USDA Symposium on Natural Resource Management to Offset Greenhouse Gas Emissions

Raleigh, North Carolina
November 19-21, 2002

USDA UNITED STATES DEPARTMENT OF AGRICULTURE

NRCS ARS ERS ECONOMIC RESEARCH SERVICE USDA CSREES Farm Service Agency

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Tillage-Induced Variation in Terrestrial Carbon Stocks and CO_2 Loss Across an Eroded Landscape

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Soil carbon (C) losses and soil translocation from tillage operations have been identified as causes of soil degradation and soil erosion. The objective of this work was to quantify the variability in terrestrial C stocks and tillage-induced CO_2 loss by moldboard and chisel plowing across an eroded landscape. The study site was a 4-ha wheat field with rolling topography and three glacial till soils in the Barnes-Langhei complex in west central Minnesota (N Lat = 45° 41', W Lon = 95° 43'). Historical tillage was primarily moldboard plow and disk harrow for the last 30 years. Soil C was measured at several depths at a 10-m spacing along east-west and north-south transects. Conventional moldboard plow (25 cm deep) and chisel plow (15 cm deep) equipment were used along the pre-marked transects. Gas exchange measurements utilized a large, portable chamber within 2 m of each sample site following tillage. The measured CO_2 fluxes were largest with the moldboard plow > chisel plow > not tilled (before tillage). The variation in CO_2 flux in the north-south transect was nearly four-fold immediately after plowing. The CO_2 loss was only partially related to soil C with lower CO_2 flux on the severely eroded sites. The CO_2 loss partially reflected the degradation of soil properties as a result of wind and water erosion and tillage-induced soil translocation. The spatial variation of soil C across the landscape suggests non-point sources are complex and the need for improved conservation tillage methods.