Sustainability

Conserving and Preserving: Soil Management and Tillage

All regions of the world rely on agriculture; soil is the primary medium for crop growth and improperly managed soil will have a significant socio-economic impact.

Soil management has a direct impact on crop yield levels, food quality and safety, the environment and climate change. Soil helps break down or "degrade" agriculture chemicals or other potential pollutants; it also serves to hold carbon, and is the medium through which water, nutrients and microbes interact—it's a buffer between production inputs and, the environment.

Beneficial soil management is essential to maintain long-term productivity, long-term environmental stability and food safety. This includes practices such as more efficient use of nutrients, pesticides and irrigation; crop residue management; and field management practices such as terraces and contour farming that act as buffer zones, underground drainage outlets and surface diversion.

Tillage

Crops cannot be produced without disturbing the soil in some way. Tillage is the farmer's way of preparing the ground for planting by breaking up and smoothing the soil. Tillage also helps control weeds and aerates the soil. Yet there are consequences to tillage: rain and wind carry loosened soil off of fields adding silt to waterways and particulate matter in the air; cultivating with a moldboard plow can lead to greater soil and water erosion.

When tillage is necessary, farmers have adapted from the historical conventional tillage practice of intensive soil disruption for weed control, to simple traditional practices, to conservation tillage which minimizes soil disturbance. By leaving crop residue for field cover and eliminating tillage trips, farmers are better able to protect the soil from water and wind erosion, conserve moisture, reduce nutrient runoff, improve wildlife habitat and limit output of labor, fuel and machinery.

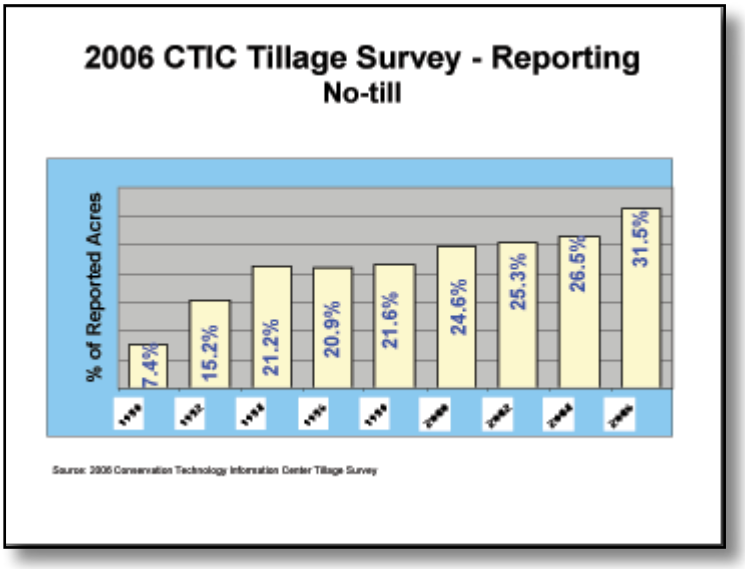
Several crop production systems fall under the heading "conservation tillage" including no-till, ridge-till, low-till and minimum-till. Common to all of these is a crop mulch covering left on the ground to provide a protective cover to the soil between seasons and improve soil fertility by maintaining nutrient-rich organic matter on the field. Conservation tillage allows organic matter to build up in the soil, absorbing carbon dioxide and helping to reduce a significant amount of greenhouse gas.

Photosynthesis is the most effective natural method of absorbing atmospheric carbon dioxide by converting carbon dioxide into plant tissue. When a plant dies, decomposing plant residue leaves a portion of the stored carbon in the soil and a larger portion is emitted back into the atmosphere. Plants are the primary vehicle for maintaining organic carbon in soils. When organic matter in the soil is enhanced, for example, by shifting from conventional tillage to conservation tillage practices and increasing the amount of crop residue returned to the soil, a higher Carbon-Stock Equilibrium (CSE) can be gained over time. Continuous use of no-till will increase soil carbon thus reaching a higher CSE reached (Brookes, Barfoot).

