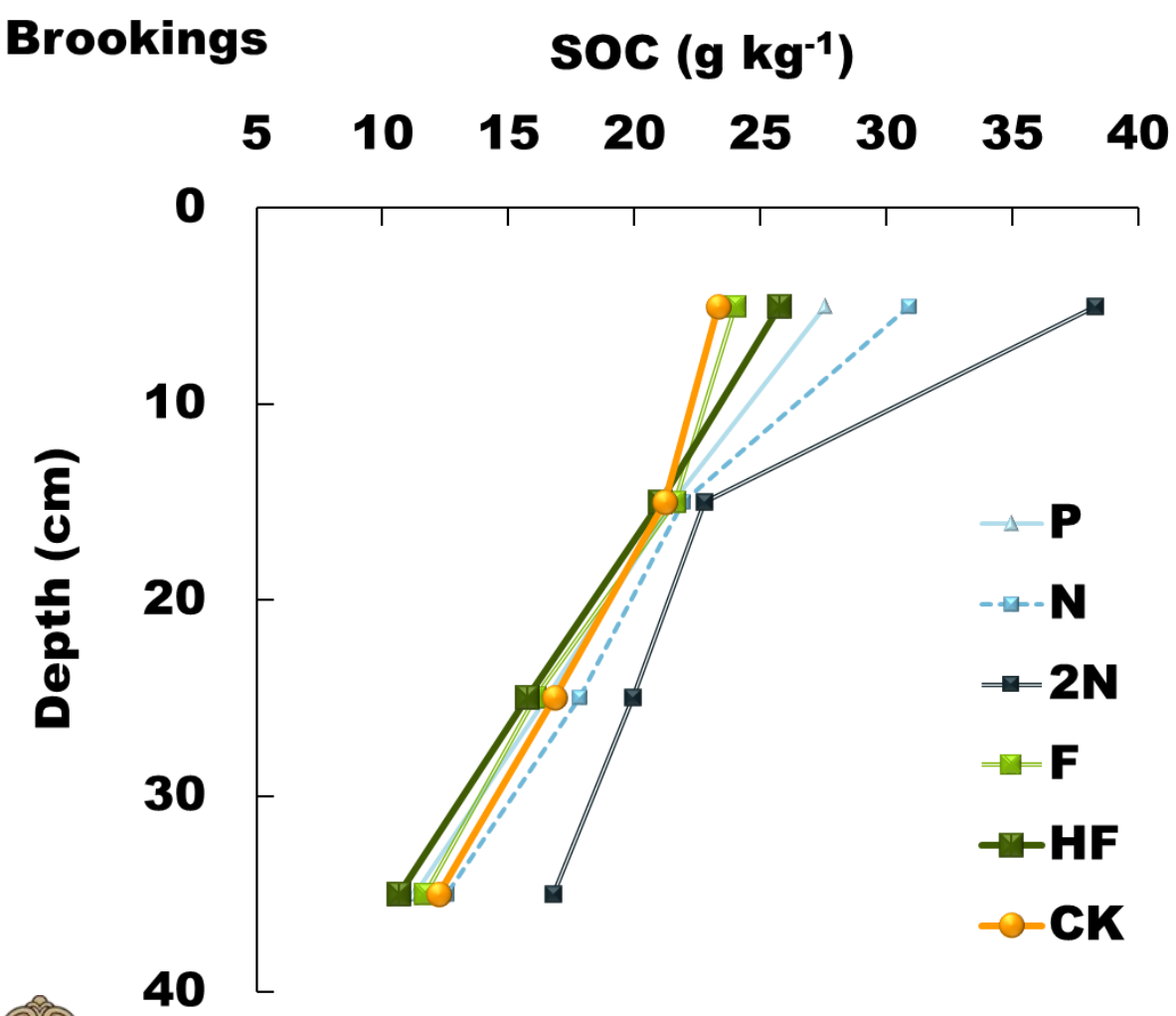

Brookings
7.9
7.4
6.9
6.4
5.9
5.4
pH
ba ba a b c ba
a a a a a a
a a a a a a
a a a a a a
0-10
10-20
20-30
30-40
Depths (cm)
P N 2N F HF CK

