Greenhouse Gas Emissions from Conventional versus Minimum Till Fields: Baseline Data

J. Lee, J. Six, A.E. Patrick, J.L. MacIntyre, C. van Kessel, D.E. Rolston, J.W. Hopmans, R.E. Plant, and K.T. Paw U
University of California, Davis

INTRODUCTION

- Agriculture contributes significantly to greenhouse gas (GHG) emissions by altering C and N cycles on regional to global scales.
- One proposed mitigation option is increasing the amount of soil C and N sequestered in minimum tillage systems.
- In agricultural systems, the mechanistic relationship between changes in C and N cycling induced by minimum tillage and the concomitant flux of GHG's remains unanswered.
- We started a study to determine soil processes regulating C and N sequestration and GHG emissions.

OBJECTIVES

- To determine spatial and temporal characteristics of factors controlling soil C and N sequestrations in a CA agricultural system.
- To determine and quantify soil processes controlling GHG emissions under CT versus MT.
- To evaluate the net effect of CT and MT systems on GHG emissions.

SITE DESCRIPTION

- Located in the Sacramento Valley (CA), managed under CT until 2002, when it was converted to MT.
- Cropping system: corn (2002), wheat (2003).
- Three soil types: Myers clay (Ms), San Ysidro loam (Sh), and Hillage loam, moderately deep, 0 to 2 percent slopes (HdA)

MATERIALS and METHODS

Soil and wheat biomass sampling

Soil samples were taken at the 0-15, 15-30, and 30-50 cm depths by using a Dutch auger in February 2003, and wheat biomass was collected by hand harvest at the same locations in May 2003.

Analysis

- Total C, total N, delta ^{13}C, delta ^{15}N, and soil texture.
- The total amount of C input via shoot and root biomass of wheat.
- Estimation of all variables across the whole field by applying kriging. Correlation and regression analyses among variables (SAS, 2003).

RESULTS and DISCUSSION

Table 1. Total C, total N, delta ^{13}C, delta ^{15}N, and soil texture and the amount of C input via wheat biomass (n=50).

	Depth (cm)	Mean	Range	CV (%)
Total C (%)	0-15	1.05	0.64~1.61	17
	15-30	0.77	0.32~1.03	17
	30-50	0.60	0.25~0.87	21
Total N (%)	0-15	0.11	0.08~0.14	13
	15-30	0.09	0.05~0.11	13
	30-50	0.07	0.04~0.09	15
Delta ^{13}C (‰)	0-15	-21.75	-22.90~-19.00	3
	15-30	-23.44	-24.44~-22.15	3
	30-50	-24.10	-25.03~-21.46	3
Delta ^{15}N (‰)	0-15	5.02	3.58~7.41	15
	15-30	4.99	2.99~6.19	14
	30-50	4.92	2.74~6.46	16
Sand (%)	0-15	29.0	18.9~43.4	26
	15-30	24.5	15.5~45.2	32
	30-50	23.1	13.0~42.4	35
Silt (%)	0-15	52.9	41.6~60.9	10
	15-30	55.6	40.5~62.5	10
	30-50	55.4	42.3~63.3	10
Clay (%)	0-15	18.2	13.3~22.8	15
	15-30	20.0	14.2~25.1	15
	30-50	21.5	14.6~27.5	14
Shoot C input (kg ha^{-1})		3427	646~7452	51
Root C input (kg ha^{-1})		276	26~548	44
Total C input (kg ha^{-1})		3703	882~7890	47
Root/shoot ratio		0.11	0.01~0.37	76

- Total C, total N, delta ^{13}C, and delta ^{15}N showed a spatial variability at the field scale.
- The root/shoot ratio was highly variable across the field.

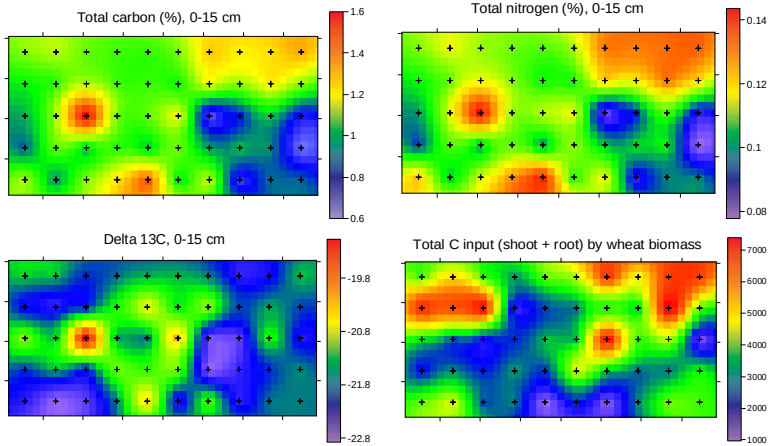

Figure 1. Estimation of total C, total N, delta ^{13}C, and the amount of C input by wheat biomass across the field.

Table 2. Pearson correlation coefficient (r) among all variables (0-15 cm)

	Total C	Total N	Delta ^{13}C	Delta ^{15}N	Sand	Silt	Clay	Shoot C input	Root C input	Total C input
Total C	-	**0.95**	**0.57**	0.21	**-0.47**	**0.53**	**0.30**	0.03	0.18	0.04
Total N		-	**0.44**	0.12	**-0.43**	**0.49**	0.26	0.13	0.12	0.14
Delta ^{13}C			-	0.09	-0.14	0.1	0.18	**-0.31**	0.09	**-0.30**
Delta ^{15}N				-	**-0.44**	**0.42**	**0.41**	0.02	0.22	0.03
Sand					-	-	-	-0.20	**-0.30**	-0.22
Silt						-	-	0.20	**0.30**	0.22
Clay							-	0.17	0.26	0.19
Shoot C input								-	-0.01	**0.99**
Root C input									-	0.06
Total C input										-

P < 0.05; **P < 0.01**; **P < 0.001**; not significant

- Total C, total N, and delta ^{15}N in the top 15 cm of soil were positively related to silt and clay content.
- Soil organic C and N were not related to C input by shoots and roots of wheat.
- There was a significant relationship between C input via root biomass and sand or silt.

CONCLUSIONS

- Spatial variability of soil organic C and N is great at the field and landscape scales.
- Silt and clay contents are key factors which control the storage and sequestration of soil C and N.
- C input by wheat biomass was a poor indicator for the spatial distribution of soil C and N.
- Other model types (e.g., polynomial) could be more useful to determine relationships between soil organic C and N and other variables than linear model.

NEXT RESEARCH APPROACH

- Total C, total N, and ^{13}C associated with particulate organic matter size classes at the 0-15 cm depth at 140 locations will be determined.
- Soil texture, bulk density, soil water, soil temperature, and other physical factors at the different depths will be measured.
- The net flux of GHG's from the soil surface as affected by different tillage practices (CT vs. MT) will be measured.
- Changes in microbial biomass in the top 15 cm of soil will be analyzed.