Soil Organic Carbon Budget and Turnover Rates under No-till Cropping Systems in a Heterogeneous Palouse Landscape

Qiuping Peng[1], Dave Huggins[1, 2], Tabitha Brown[1], David Brown[1], Lynne Carpenter-Boggs[1], and Claudio Stöckle[3]

[1]Dept. Crop and Soil Sciences, Washington State University; [2]USDA-ARS, Pullman, Washington; [3]Dept. of Biological Systems Engineering, Washington State University

Introduction

Conversion from conventional tillage (CT) to no-tillage (NT) will change soil profile C stocks as well as pool dynamics. Following conversion to NT, we hypothesize that labile soil C pools near the surface may be augmented while subsoil C pools may be depleted. In the Palouse region of Eastern WA, landscape processes, soil heterogeneity and management history have interacted to produce highly variable soil C stocks and associated dynamics.

Our objectives are to: (1) assess changes in profile (0 to 1.5 m) C stocks in a heterogeneous landscape following conversion from CT to NT; (2) evaluate and improve process-based models (e.g. CropSyst); and (3) quantify landscape, soil and management interactive effects on C pool dynamics.

Objectives and work flow

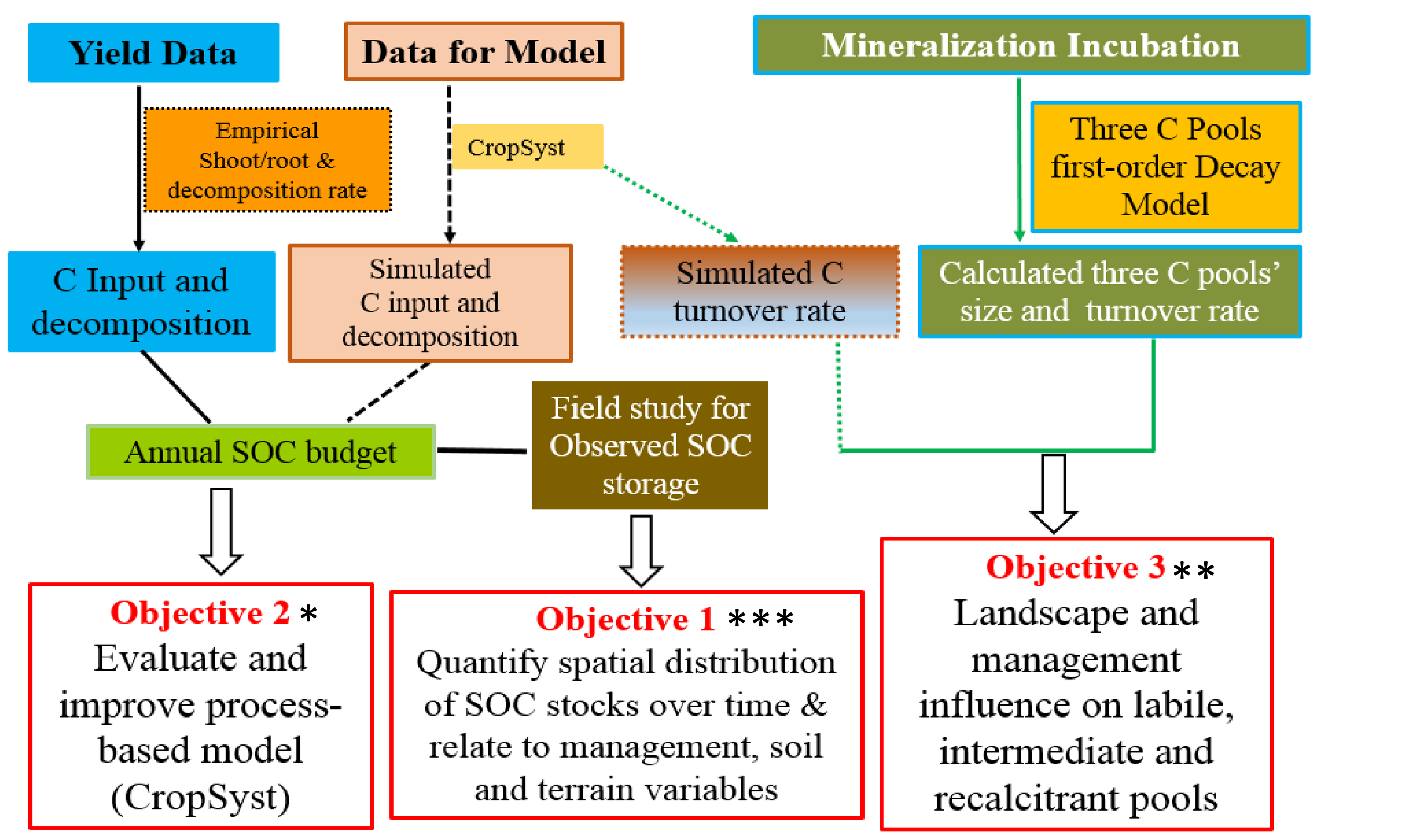

Figure 1. Project objectives and work flow

*** Not started   **Ready to go   *** Complete sample collection with analyses underway**

Methodology