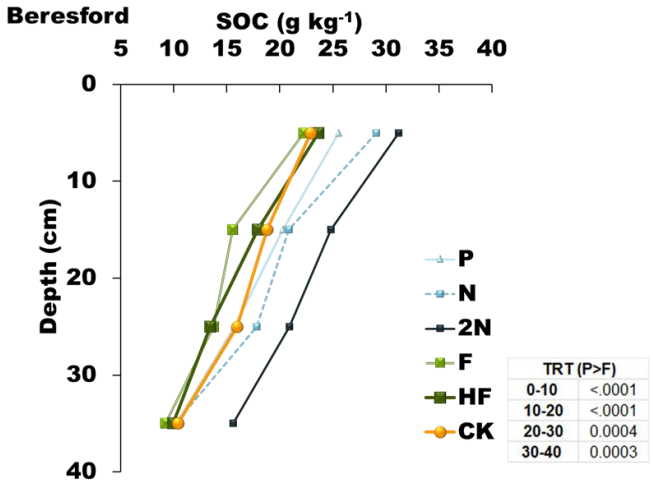

Beresford
7.9
7.4
6.9
6.4
5.9
5.4
pH
a a a cb c b
a a a a a a
a a a a a a
a a a a a a
0-10
10-20
20-30
30-40
Depths (cm)
P N 2N F HF CK

EC ($\mu S\ cm^{-1}$)

Treatments	Brookings				Beresford			
	----------Depths (cm)----------							
	0-10	10-20	20-30	30-40	0-10	10-20	20-30	30-40
P	1149^{c}	734^{cb}	738^{cb}	749^{cb}	768^{b}	369^{cb}	367^{ba}	451^{ba}
N	1508^{b}	828^{b}	783^{b}	777^{b}	934^{a}	478^{b}	423^{a}	409^{bc}
2N	**2010^{a}**	**1078^{a}**	**1062^{a}**	**954^{a}**	**1083^{a}**	**749^{a}**	**522^{a}**	**584^{a}**
F	754^{d}	575^{c}	651^{cd}	653^{d}	321^{c}	183^{c}	184^{c}	244^{d}
HF	662^{d}	599^{c}	631^{d}	736^{cbd}	359^{c}	307^{cb}	408^{a}	479^{ba}
CK	719^{d}	616^{c}	622^{d}	667^{cd}	437^{c}	265^{cb}	240^{bc}	297^{dc}
	Analysis of Variance (P>F)							
Treatment	*<.0001*	*0.0004*	*<.0001*	*<.0001*	*<.0001*	*0.0009*	*0.003*	*0.001*
P vs. 2N	*<.0001*	*0.001*	*<.0001*	*0.0003*	*0.0005*	*0.002*	*0.05*	*0.06*
Manure vs. Fertilizer	*<.0001*	*0.0012*	*<.0001*	*0.008*	*0.0001*	*0.01*	*0.05*	*0.05*

