CONSERVATION TILLAGE DEVELOPMENT IN THE SOUTHEASTERN UNITED STATES

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HISTORICAL PERSPECTIVE

Crop residues were recognized as an important renewable natural resource in the humid Southeast during the early 1700s. but European settlers did not possess the conservation expertise to successfully farm highly erodible lands of the southeast U.S. (Bennett, 1947; Soil survey, 1913; Trimble, 1974). Distinguished citizen-farmers of the eastern U.S. such as Franklin, Washington, Jefferson, Madison, and Ruffin recognized soil erodibility problems (Bennett, 1939, 1947; Ruffin, 1932). Because of poor available conservation technology, Ruffin stated that "managing legume cover crops was troublesome and imperfect."

Although the humid eastern U.S. had experienced some irreversible soil erosion prior to 1900 (Trimble, 1974; Jenny, 1961; Carr, 1911; Soil Survey, 1913). research funds to develop conservation tillage systems did not become available until the "Dust Bowl Era" (Buchanan, 1928). Ten soil erosion experiment stations were funded with the 1930 Buchanan Amendment to the Agricultural Appropriation Bill. The chief of the U.S. Interior Department's Soil Erosion Service, H. H. Bennett, apparently lobbied strongly for these research stations (Helms, 1992). Bennett's passionate soil conservation leadership led to this legislative action mandating research for control of soil erosion (Bennett, 1939, 1947). Bennett's leadership also led to federal funding that precipitated a national soil conservation thrust via the Soil Erosion Service in 1933 and the Soil Conservation Service of the USDA in 1935 (Helms, 1992). Managing crop residues at or near the soil surface has been a technological struggle, but we now have accumulated technologies to manage crop residues and restore and sustain crop production. Long-term research efforts associated with the development of conservation tillage systems account for these technologies.

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BIRTH OF CONSERVATION TILLAGE RESEARCH

Beginning in the mid 1930s. a soil and water conservation research group was created within the Soil Conservation Service. The core of this research team was employed earlier by the agency. Many of these researchers were housed on or near Land Grant University Campuses and Experiment Stations. Multi-agency and multi-discipline soil and water conservation teams were developed. Hypotheses for managing cool season crop residues for the Southeast were initiated among these researchers. The first conservation tillage procedure developed to manage large quantities of crop residues on the soil surface is referred to in literature as the "Contour-Balk Method". This procedure consisted of plowing (middlebuster) furrows into winter cover crops. A ubiquitous cool season cover was crimson clover and rye grass. This tillage method was initially developed in 1932 at Tyler, Texas, location of one of the original ten soil erosion experiment stations created by the Buchanan Amendment (Barnett, 1987). This tillage research continued at Watkinsville, Georgia's Southern Piedmont Conservation Research Center via H. B. Hendrickson's transfer from Tyler, Texas to Watkinsville circa 1935 (Barnett 1987). Mr. Hendrickson was given credit for coining the method name, "Contour Balk". Near the same time, an innovative Hall County, Georgia, farmer, Mr. J. Mack Gowder, developed his stubble mulch method, called the Bull-Tongue Scooter (Martin, 1944; Middleton, 1952). This implement was a 4-inch chisel plow formed from a worn road grader blade. This hardened steel chisel tilled the soil while leaving most crop residues on the surface. His motive was to mimic forest soil observed on steep slopes.

GREAT PLAINS TILLAGE INFLUENCE ON THE HUMID EAST

In 1938, a noninversion tillage research team was formed at Lincoln, Nebraska (Allen and Fenster, 1986). This pioneering tillage team included J. C. Russell and F. L. Duley, employees of the research arm of the Soil Conservation Service. This team in cooperation with the University of Nebraska developed the Stubble

Mulch concept. Their first subtillage manuscript submitted to Washington, D.C. for approval was entitled, "Noninversion Tillage". In the review process, the Soil Conservation Service Director, H. H. Bennett, changed the title to "Stubble-Mulch Tillage." The "Stubble-Mulch Tillage" umbrella terminology later included several conservation tillage procedures. Two innovative stubble mulch farmers of the Great Plains were Fred Hoeme and C. S. Noble (Allen and Fenster. 1986). Searching for tillage tools to control wind erosion, their names became associated with two pioneering stubble mulch tillage implements, the Graham-Hoeme Chisel and the Noble Blade Cultivator, respectively. Some of this equipment technology was important for the initial stubble-mulch research efforts in the Southern Piedmont.

