Prairie Soil Organic Matter Shown to be Resilient Under Intensive Agriculture

Carbon and nitrogen pools in soil (organic matter) are important because their alteration can affect greenhouse gases and the sustainability of agricultural production. Thus, monitoring their changes through time is important but fraught with difficulties. Short-term, soil–landscape variability accounts for considerable differences in soil organic matter and is slow to respond to management shifts. Over long time periods, locations of sampling sites are lost, and few samples are archived. Although conversion of prairie soils to agricultural fields in the Midwest have been documented to reduce organic matter, much of the literature addresses only surface soils, and there is relatively little information on changes due to artificial tile drainage.

A team of scientists at the University of Illinois at Urbana-Champaign utilized previously sampled fields, archived soil samples, and prairie remnants to document changes in soil carbon and nitrogen pools in response to agricultural production. Results from the study were published in the January–February 2009 issue of the *Journal of Environmental Quality*.

"Well-documented sampling sites, archived soil samples, and chemical analysis of agricultural fields in central Illinois from 1901 to 1904 collected by Dr. Cyril Hopkins were utilized, explains team member Robert Darmody. "Hopkins at that time was head of the Department of Agronomy and collected the first systematic soil samples in the state beginning in 1901. His meticulous field notes and maps, laboratory analysis books, and archived samples allowed us to resample fields to compare current soil carbon and nitrogen pools to those from 100 years earlier."

In addition, Soil Conservation Service sampling sites and data from 1957 were utilized so that soil changes during the modern production era of fertilizers, pesticides, and hybrids could be evaluated. Finally, current prairie remnants were sampled as were neighboring agricultural fields.

Dry subsamples of the soils collected by Hopkins (and others) have been kept in glass jars in storage at the University of Illinois since the early 1900s. Analysis of these archived soil samples allowed modern chemical techniques to be compared with early ones. Modern values of carbon and nitrogen on the archived soil samples were found to match extremely well with the values recorded in Hopkins' laboratory books.

"It was reassuring to see the continuity in the results between the old and new methods, says team leader Mark David. "The University of Illinois has a unique and large archive of soil samples from this early period and throughout the 20th century that many studies have used, including the well-known Morrow Plots."

The study confirmed the large reduction in organic C and total N pools when prairies were first cultivated and drained but documented no consistent pattern of change in these organic matter pools during the period of synthetic fertilizer use (1957–2002). Most of the decline in organic matter prior to the 1950s had occurred in the top 50 cm of soil, with evidence of increased carbon and nitrogen in deeper layers, possibly enhanced by tile drainage.

"Most studies of this nature have sampled only the surface soils, but this is one of the few that examines long-term changes to a depth of one meter at multiple locations and considers the influences of bulk density," says team member Greg McIsaac.

For these prairie soils, some of the most productive in the world, declines in organic matter from cultivation were likely completed by the 1950s, David says. Since then, organic matter pools have remained relatively constant under modern production practices.

LEFT: Professor Cyril Hopkins (on right) taking a soil sample in Illinois in 1904. On the left is James H. Pettit, assistant soil analyst at the Illinois Agricultural Experiment Station. RIGHT: Robert Darmody collecting a soil sample in a remnant prairie in Illinois. Photo by R.A. Omonode.

David, M.B., G.F. McIsaac, R.G. Darmody, and R.A. Omonode. 2009. Long-term changes in Mollisol organic carbon and nitrogen. J. Environ. Qual. 38:200–211. View the full article at http://jeq.scijournals.org/content/vol38/issue1/