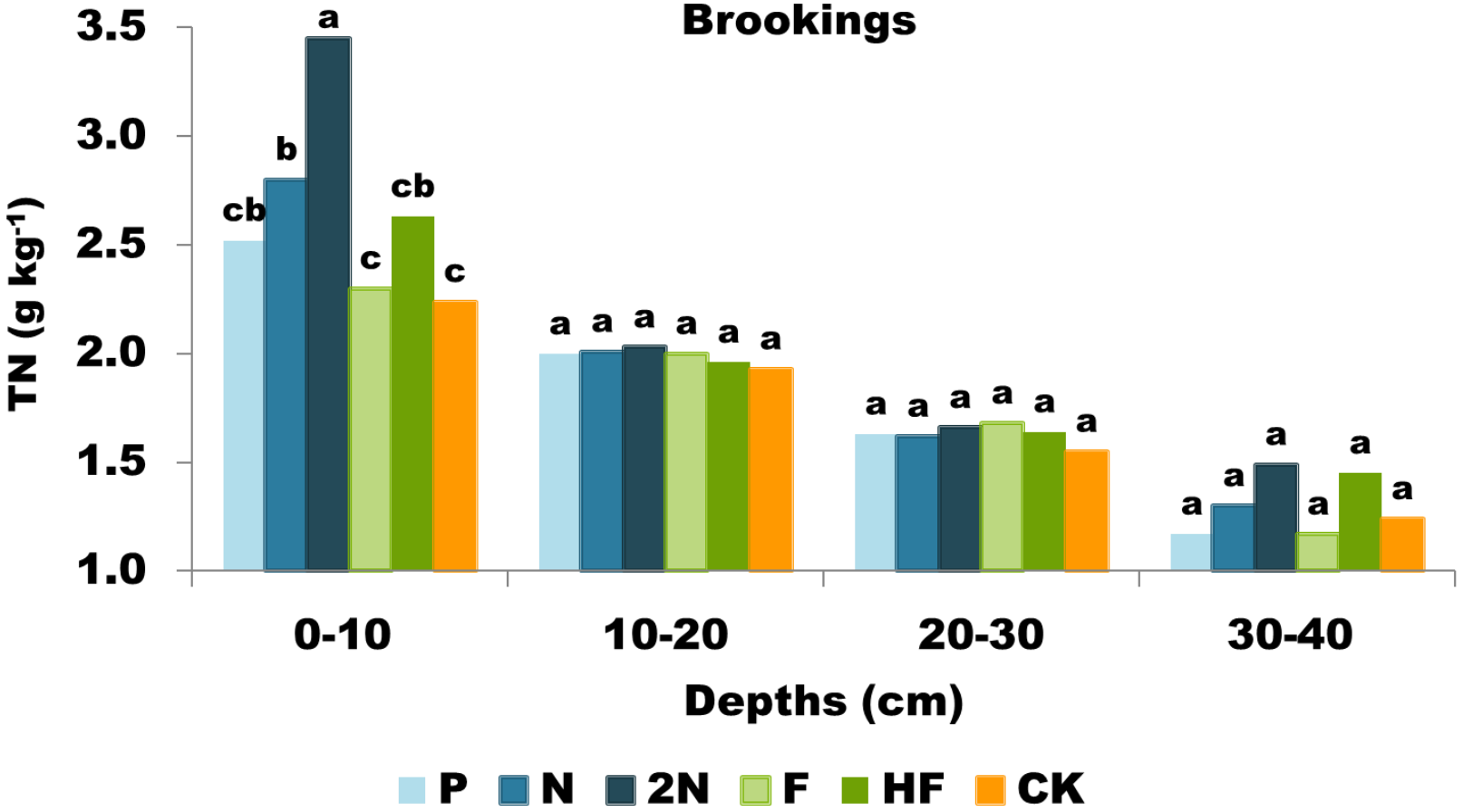
Soil Organic Carbon (g kg^{-1})

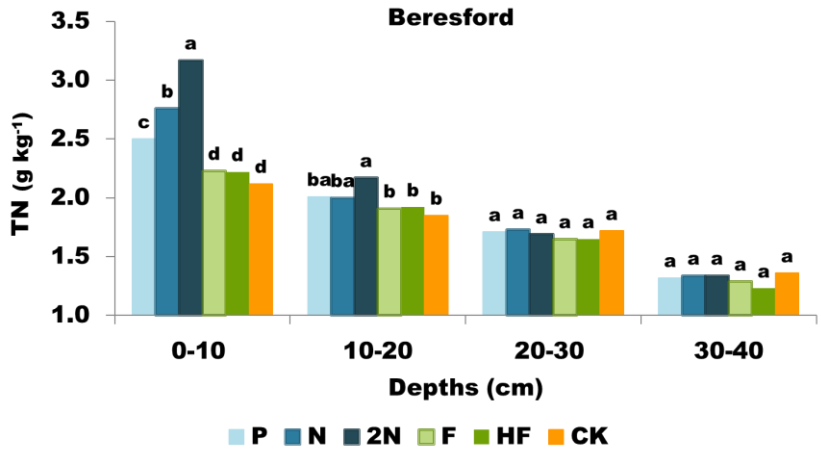




TRT (P>F)	
0-10	<.0001
10-20	0.0003
20-30	0.0001
30-40	<.0001

Soil Total Nitrogen (g kg^{-1})





Bulk Density (Mg m^{-3})

Treatments	Brookings		Beresford	
	----------Depths (cm) ----------			
	0-10	10-20	0-10	10-20
P	1.13^{b}	1.33^{ba}	1.10^{bc}	1.34^{a}
N	1.07^{b}	1.30^{b}	1.08^{c}	1.26^{a}
2N	**0.87^{c}**	**1.21^{c}**	**1.06^{c}**	1.24^{a}
F	1.27^{a}	1.36^{a}	1.22^{a}	1.32^{a}
HF	1.27^{a}	1.30^{b}	1.20^{ba}	1.35^{a}
CK	**1.29^{a}**	**1.38^{a}**	**1.22^{a}**	1.32^{a}
	Analysis of Variance (P>F)			
Treatment	*<.0001*	*<.0001*	*0.008*	*0.2*
P vs. 2N	*0.0001*	*<.0001*	*0.4*	*0.06*
Manure vs. Fertilizer	*0.0005*	*0.003*	*0.008*	*0.2*