Close to the same time frame that the Duley-Russell team was organized in Nebraska, the Peele-Beale team (T. C. Peele and O. W. Beale) was transferred from Spartanburg, South Carolina (Peele, 1942) to Clemson, South Carolina to conduct mulch tillage research. Peele had organized this team during the Soil Erosion Service era[2]. There is a high probability that H. H. Bennett and his research chief, M. L. Nichols were coordinating the research thrust in both South Carolina and Nebraska, as well as activities in several other states. Clearly the SCS administrators were searching for Land Grant University environments to develop mulch tillage research. Nichols was the mentor for most of these conservation tillage researchers'. He was a graduate student major professor as well as a supervisor for J. R. Carreker. At Clemson University, agricultural engineers G. W. Nutt and W. N. McAdams were recruited as mulch-tillage cooperators (Nutt et al., 1943). Because of the Southern Piedmont soil strength, the Noble Sweep did not perform well[2]. Several modifications were described by Nutt et al. (1943) and Peele et al. (1947). Obvious modifications were decreased sweep width and increased implement strength as well as the addition of a smooth coulter to sever crop residues. One modification was a notched coulter followed by 22-inch middlebuster shares. Some of these tools as well as the Graham-Hoeme (Allen and Fenster, 1986) were used on the "bench mark" Ravenel Runoff Plots (Clemson University). Research on these plots is described by Beale et al. (1955). Some of the first successful crop residue management research occurred on these plots. The runoff and sediment data were also used to develop the first soil erosion model--Universal Soil Loss Equation [Wischmeier and Smith. 19651.

During the 1950s the conservation tillage research thrust in the humid area had shifted from "Stubble Mulch" to "Plow-Plant" and "Wheel Track" procedures (McAdams and Beale, 1959; Larson and Beale, 1961). Soil strength was probably responsible for this new direction. These tillage procedures inverted soil with moldboard plows, leaving a rough soil surface to control erosion. Planters followed in tractor or implement tracks, thus becoming known as wheel-track planters. The plow-plant tillage originated in the mid-western U.S. W. E. Larson is responsible for considerable cooperative efforts associated with its adaption to the Southeastern U.S. (Larson and Beale, 1961). W. N. McAdams provided most of the modifications of these plow-plant methods for tlie Southern Piedmont. This was the first conservation tillage research experience for the author.

A second plow-plant tillage procedure was developed by J. C. McAlister and referred to as lister tillage (McAlister, 1962). This procedure used middlebuster type shares and rolling wings to sever crop residues or sods. This procedure opened a furrow for planting and covered most of the balk area with soil from the furrow. It was a light-duty version of the fire-line plow. Several implement companies manufactured a few versions. Considerable quantities of literature are associated with lister-tillage innovation (Hendrickson et al., 1963; Beale and Langdale, 1964 and 1967; Sanford et al., 1964; Adams et al.. 1973). The first major effort to transfer conservation tillage technology to the farm occurred during the early 1960s because of the availability of farm capital and power.

HERBICIDE ERA

Intensive secondary cultivation was required until selective phenoxy herbicides were introduced after World War II (Hamner and Tukey, 1944). Some secondary cultivation was required for weed control until other selective herbicides--triazines--were introduced in the late 1950s (Hance and Holly, 1955). These were simazine in 1956 and atrazine in 1958.

[2] Personal communication with Dr. T. C. Peele.
[3] Personal communication with Mr. J. R. Carraker.

