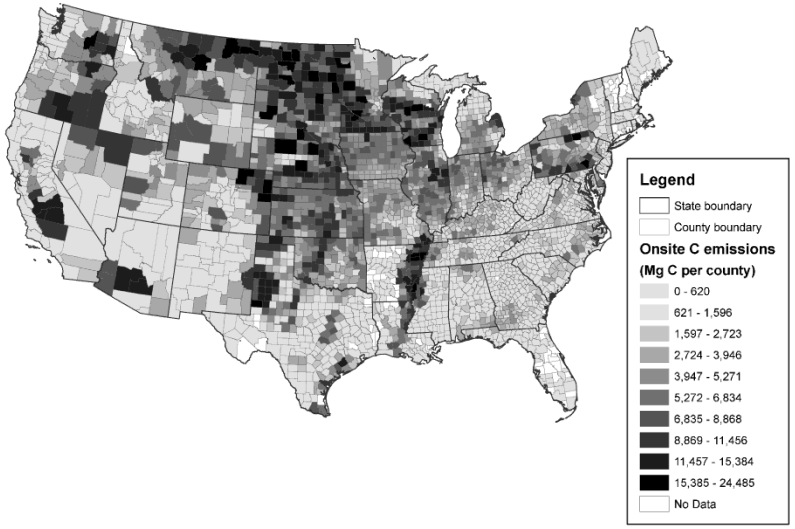
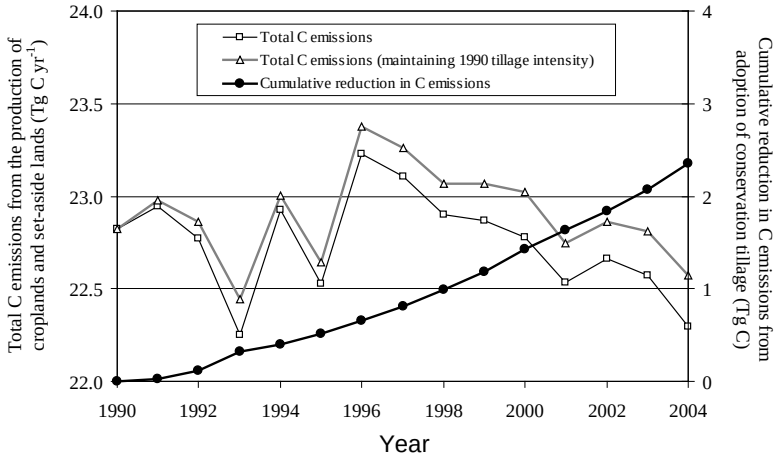
Patterns of Fossil-based CO_2 Emissions from US Croplands

Contact: Tris West, 865-574-7322, westto@ornl.gov
Funding: DOE Office of Science, Biological and Environmental Research; and DOE Office of Biomass

- The capability to estimate fossil-based CO_2 emissions (FCE) associated with land management is important (a) for carbon accounting and monitoring purposes, and (b) for use in regional carbon budgets and carbon flux estimates.
- A method was developed to estimate on-site and off-site FCE associated with cropland production.
- FCE differ not only by crop, but by region because of changes in crop production energy requirements driven by environmental differences (e.g., soil texture, soil chemistry, and climate).
- Annual shifts in FCE associated with cropland production have occurred due to abrupt changes in policies (e.g., Farm Bills) and abrupt changes in annual weather patterns (e.g., droughts and wet years). General upward or downward trends for given crops reflect their respective crop prices.
- Adoption of reduced tillage between 1990-2004 reduced cumulative FCE by 2.4 Tg C.





U.S. DEPARTMENT OF ENERGY

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

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Abstract:

Changes in cropland production and management influence energy consumption and emissions of CO_2 from fossil-fuel combustion. A method was developed to calculate on-site and off-site energy and CO_2 emissions for cropping practices in the US at the county scale. Energy consumption and emissions occur on-site from the operation of farm machinery and occur off-site from the manufacture and transport of cropland production inputs, such as fertilizers, pesticides, and agricultural lime. Estimates of fossil-fuel consumption and associated CO_2 emissions for cropping practices enable (a) the monitoring of energy and emissions with changes in land management, and (b) the calculation and balancing of regional and national carbon budgets. Results indicate on-site energy use and total energy use (i.e., the sum of on-site and off-site) on US croplands in 2004 ranged from 1.6-7.9 GJ ha^{-1} yr^{-1} and from 5.5-20.5 GJ ha^{-1} yr^{-1}, respectively. On-site and total CO_2 emissions in 2004 ranged from 23-176 kg C ha^{-1} yr^{-1} and from 91-365 kg C ha^{-1} yr^{-1}, respectively. During the period of this analysis (1990-2004), national total energy consumption for crop production ranged from 1204-1297 PJ yr^{-1} (Petajoule = 1×1015 Joule) with associated total fossil CO_2 emissions ranging from 22.0-23.2 Tg C yr^{-1} (Teragram = 1×1012 gram). The annual proportion of on-site CO_2 to total CO_2 emissions changed depending on the diversity of crops planted. Adoption of reduced tillage practices in the US from 1990 to 2004 resulted in a net emissions reduction of 2.4 Tg C.

Citation:

Nelson, R.G., C.M. Hellwinckel, C.C. Brandt, T.O. West, D.G. De La Torre Ugarte, G. Marland. 2009. Energy Use and Carbon Dioxide Emissions from Cropland Production in the United States, 1990-2004. Journal of Environmental Quality 38: 418-425.

This specific work was conducted as part of the DOE Consortium for Carbon Sequestration in Terrestrial Ecosystems (CSITE). Estimates of fossil-fuel CO_2 emissions associated with bioenergy crop production are being supported by DOE Office of Biomass. NASA is supporting the integration of these county-level data with remotely-sensed land cover products to produce estimates at a sub-county scale. Data are archived at http://cdiac.ornl.gov/carbonmanagement/ with support from CDIAC. Oak Ridge National Laboratory (ORNL) is managed by UT-Battelle, LLC for the U. S. Department of Energy under Contract No. DE-AC05-00OR22725.