Wet Aggregate Stability (%)

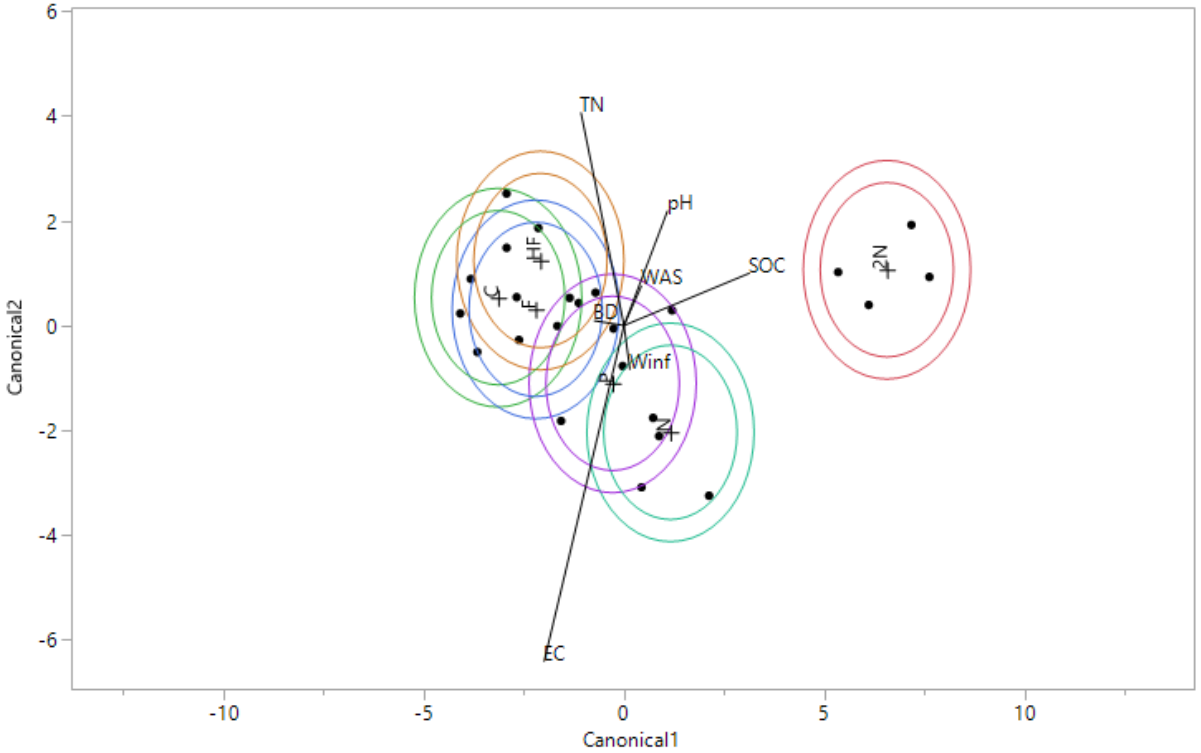
Treatments	Brookings		Beresford	
	----------Depths (cm)----------			
	0-10	10-20	0-10	10-20
P	91.90^{bc}	90.12^{a}	92.86^{bac}	92.31^{a}
N	93.51^{ba}	92.28^{a}	93.29^{ba}	92.15^{a}
2N	**98.59^{a}**	92.40^{a}	**96.73^{a}**	92.85^{a}
F	89.22^{bc}	89.11^{a}	89.36^{c}	89.20^{a}
HF	**87.39^{c}**	84.55^{a}	**89.14^{c}**	88.93^{a}
CK	90.11^{bc}	90.41^{a}	92.42^{bc}	90.52^{a}
	Analysis of Variance (P>F)			
Treatment	*0.01*	*0.5*	*0.01*	*0.08*
P vs. 2N	*0.02*	*0.6*	*0.05*	*0.7*
Manure vs. Fertilizer	*0.02*	*0.2*	*0.001*	*0.01*

