25x'25 Background Paper

Crop Production Practices, Residue Management Combat Climate Change

In the face of news reports and studies suggesting potential negatives from the imprudent expansion of biofuel production, it is important to understand that technology and conservation practices are available to not only negate possibly adverse effects of expanded production, but actually promote benefits to our environment. Conservation tillage and residue management can provide a constant buildup of soil organic carbon and together constitute an agronomic practice that not only produces a crop but also reduces greenhouse gas emissions by preventing carbon from transforming into carbon dioxide through decomposition. One study found that converting from conventional plowing to conservation tillage resulted in a 56 percent increase in soil organic carbon over a ten year period.[1] While soil carbon content increases might be slight in the first two to five years, large annual increases occur in the next five to ten years, and depending on soil, climate and management conditions, could continue to build over a 25 to 50 year period.[2]

Dr. Rattan Lal, of Ohio State University, estimates that the total carbon sequestration potential of U.S. cropland through improved management ranges from 75 million metric tons to 208 million metric tons of carbon per year, or the equivalent of 275 million to 763 million metric tons of carbon dioxide[3]. If the range was split, it would result in an average of 142 million metric tons of carbon per year (more than 500 million metric tons of carbon dioxide), representing 9.5 percent of the total U.S. greenhouse gas (GHG) emissions[4]. Lal also says that using conservation tillage practices would also result in a potential savings of fossil fuel use – they require fewer trips over the cropfield - equivalent to 1.2 million metric tons of carbon, or 4.4 million metric tons of carbon dioxide emissions.[5]

This is only a portion of the total amount of carbon that could be sequestered through the full array of agricultural and forestry practices, says Lal. He and other researchers estimate that the total potential of soil organic carbon sequestration in the United States is 144 to 432 million metric tons of carbon per year. Splitting that potential sequestration down the middle at 288 million metric tons of carbon per year from cropland, grazing land and woodland soils, that represents more than 1000 million metric tons of carbon dioxide emissions annually[6]. If you add in an additional 300 million tons sequestered per year from U.S. forests[7]., the total potential of carbon sequestration in soils and forests of the U.S. is nearly 600 million metric tons of carbon, or more than 2,200 million metric tons of carbon dioxide emissions - about 33 percent of total U.S. emissions.

Conventional tillage uses plow-based methods that turn the soil over, mixing oxygen with soil and organic matter and speeding up the decomposition of the organic content, including loss of carbon converting to carbon dioxide.[8] Conservation tillage is a set of practices that provide minimal disturbance of the soil and leave at least 30 percent of the surface covered with crop residues. Conservation tillage practices provide benefits by adding organic material to the topsoil, improving fertility and productivity, and resulting in greater yields and plant health. Conservation tillage maintains a constant cover of organic material allowing the crop field to maximize infiltration of rainfall, retain moisture and minimize runoff events, reducing erosion and sedimentation, and improving water quality and biodiversity. Also, by applying crop residues each year, a body of biomass carbon (humus) builds and is resistant to biological degradation[9]. And only one trip across the field is required to plant a crop, resulting in a significant savings of time, labor, machine wear and fuel. [10]

There are several versions of conservation tillage that are practiced across the country, with implementation based on soil conditions such as soil type, tendency for compaction, frost free date, moisture retention and other factors. No-till involves a planter that cuts narrow slots in the soil to deposit seeds and then closes the slots through the cover of the residue of the previous crop. Strip-till requires custom equipment that creates a strip through residue cover and disturbs no more than a third of the row width[11], while Ridge-till plants seeds in a narrow band on top of small, 4"-6" ridges formed by cultivation on the contour across a field, leaving crop residue between the rows.[12] Mulch-till method uses full-width tillage with one or two passes - soil is disturbed prior to planting using chisel plows and other equipment which loosens the soil but doesn't turn it over like conventional plowing- leaving at least 30 percent of the field covered with residue.[13]

Based on the most current national data gathered in 2004 by the Conservation Technology Information Center, all forms of conservation tillage constituted 40.7 percent of U.S. cropland on 112.6 million acres. Of that, no-till and strip-till was practiced on 22.6 percent (up from 6 percent in 1990); ridge-till was 0.8 percent (down from 1.1 percent in 1990); and mulch-till was 17.4 percent (down from 19 percent in 1990). Some form of crop residue management, which includes conservation tillage plus "reduced tillage," totaled 62.2 percent of total cropland.

