Straw Management and Crop Rotation Alternatives to Stubble Burning:

Assessing Economic and Environmental Trade-offs

DOE Presentation – Nov 9, 2010

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Co-Principle Investigators

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Project Objectives

(1) Analyze wheat stubble burning effects (SOM; C, N, P losses).

(2) Assess crop rotations that benefit from retaining the residues in DS systems.

(3) Investigate effects of wheat straw management and rotation alternatives on root pathogens.

Cook Agronomy Farm
Direct Seed and Precision Farming Systems

Location of Field Studies based on the 3 Objectives

Field Studies and Lab Analyses

DOE-1 Field Study (12 x 12 ft plots)

- 15 sites with 6 treatments (Fall '09 Burn, Spg. '10 Burn, Control, Fertilized/Nonfert.)
- Collected residue after each harvest.

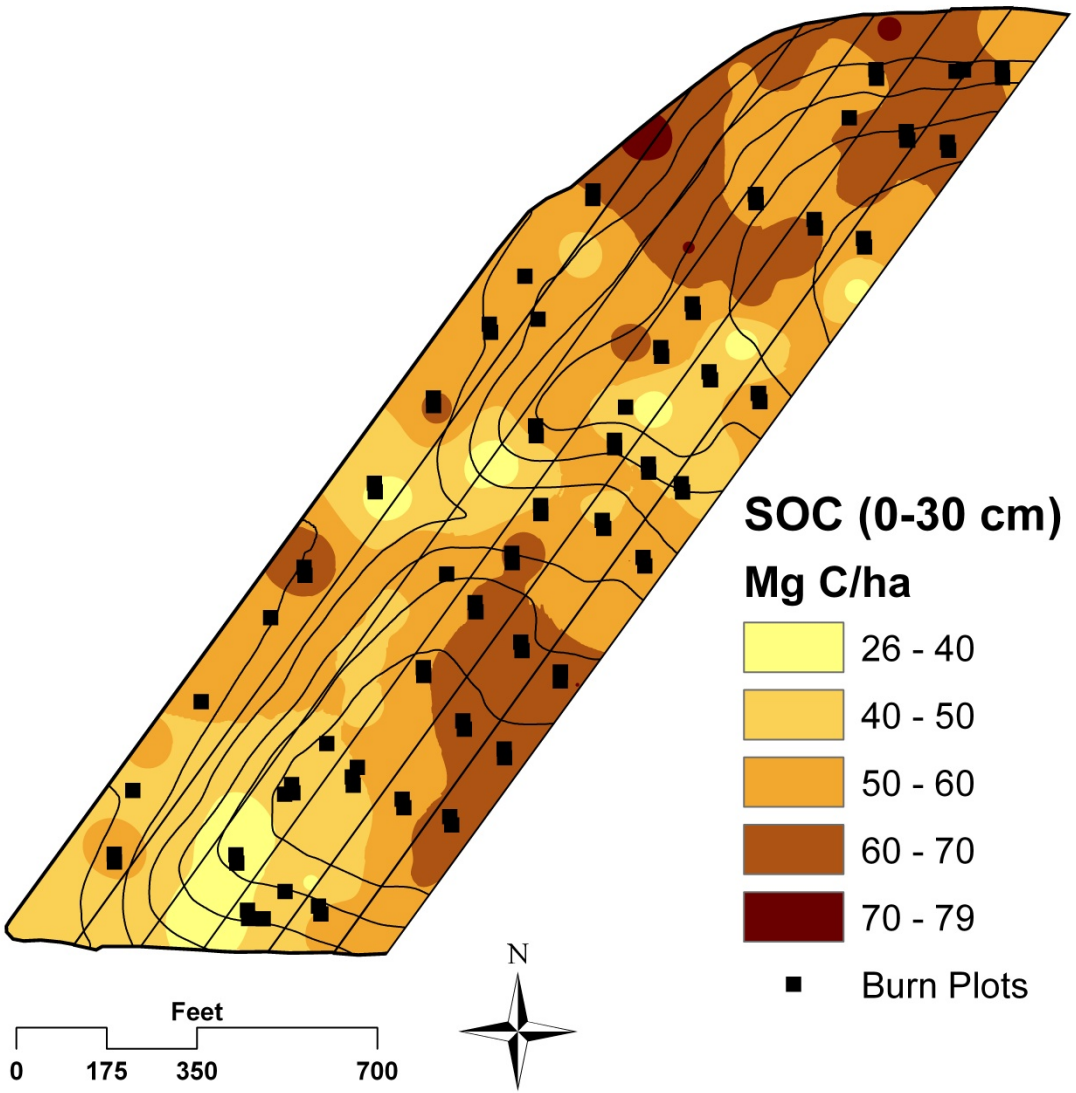
DOE-2 Field Study (12 x 12 ft plots)

- Rotations after Fall Burn: (1) ww-sb-sw; (2) ww-cp-sw; (3) ww-ww-sw.

