

# Conservation tillage: Monitoring adoption with satellite imagery

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**T**he term conservation tillage is used to refer to any method of tillage that minimally disturbs the surface, leaving at least 30% residue cover after planting. As such, conservation tillage is one of the most widely adopted conservation practices. Conservation tillage is oftentimes coupled with a crop residue management program, which in the southeastern United States typically includes a winter cover crop for biomass production. Conservation tillage has been attributed with improving soil quality, reducing runoff, and reducing fuel costs. In the southeastern United States, conservation tillage has also been hailed with increasing plant available water and reducing the total number of irrigations necessary to produce a crop. Because many states in this region of the nation are facing water restrictions and severe drought conditions, conservation tillage shows promise as a sustainable, water saving practice.

In 2004, the Conservation Technology Information Center estimated that  $4.55 \times 10^7$  ha ( $1.13 \times 10^8$  ac) of the nation's cropland has adopted some form of conservation tillage, an overall increase of  $4.0 \times 10^6$  ha ( $1.0 \times 10^7$  ac) since 2002. However, at the present time, no national monitoring system is in place to continue these efforts on a regular basis. Natural resource inventory, compliance with federal cost-share programs, and conservation practice assessments necessitate a spatially representative and time-efficient way to map trends in conservation tillage adoption.

Satellite imagery and other remote sensing tools have been evaluated as new methods for rapidly and objectively mapping conservation tillage adoption at the field and watershed scale. In March 2007, the USDA Agricultural Research Service in Tifton, Georgia, created and evaluated conservation tillage maps using Landsat TM 5 imagery. The spatial resolution of the satellite images was 30 m (98 ft), and spectral bands within the 0.45 to 2.35  $\mu$ m range were used to delineate tillage regime. Data were collected over a 930 km<sup>2</sup> (359 mi<sup>2</sup>) area centered on the Little



Field site used to develop the conservation tillage map, located in the Little River experimental watershed, Georgia.

River Experimental Watershed, one of 14 designated national benchmark watersheds in the USDA Conservation Effects Assessment Project–Watershed Assessment Study. Along with satellite data, a windshield survey was conducted, identifying 61 conservation tillage (>30% cover) and 77 conventional tillage (<30% cover) sites.

Two subsamples of the surveyed sites were randomly selected to (1) develop models relating spectral reflectance to tillage regime and (2) determine a minimum ground truth dataset. The remaining 98 sites were retained and used for model validation. Two tillage models, using a subset of either 20 or 44 sample points, were applied to satellite imagery in a series of steps. First, all nonagricultural areas were eliminated from the image. Second, all fields with actively growing vegetation (weeds or live winter cover) were classified as vegetated and removed. Finally, each of the tillage models was applied to the remaining fields in the image and used to delineate tillage regime. Satellite-derived tillage maps delineating conventional tillage, conservation tillage, vegetated area, and unclassified area were produced for each model.

Using survey sites retained for accuracy, validated maps had accuracies ranging from 71% to 78%. Model accuracy was best using a minimum of 22 conventional and 22 conservation tillage sites as ground truth observations.

Errors were mostly due to variability

in surface soil color. Thus, the application of this model over more variable terrain would necessitate a geographic soil database and the collection of ground truth observations for each soil “color group.” This type of information may be easily obtained via the Soil Survey Geographic Database.

Results from this study have provided a foundation by which to begin evaluating the impacts of conservation tillage adoption and placement in the Little River Experimental Watershed in Tifton, Georgia. Satellite-derived maps created during this study directly contribute to a national effort to evaluate the impact of federally cost-shared conservation practices—that is, the Conservation Effects Assessment Project–Watershed Assessment Study. In keeping with the goals of that effort, the proposed satellite mapping algorithm shows promise as a tool to (1) streamline national efforts to monitor changes in conservation tillage adoption over time, (2) evaluate the efficacy of conservation tillage placement, and (3) reduce the need for time-consuming field surveys used to ensure compliance with federal cost-sharing programs.

For more information see the full paper on pages 112 to 119 of this issue (Sullivan et al. 2008).

## REFERENCE

- Sullivan, D.G., T.C. Strickland, and M.H. Masters. 2008. Satellite mapping of conservation tillage adoption in the Little River experimental watershed, Georgia. *Journal of Soil and Water Conservation* 63(3):112-119.