As competition for water resources intensifies, agriculture producers must make the most of irrigation water and soil moisture. Crop residue slows evaporation by shading the ground. Reduced tillage improves the soil structure, thereby increasing water movement through the soil and retaining necessary moisture in the soil. According to the U.S. Department of Agriculture (USDA), a farmer can save at least 3.5 gallons of fuel per acre

by switching from conservation tillage to no-till (USDA/NRCS). At April 2007 diesel prices, this amounted to production cost savings of $9.80 per acre. On a farm with 1,000 acres of cropland, this adds up to a savings of 3,500 gallons of diesel fuel per year, or $9,800.

No-till planting is the most cost-effective practice to reduce tillage trips to protect and enhance the environment. Elimination of tillage means farmers must rely on herbicides to control weeds. Without herbicide use, no-till agriculture becomes impossible, resulting in increased erosion estimated to be more than 300 billion pounds of soil annually. Much of this soil erosion would enter waterways and significantly reduce the quality of the nation's surface water.



Conservation tillage practices reduce rainfall runoff by more than 60 percent and soil loss by more than 90 percent (Werblow). The impact energy of falling raindrops is minimized by crop residue or cover crops, thereby reducing erosion. The soil benefits as the physical, chemical and biological properties are enhanced—residues located on or near the ground surface act as small dams to reduce the speed at which water runs across the surface of the field, resulting in reduced soil erosion.

As a result of increasing adoption of conservation tillage and other soil conservation practices, soil erosion from U.S. cropland has steadily declined. A National Resources Inventory (NRI) report (2007) published by the Natural Resources Conservation Service (NRCS) states soil erosion resulting from rainfall and runoff (sheet and rill erosion) has declined 42 percent between 1982 and 2003. Likewise, soil erosion from high winds has declined 44 percent during the same timeframe. The "most significant reductions," according to the NRI report, occurred in two major river basins, the Missouri and Souris-Red-Rainy/Upper Mississippi, where approximately half of the nation's cropland is located.

Much of this decline in erosion has occurred by reducing tillage. Other conservation measures that have also been successfully used on corn acres include contour farming, grass waterways and terraces.

Agriculture production systems offer a wide variety of opportunities to increase carbon storage, or sequestration, in soils and vegetation. Total conservation tillage effects indicate 1,000 pounds of carbon can be sequestered per acre per year (Lal, et al). This equates to a carbon dioxide saving equivalent of burning 75 gallons of gasoline (Werblow). If these effects are translated to full potential, 450 million tons of carbon can be sequestered into the soil per year (Lal, et. al).

Agriculture is shifting its focus from output growth to a holistic output efficiency that not only increases productivity but reduces labor, pesticides, herbicides, fertilizer and mechanical inputs. The wide-scale adoption

of no-till farming with better crop inputs as well as biotechnology has reduced the carbon footprint for the production of a bushel of corn. For example, from 1990 to 2004, no till practices have increased 394 percent, resulting in total carbon emission savings of at least 17 billion pounds of CO2 over the 14-year period.

Key Points:

- Soil management has a direct impact on crop yield levels, food quality and safety, the environment and climate change.
- Beneficial soil management is essential to maintain long-term productivity, long-term environmental stability and food safety. This includes practices such as more efficient use of nutrients, pesticides and irrigation; crop residue management; and field management practices such as terraces and contour farming that act as buffer zones, underground drainage outlets and surface diversion.
- Conservation tillage allows organic matter to build up in the soil, absorbing carbon dioxide and helping to reduce a significant amount of greenhouse gas.

- By leaving crop residue for field cover and eliminating tillage trips, farmers are better able to protect the soil from water and wind erosion, conserve moisture, reduce nutrient runoff, improve wildlife habitat and limit output of labor, fuel and machinery.
- As a result of increasing adoption of conservation tillage and other soil conservation practices, soil erosion from U.S. cropland has steadily declined.

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