DOE-3 Field Study (10 x 50 ft plots)

- 2 rotations (ww and ww-l) and 3 tillage

DOE1: Burn Locations Fall 2009 - Spring 2010



DOE 3 Field Study Parameters

- 2 different rotations:
  - continuous ww
  - ww-legume
- 3 types of tillage:
  - conventional
  - cross slot
  - Horsh
- 4 replicates taken

Rotation W - continuous winter wheat

W-1 CT	Conventional Tillage
W-2 FBCS	Fall Burn, Cross Slot
W-3 NBCS	No Burn, Cross Slot
W-4 NBH	No Burn, Horsh

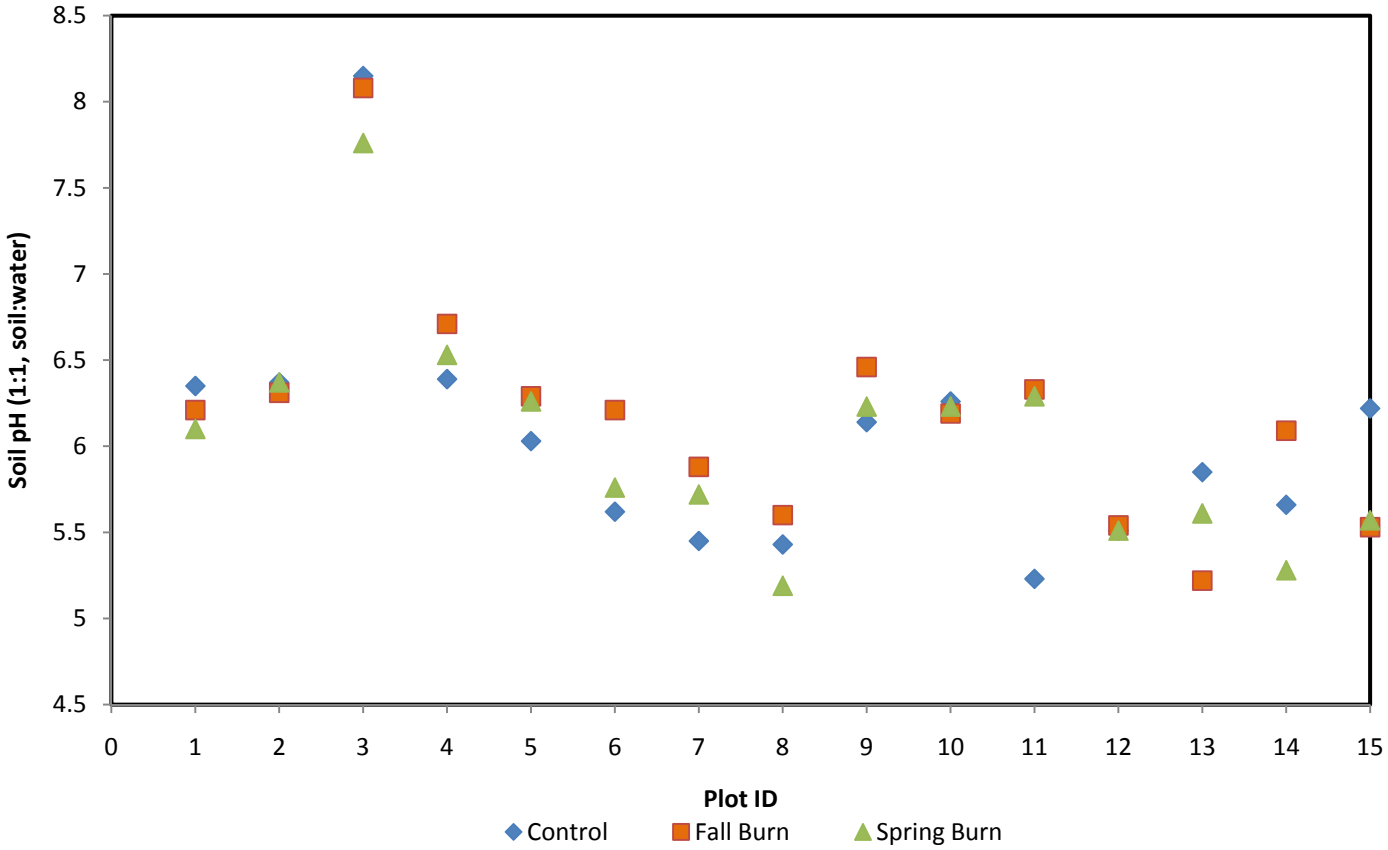
Rotation W-L - winter wheat-legume

W-L-1 CT	Conventional Tillage