Infiltration rate (mm hr^{-1})

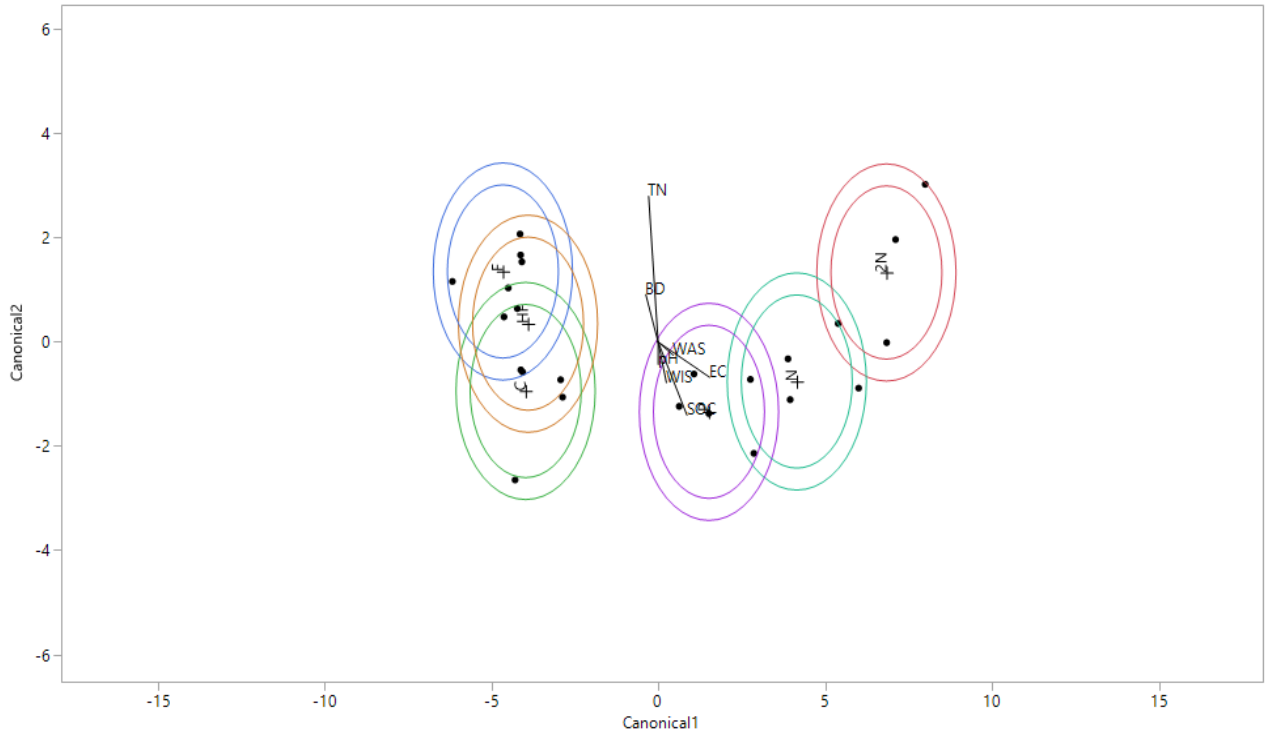
Treatment	Brookings	Beresford
P	304^{bc}	250^{bc}
N	326^{ba}	264^{ba}
2N	**412^{a}**	**329^{a}**
F	241^{bc}	**143^{d}**
HF	**225^{c}**	178^{dc}
CK	245^{bc}	179^{dc}
	Analysis of Variance (P > F)	
Treatment	*0.01*	*0.001*
P vs. 2N	*0.04*	*0.04*
Manure vs. Fertilizer	*0.001*	*0.001*

Discriminant Analysis

Brookings (7 Years)



Beresford (12 years)



Conclusions

- ✓Manure maintained soil pH. However, inorganic fertilizer decreased the soil pH as compared to manure and control treatments.
- ✓Manure application increased the SOC, TN, EC, *q*s, and WAS at either site as compared to inorganic fertilizer and control treatments.
- ✓Manure lowered the bulk density at 0-10 cm depth.
- ✓Overall, the application of manure helps in improving the soil quality indicators as compared to that of inorganic fertilizer.

Acknowledgements

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Source; *(Harold van Es, 2015)*