- **R.J. Cook Agronomy Farm (CAF),** A USDA Long-Term Agroecosystems Research (LTAR) site, near Pullman, WA (46°47' N, 117°5' W) under a continuous NT, dryland cropping system. The 37-ha research farm was converted from CT in 1998 to NT using a Great Plains (low disturbance, double-disk) drill from 1999-2009 and a Horsch-Anderson (high disturbance, hoe-type) drill from 2010-2015. Systematic, non-aligned grid of 369 geo-referenced sample locations were established in 1999. Soil baseline samples were collected in 1999 with follow-up in 2008 and 2015.
- **Six crop rotations** encompass cropping systems research with a rotation of Winter wheat (WW)-Alternative Crop-Spring Wheat (SW) (Fig. 2).
- **Deep core sampling:** Soil profile cores (0 to 153 cm) were sampled at 184 geo-referenced locations (1999, 2008, 2015). Soil cores were divided by 10-cm increments to a depth of 30 cm and then by soil horizon to a depth of 153 cm for analyses of soil bulk density, total C and N (dry combustion, TruSpec CN, Leco Corp.).
- **Mulch layer** (Fig. 3) was observed to have formed by 2008 and defined as a mixture of partially decomposed crop residue and mineral soil. The mulch layer is likely an important C pool and was observed to accumulate over the first 10 years of continuous, low disturbance NT management.
- **Mulch layer sampling:** Four samples at all 369 geo-referenced locations were collected in July 2008, and composited for determination of bulk density and total C and N.

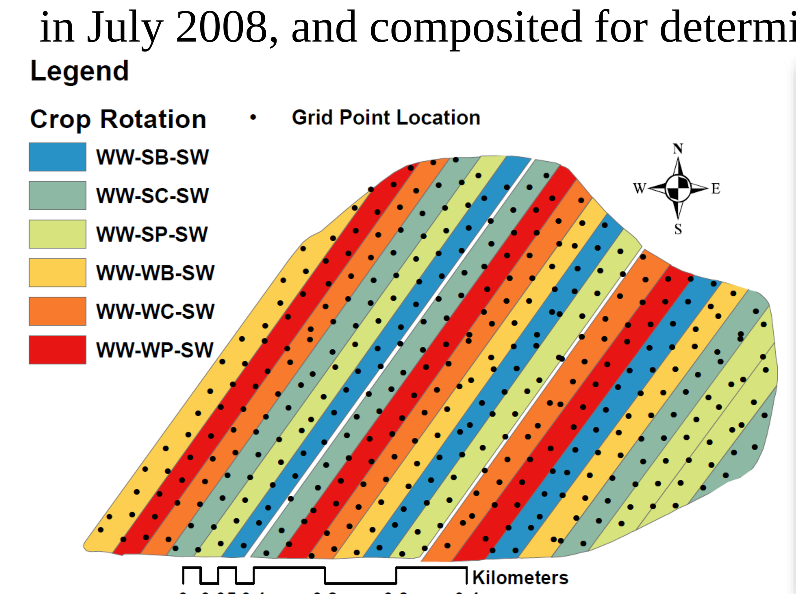

Figure 2. Crop rotation at CAF during 2001 to 2009 harvest years emphasizing the alternative crop