W-L-2 FBCS	Fall Burn, Cross Slot
W-L-3 SBCS	Spring Burn, Cross Slot
W-L-4 NBCS	No Burn, Cross Slot
W-L-5 NBH	No Burn, Horsh

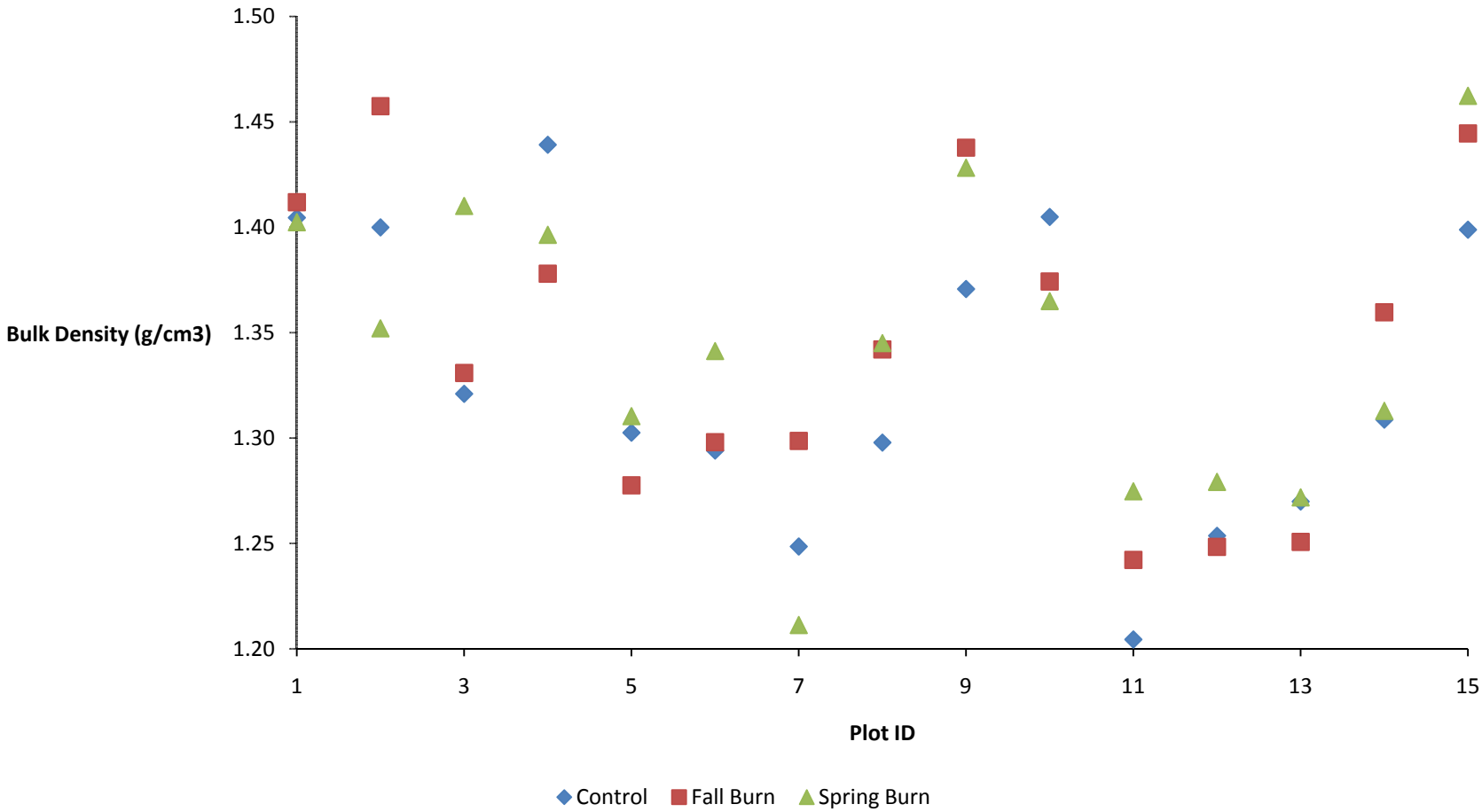
Methodology Used to Accomplish the Objectives

- Measured soil chemical and physical characteristics (soil pH, POM, bulk density, water content, nutrient contents).
- Assessed the residue loads (biomass, yields, C and N contents, net collected weights).
- Accounted for C, N, and P losses (mass balance on soil, plants, and residue).
- Evaluated micronutrient fluxes (PRS probes).

