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The evolution and purpose of tillage systems: Range of systems and extent of use

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Crop residue was recognized as an important renewable natural resource during the early 1700s for its ability to sustain the soil resource. Distinguished citizen-farmers of the humid eastern United States, notably Franklin, Washington, Jefferson, Madison, and Ruffin, recognized soil erodibility problems. Settlers were experiencing much greater rainfall energy and soil erosion risk than exposed to in Europe. Because of poor available conservation technology, Ruffin stated, "managing cover crops was troublesome and imperfect." The crop residue management difficulties accompanied with accelerated soil erosion has provided a challenge to farmers and researchers for almost two centuries.

A "slash and burn" philosophy dominated until the Dust Bowl Era when soil erosion experiment stations were funded with the 1930 Buchanan Amendment to the Agricultural Appropriations Bill. Much of the soil conservation direction for the experiment stations was conceived via the passionate pleas of H. H. Bennett, the chief of the U.S. Interior Department's Soil Erosion Service. Reports developed from these research stations suggest that there were primitive attempts to develop conservation tillage systems at that time. However, one of the first methods reported in the literature was the "Contour Balk." This procedure consisted of plowing (middlebuster) furrows into winter cover crops. This tillage procedure was initially developed in 1932 at Tyler, Texas, location of one of the original ten soil erosion experiment stations created by the Buchanan Amendment.

Concentrated conservation tillage research thrusts came only after the birth of the Soil Conservation Service in 1935. Bennett was also the charter chief of the Soil Conservation Service and recruited a talented research administrator, M. L. Nichols. Under Nichols' leadership, several conservation tillage research teams were organized, primarily on Land Grant University Experiment Stations.

Some of the most visible teams formed by Nichols were J.C. Russell and E.L. Duley at Lincoln, Nebraska, and T.C. Peele and O.W. Beale at Clemson, South Carolina. Russell and Duley's first manuscript submitted to Washington, D.C., for approval was entitled "Noninversion Tillage." In the review process, the Soil Conservation Services leadership changed the title to "Stubble-Mulch Tillage."

Because of the Southern Piedmont's much greater soil strength than experienced on the Great Plains, conservation tillage technology was difficult to transfer across major soil resources areas. Thus, researchers learned early that the concept of conservation tillage diversity was critical. Peele and Beale's most important contribution was a notched coulter followed by a 22-inch middlebuster share to deal with increased soil strength.

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Concomitant with pioneering agency/university conservation tillage research, farmer contributions were beginning to emerge. The most notable conservation tillage tools were the C.S. Noble Blade Cultivator and the Graham-Hoeme chisel. Only the Graham-Hoeme was successfully used on Southern Piedmont soils. Another innovative farmer was J. Mack Gowder of Hall County, Georgia. He developed a stubble mulch method, called the Bull-Tongue Scooter. His tillage implement was formed from a hardened steel road grader blade.

Following World War II, plow plant methods were developed throughout the U.S. by the U.S. Department of Agriculture and Land Grant University scientists. The best soil conservation contribution of these methods was surface roughness to control runoff. Although cool season crop residues were managed near the soil surface, some secondary cultivation was usually required for weed control even though selective phenoxy herbicides were available.

The birth of the Soil Conservation Society in 1945 and E. H. Faulkner's book *Plowman's Folly* in 1943 probably enhanced our research awareness concerning conservation tillage. Industry, land grant universities, and the U.S. Department of Agriculture increased their conservation tillage budget following World War II. Purdue University scientists Russell Poyner and George Scarseth gave us the first no-till planter, the M-21, in 1946. From the mid 1950s to the mid 1960s triazine herbicides, paraquat, and the wavy coulter all became commercially available. The important evolutionary steps are chronicled by Hill et al. in 1994 *National Conservation Tillage Digest's* volume 1, numbers 3 and 4. Many other forms of conservation tillage emerged during the 1960s and 1970s; for example, ridge-till for cold-wet soils of the Corn-Belt and strip-till for restrictive horizon Ultisols of the Southeast. Again, some of these innovations were provided by creative farmers.

As this white paper is written, conservation tillage evolution continues. Recent motives to develop conservation tillage for cotton for the Southeast U.S. were environmentally legislative—the 1985 and 1990 farm bills. However, no additional research funds were appropriated to accomplish this task during an inflationary economic period. Credit for much of these accomplishments must be attributed to dedicated land grant universities, USDA, and industry researchers.

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