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Tillage-induced CO_2 loss across an eroded landscape in the North American Great Plains

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Agriculture's role in sequestering carbon is not clearly understood. Intensive tillage reportedly has caused between a 30-50% decrease in soil carbon (C) since many of the soils were brought into cultivation. The objective of this work was to evaluate the long-term effects (3 months) of moldboard plowing on CO_2 loss from a Barnes loam (Udic Haploborolls, fine-loamy, mixed) in west central Minnesota, USA (45˚41'14" N latitude and 95˚47'57" west longitude). Tillage-induced CO_2 loss was periodically measured using a large portable chamber for eighty-seven days during summer of 1998. The soil CO_2 concentration was measured at 5, 10, 20, 30, 50 and 70-cm depths in the no-till plots and 30, 50 and 70-cm depths in plowed plots. Gas samples were taken with gas-tight syringes and run through an infrared gas analyzer using a computer-controlled data system and numerical integration techniques to determine the concentration. The initial flush of CO_2 immediately after moldboard plowing was nearly 100 g CO_2 m^{-2} h^{-1} while that from the not tilled treatment was less than 0.9 g CO_2 m^{-2} h^{-1}. The flux from the plowed plots declined rapidly during the first four hours to 7 g CO_2 m^{-2} $h^{-1}$and yielded a cumulative CO_2flux from the moldboard plow treatment fourteen times that from not tilled. For the 85-day period following tillage, the cumulative CO_2 flux from the plowed treatment was 2.4 times higher that from not tilled. Soil gas samples showed a similar trend with an increase in the CO_2 concentration at depth on the not tilled plots until Day 200, then a gradual decline as soil carbon resources were used and temperatures decreased. Carbon dioxide concentrations were highest at the 30, 50, 70-cm depths. The decline in soil CO_2 concentration on the moldboard plow treatment was more dramatic than on the not tilled treatment suggesting that higher air permeability in the tilled layer resulted in the

higher gas exchange. The results support previous short-term fluxes and confirm the role of intensive tillage in long-term soil C decline. The large differences in CO_2 loss between moldboard plow and not-tilled treatments reflect the need for improved soil management and conservation policies that favor conservation tillage to enable carbon sequestration in agricultural production systems.