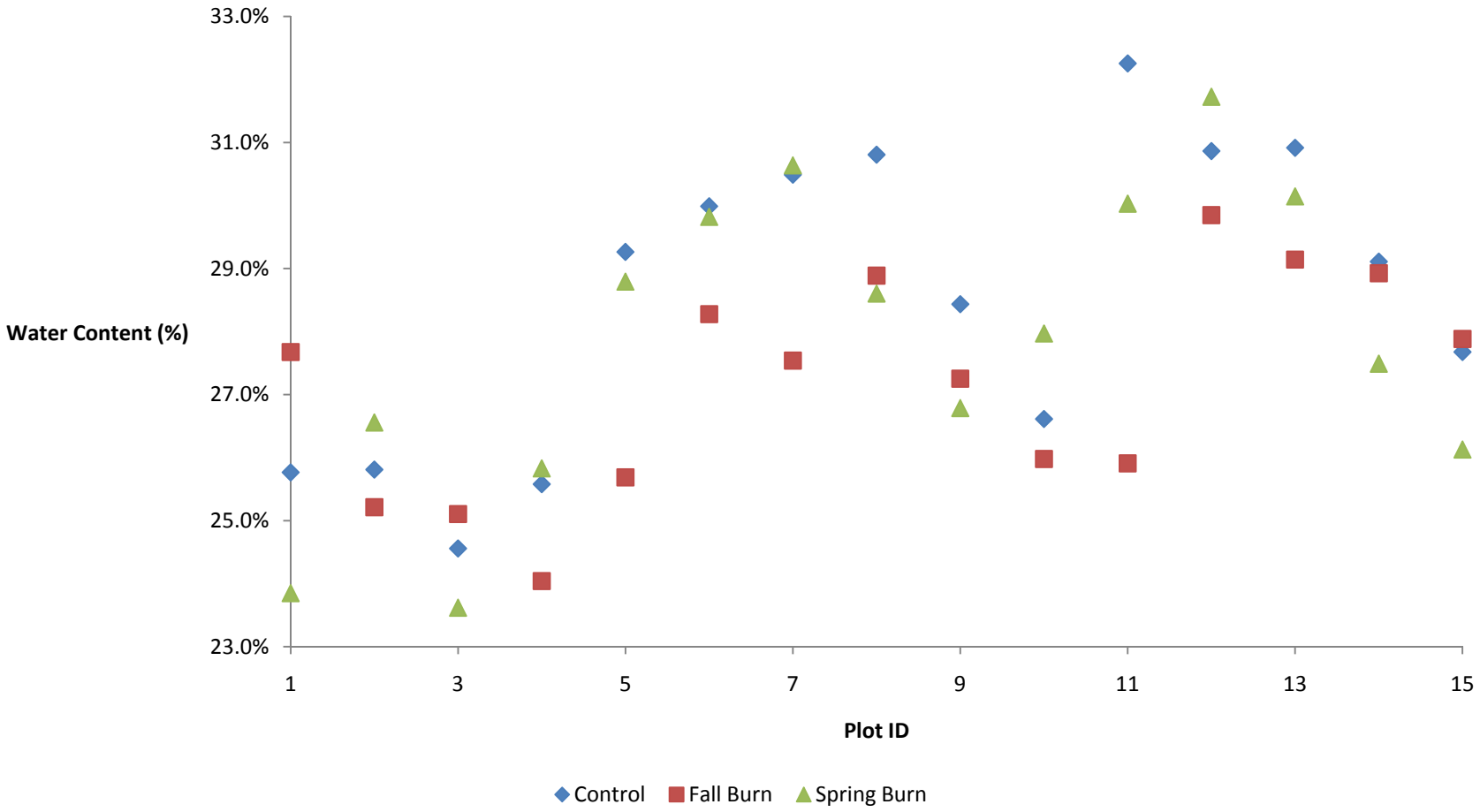
Soil pH Variance per Treatment



Bulk Density Variance per Treatment



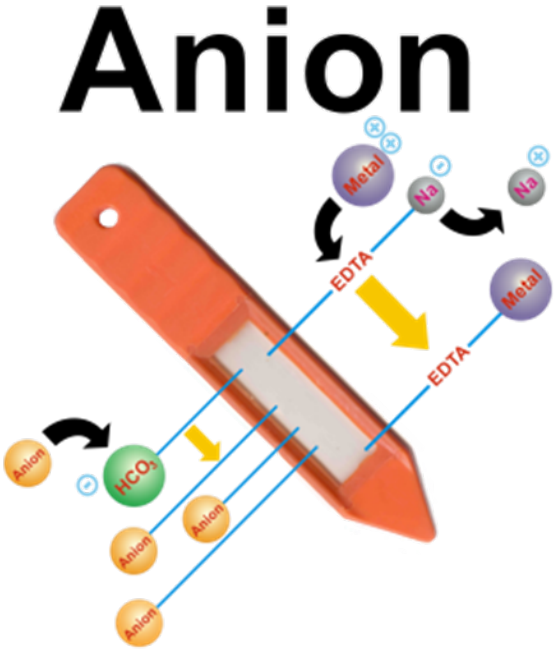
Water Content at Each Treatment

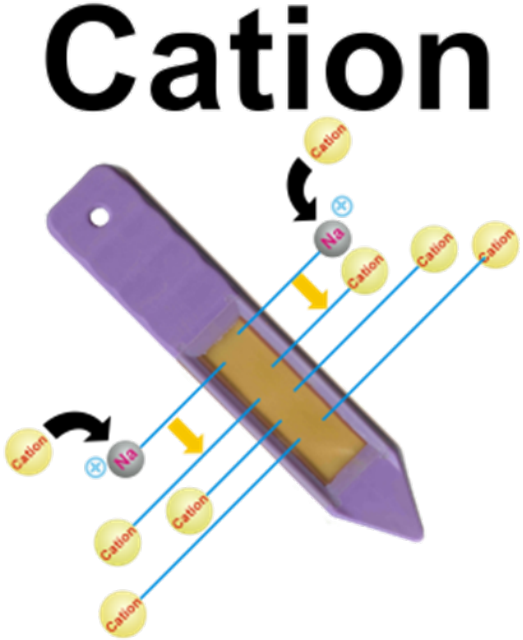


CAF Steep PRS Incu. May 2010
HIGH R : 1 P : B FB
Lab Rep : 2 PRS Bag : 18
Lab Rep : 1 PRS Bag : 6
846.4
CAF N-Min Steep 0-20cm May 2010
LOW R:4 P:C FB T:28 LR:3
CFStSp10Min_L_R4PC_T28_3
CFStSp10Min_H_R2PD_T28_2

PRS (Plant Root Simulator)™-probe

It employs an ion exchange resin membrane to provide a dynamic ion flux in soil and other heterogeneous media. When chemically pre-treated, the anion and cation exchange resin membranes exhibit surface characteristics and nutrient sorption phenomena that closely resemble a plant root surface. When buried in soil, the PRS™-probe can assess nutrient supply rates by continuously adsorbing charged ionic species over the burial period.





Preliminary PRS Probe Data

For Field Deployment of Probes Over a 3-week Interval