Properly managed, conservation tillage and crop residue management systems could provide another option to reduce greenhouse gases by providing up to 50 percent of the crop residue for cellulosic ethanol production without sacrificing sufficient carbon storage in the field along with the other ecological benefits. The carbon dioxide released from ethanol made from plant material is recycling that which was taken in by photosynthesis during its growth and is therefore carbon neutral. Conservation tillage reduces the fossil fuel inputs that affect the life cycle of processes from the field to the ethanol plant.

When the crop is a biofuel crop such as switchgrass, carbon sequestration can increase and fossil fuel inputs decrease with conservation tillage. Switchgrass is a perennial native grass that doesn't require annual planting, and is harvested by taking annual cuttings. The plants require fewer inputs such as fertilizer and pesticides and have tremendous root systems that sequester carbon continuously. A study of perennial grasses established on the more than 34 million acres of marginal croplands enrolled in the Conservation Reserve Program determined that 0.5 tons of carbon (1.84 tons of carbon dioxide equivalent) is deposited annually.[14] Cellulosic ethanol made from biofuel crops like switchgrass have a higher ratio of energy output versus energy input and a greater overall reduction of greenhouse gases.

[1] R. Lal, J. Kimble, R. Follett, C. Cole, *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect*, Ann Arbor Press, 1998, p.58

[2] Lal et al, p. 58

[3] Carbon comprises 12/44 of the mass of carbon dioxide; thus to convert from CO-2 equivalent to C equivalent, one multiplies by 0.2727. Conversely, to convert carbon equivalents to carbon dioxide, multiply the carbon equivalent by 3.67. Sustainable Energy and Economy Network, http://www.seen.org/pages/db/method.shtml

[4] Lal et al. Executive summary, p. *v*.

[5] Lal et al, p. 63

[6] "Achieving Soil Carbon Sequestration in the United States: A Challenge to the Policy Makers". by R.Lal, R.F.Follett and J.M.Kimble (2003).Soil Science 168:827-845, Abstract, p. 827.

[7]) Linda Heath,James E.Smith and Richard A.Birdsey (2003) "Carbon trends in U.S.Forestlands: A context for the role of soils in forest carbon sequestration" .In J.M.Kimble,L.S .Heath ,R.A.Birdsey and R.Lal(eds) "The Potential of U.S.Forest Soils to Sequester Carbon and Mitigate the Greenhouse Effect",Lewis Publishers/CRC Boca Raton, Fl:35-45.

[8] D. Curtin,* H. Wang, F. Selles, B. G. McConkey, and C. A. Campbell, *Tillage Effects on Carbon Fluxes in Continuous Wheat and Fallow–Wheat Rotations*, Soil Sci. Soc. Am. J., Vol. 64, November–December 2000, p. 2080. http://soil.scijournals.org/cgi/reprint/64/6/2080.pdf

[9] R. Lal, J. Kimble, R. Follett, C. Cole, *The Potential of U.S. Cropland to Sequester Carbon and Mitigate the Greenhouse Effect*, Ann Arbor Press, 1998, p.26

[10] Conservation Technology Information Center, *Top 10 Benefits*, http://www2.ctic.purdue.edu/Core4/CT/CTSurvey/10Benefits.html

[11] Conservation Technology Information Center, *Why Use A Conservation Tillage System?*, http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf

[12] University of Illinois at Urbana - Champaign, College of Agriculture, Cooperative Extension Service, *Ridging, The Pros and Cons of Ridge Till*, Land & Water, http://web.aces.uiuc.edu/vista/pdf_pubs/RIDGING.PDF

[13] Conservation Technology Information Center, *Why Use A Conservation Tillage System?*, http://www.conservationinformation.org/Core4Brochures/CTBrochure.pdf

[14] USDA- Agricultural Research Service, http://www.ars.usda.gov/research/programs/programs.htm?npnumber=204&docid=855#cccs