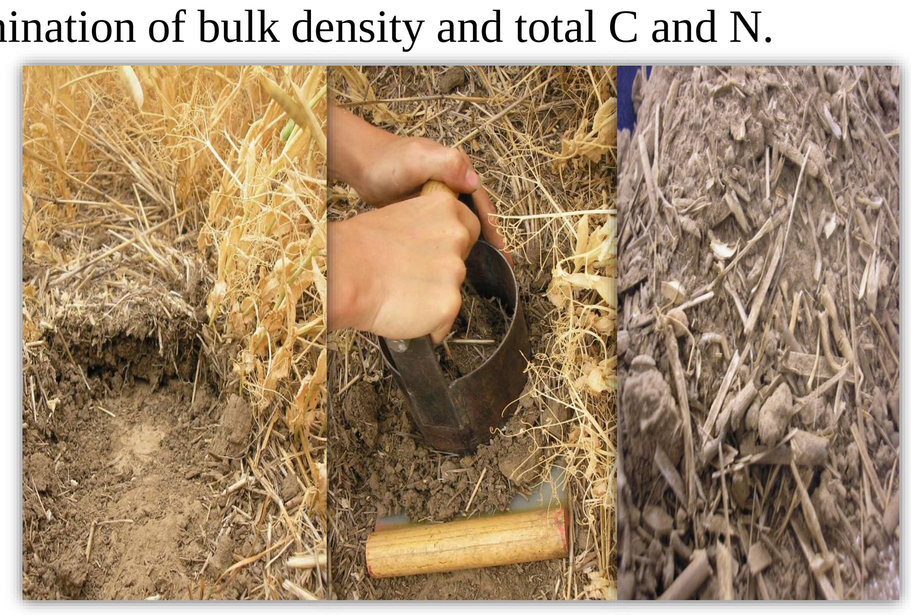

Figure 3. Photos of defined mulch layer and collection at CAF in 2008

Preliminary results

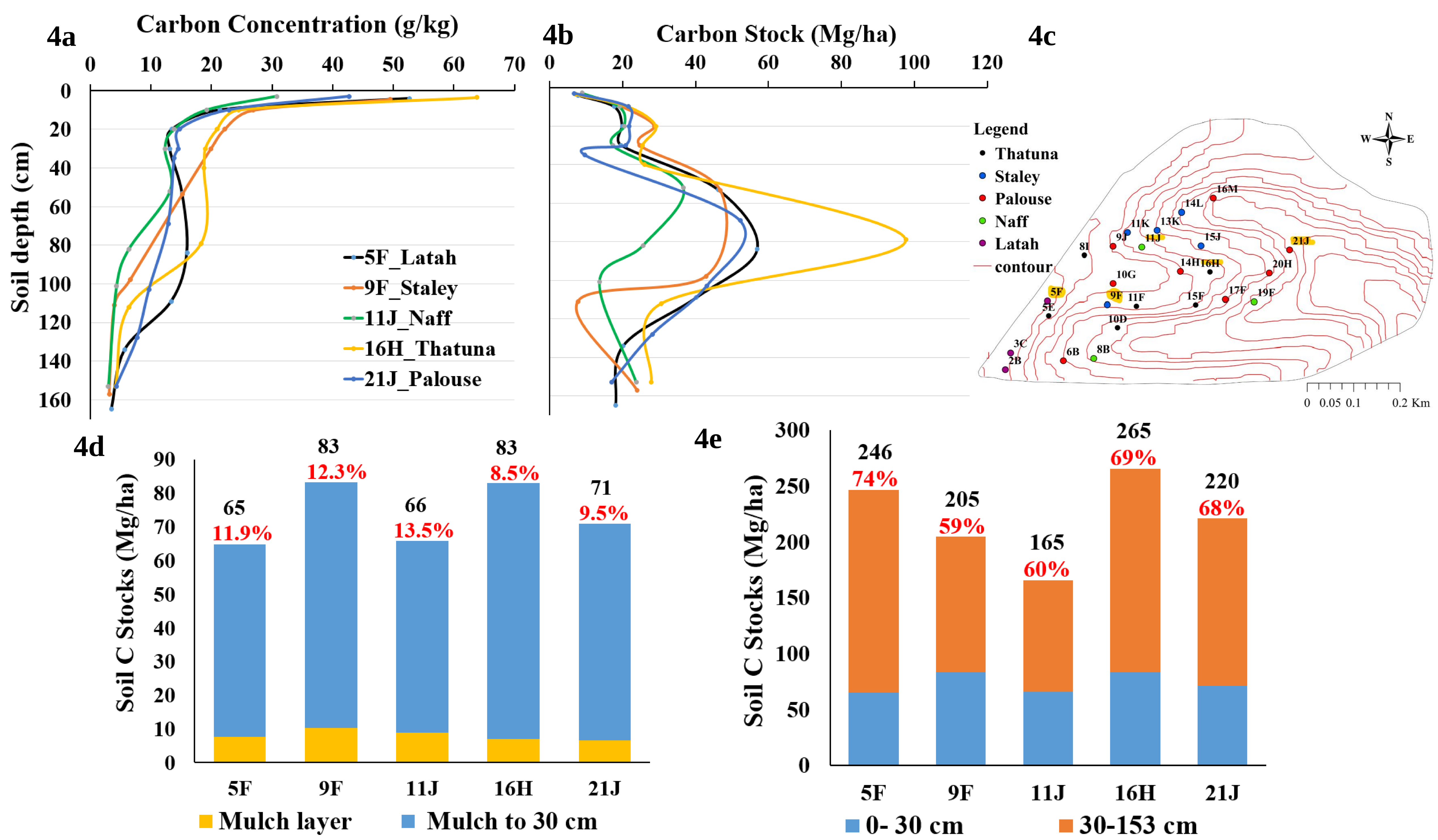

Figure 4. 2008 CAF soil carbon for :

4a. Profile C concentration depth distribution; **4b.** Profile C stock depth distribution; **4c.** Map of deep core locations for entire project highlighting 5 examples in 4a-e; **4d.** Mulch layer and upper 30 cm C stocks; **4e.** 0-30 and 30-153 cm C stocks.

➢Profile C concentrations ranged from 2.95 to 63.8 g/kg; subsoil C concentrations ranged from 2.95 to 18.9 g/kg; mulch layer C concentrations varied from 30.7 to 63.8 g/kg. Subsoil C concentrations generally decreased with the depth; however, increases were observed in 5F and 16H, likely due to soil erosion processes that buried topsoil C under long-term CT (Fig. 4a & 4c).

➢Profile C stocks ranged from 6.7 to 97.6 Mg/ha; subsoil C stocks ranged from 9.6 to 97.6 Mg/ha; mulch layer C stocks ranged from 6.7 to 10.2 Mg/ha, which was similar to the lowest subsoil C stock of 6.7 Mg/ha (Fig. 4b).

➢Upper 30-cm soil C stocks ranged from 65 to 83 Mg/ha, and the contribution of the mulch layer to upper 30-cm C stocks ranged from 8.5 to 13.5% (Fig. 4d).