Plot ID #	Treatment	PRS Probe Nutrient Supply Rate (µg/10cm^2/burial length) [Method Detection Limits (mdl)]										
		Total N [2]	Ca [2]	Mg [4]	K [4]	P [0.2]	Fe [0.4]	Mn [0.2]	Cu [0.2]	B 0.2	S [2]	Al [0.4]
1	Fall Burn	51.2	1018.0	152.2	13.8	0.6	3.0	2.4	1.0	0.4	15.4	16.8
1	Control	65.6	1237.0	197.8	20.2	1.0	5.4	4.0	1.4	0.4	18.2	20.4
7	Fall Burn	152.8	862.2	130.6	62.8	1.0	10.0	6.2	1.4	0.4	34.0	17.6
7	Control	50.6	825.2	127.4	39.0	1.6	4.0	2.8	1.2	0.4	33.4	14.4
5	Fall Burn	133.8	788.0	128.0	133.2	2.4	7.2	5.4	1.2	0.4	25.0	15.4
5	Control	55.0	726.2	123.8	157.0	3.2	5.2	8.2	1.2	0.4	32.6	16.0
8	Fall Burn	130.4	579.6	87.2	166.2	1.6	8.0	6.0	1.2	0.6	19.0	18.0
8	Control	239.8	977.2	175.4	69.8	1.8	13.0	9.6	1.0	0.4	31.8	17.6
12	Fall Burn	51.4	565.6	88.0	141.2	1.8	3.2	3.6	0.8	0.4	26.0	14.4
12	Control	66.8	647.4	130.6	84.2	1.6	3.8	2.6	1.0	0.4	30.2	14.4

3.6 - denotes a value below the detection limits

It is only a fraction of the data for this time interval.

More Preliminary PRS Probe Data

		PRS Probe Nutrient Supply Rate (µg/10cm2/burial length)								
			[Method Detection Limits (mdl)]							
Time	Field Site		Field Data (w/o corrections)				Lab Data (w/o corrections)			
Interval	Treatment	Test Plot	Total N	NO3-N	NH4-N	P	Total N	NO3-N	NH4-N	P
		ID #	[2]	[2]	[2]	[0.2]	[2]	[2]	[2]	[0.2]
24-hrs	Fall Burn	1	12.8	7.8	5.0	0.4	31.6	31.6	0.0	0.2
24-hrs	Control	1	10.2	7.0	3.2	0.2	38.0	38.0	0.0	0.2
24-hrs	Fall Burn	10	38.4	35.6	2.8	0.6	40.2	40.2	0.0	1.0
24-hrs	Control	10	10.8	8.2	2.6	0.4	10.8	10.8	0.0	0.4
24-hrs	Fall Burn	8	27.0	20.0	7.0	0.6	32.6	32.6	0.0	0.6
24-hrs	Control	8	20.8	9.8	11.0	1.6	23.4	23.4	0.0	0.6
24-hrs	Fall Burn	11	22.8	21.0	1.8	0.6	29.4	29.4	0.0	0.6
24-hrs	Control	11	23.8	15.8	8.0	1.2	43.0	43.0	0.0	0.8
24-hrs	Fall Burn	15	27.6	24.6	3.0	0.6	24.6	24.6	0.0	0.6
24-hrs	Control	15	13.2	12.8	0.4	0.6	26.2	26.2	0.0	0.6
1-week	Fall Burn	1	61.8	58.0	3.8	1.0	80.2	78.4	1.8	0.2
1-week	Control	1	49.6	45.6	4.0	0.8	224.6	221.2	3.4	0.4
1-week	Fall Burn	10	81.0	79.4	1.6	2.2	114.8	111.2	3.6	1.0
1-week	Control	10	204.2	202.4	1.8	1.6	165.4	164.8	0.6	3.0
1-week	Fall Burn	8	96.0	94.0	2.0	2.0	191.2	188.8	2.4	0.6
1-week	Control	8	49.2	45.8	3.4	4.1	155.0	153.4	1.6	1.0
1-week	Fall Burn	11	163.4	162.6	0.8	2.8	65.6	64.4	1.2	0.2
1-week	Control	11	69.6	67.4	2.2	2.4	98.2	95.4	2.8	0.2
1-week	Fall Burn	15	131.0	128.4	2.6	1.6	64.6	63.8	0.8	0.4
1-week	Control	15	74.2	73.6	0.6	1.4	75.0	75.0	0.0	1.4

A subset of the data is shown for comparison purposes.

Average Yield Data (wet wts.) for the 6 Treatments from DOE-1

Sample #	Treatment	Fertilizer Applied	Average Plot Yields for 15 locations (bu/ac)
1	Control	Fertilizer	55.6
2	Control	No Fertilizer	44.6
3	Fall Burn	Fertilizer	53.6
4	Fall Burn	No Fertilizer	50.4
5	Spring Burn	Fertilizer	50.2
6	Spring Burn	No Fertilizer	42.9

Tasks Accomplished To-date (Data still needs to be analyzed.)

- Particulate Organic Matter (POM) on 45 samples
- N Mineralization for a 5-week incubation study
- Plant C & N content for 10 plots using PRS probes
- Residue Loads for Fall Burn (60 samples)
- Residue Loads for Spring Burn (90 samples)
- PRS probe Nutrient Analyses (both for the field deployment and lab study)

Major Items to Complete

- Complete residue separations and preparation for analysis (20 are left).
- Analyze residue C and N contents for both Fall and Spg. Burns (150 samples).
- Perform soil total N content collected in October 2010 (450 samples).
- Examine POM C content (45 samples).
- Carry out a statistical analysis on the data.
- Assemble results and compile a final report.

It has been a real pleasure working on this project with such talented people.