➢Greater C stocks were observed in the subsoil (30 to 153 cm), ranging from 99 to181 Mg/ha. The contribution of subsoil to profile C stocks ranged from 59 to 74% (Fig. 4e).

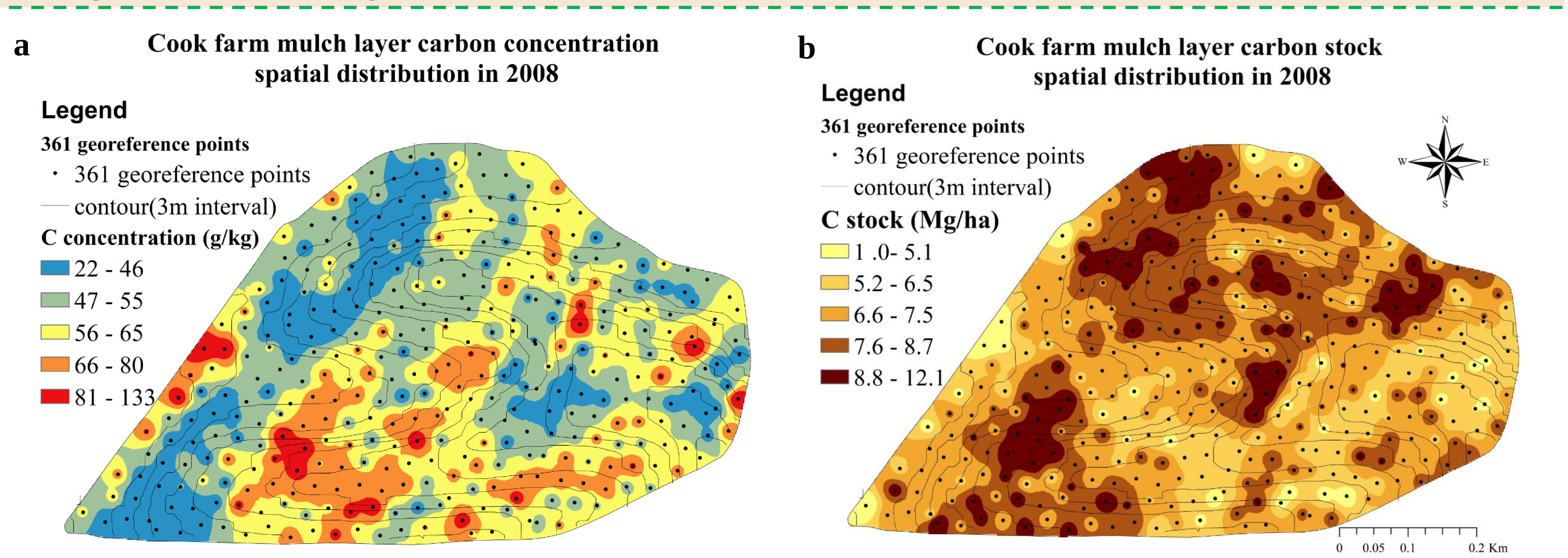

Figure 5. Carbon concentration and stock spatial distribution in mulch layer across CAF in 2008 (Inverse Distance Weighted interpolation)

➢C concentration in mulch layer ranged from 22 g/kg to 133 g/kg and averaged 55.8 g/kg (Fig. 5a).

➢C stock in mulch layer varied from 1.0 to 12.1 Mg/ha and averaged 7.28 Mg/ha (Fig. 5b).

➢Inconsistent spatial relationship was observed between C concentration and C stock of mulch layer, likely due to interactive effects of crop rotation, terrain and soil variables (e.g., bulk density, depth of mulch layer and returned residue) (Figs. 5a and 5b).

Acknowledgement

We thank REACCH (Regional Approaches to Climate Change) project award #2011-68002-30191 from USDA National Institute of Food and Agriculture and the USDA-ARS for funding support. We also thank all that contributed to field work and sample analyses.

Poster # 329-518

Contact: qiuping.peng@wsu.edu