Two of the earliest studies cited in the literature that involved this family of herbicides and no-tillage occurred in Virginia (Moody et al., 1961) and Texas (Wiese et al., 1967). In the Virginia study, corn was hand-planted in holes made in cool season sods with a tube sampler. No-till corn planting into cool season sods improved immensely during the late 1960s and early 1970s when non-selective dessicant-herbicides such as paraquat became available for preplarit vegetation control and commercial fluted coulters became available (Carreker et al., 1977; Langdale et al., 1984 and 1991; McCalla and Army, 1961; Sojka et al., 1984; Phillips et al., 1980; Box et al., 1976; Reicosky et al., 1977; Spain, 1966; Triplett, 1976; Unger et al., 1988). Conservationlno-tillage research increased exponentially during the 1970s and early 1980s. The conservation tillage conference proceedings (begun in 1978) provided good visibility for this research in the Southeast U S. Usually the research centers with the greatest investment in conservation tillage were bidding to host the earlier conferences.

SUBSURFACE TILLAGE

The no-till planter implement provided by several U S. manufacturers performed exceptionally well on silt loam soils of the upper Southeast, particularly in cool season sods and early-killed small grains. However, restrictive B and E horizons of Ultisols of the Southern Piedmont and Southern Coastal Plains, respectively, created additional challenges to no-tillage acceptance. The coulter in-row chisellsubsoil implement was developed by a farmer, Mr. Jerrell Harden, near Banks, Alabama, beginning in 1972. The current versions of this implement is now referred to in the literature as strip or row tillage. This implement significantly increased *Graminae* crop yields and reduced runoff significantly (Langdale et al. 1990, 1992, 1981, 1983a and **b,** 1978. 1979).

TECHNOLOGY TRANSFER

In the Southeast U.S., J. T. McAlister (1962). a Soil Conservation Service engineer who studied under Nutt and McAdams, was a lone plow-plant crusader in the late 1950s to mid 1960s. However, Kentucky must be credited with the first holistic approach to persuade growers to adopt conservation tillage (Philips et al., 1980). This team included the University of Kentucky researcherslextension staffs as well as several state and federal action agencies. Many of these researchers were introduced to no-tillage techniques as graduate students at Virginia Polytechnic Institute (Shear, 1968; Shear and Moschler, 1969). This team attracted not only the Southeastern farmer, but global attention. The University of Tennessee was first in the development of a no-till experiment station at Milan, Tennessee, under Mr. Tom McCutchen's leadership, to transfer this technology (Southern Conservation Tillage Proc. 1983). Newer innovations such as inter-cropping developed at Clemson University and no-till drilling of both cool and warm season annuals are documented in the Southern Conservation Tillage Proceedings from 1978-1993. The soil erosion control value of tillage procedures described herein is presented in the 1983 proceedings by Langdale et al. (pp. 56-611.

CURRENT STATUS AND FUTURE

More than 30% of the crop acreage in the 13 southern states, represented by the Southern Conservation Tillage Conference, is currently conservation tilled. Both total acreage and percentage must increase in the humid east as water deficits develop on western irrigated lands. Currently conservation tillage technologies are slowly accumulating. However, farm market depressions are suppressing adoption.

Conservation tillage and surface crop residue management terminologies are essentially synonymous. Crop residues are the most globally abused renewable natural resource. Crop residues are the only renewable natural resource that man can successfully manage in order to conserve nonrenewable natural resources--soil and water. Over 50 years of research in the U.S. have proven the value of wise management of these natural resources (Langdale et al., 1994; Unger et al., 1988).

Civilization has suffered immensely because of resource abuse (Lowdermilk, 19531. Currently, disastrous resource degradation is occurring on tropical and semi-arid tropical landscapes. The human population explosion accounts for considerable natural resources pressure, thus accelerated degradation of these resources. The humid Southeastern U.S. may represent the last frontier for agriculture in North America. Urbanization and unwise management are beginning to create considerable pressure on our natural resources. One of the greatest abuses is

federal policies that diminish crop rotation incentives. The first soil erosion model, The Universal Soil Erosion Equation (Wischmeier and Smith. 1965, Wischmeier, 1973), included row-crop rotations with a meadow. A recent government opportunity to provide a sod-based crop incentive was scrubbed in favor of pine trees for most of the lower South (Food Security Act, 1985). Much of the current success of conservation tillage in the Southeast U.S. may be attributed to a federal, state, and industry research and technology transfer team effort. The complex environmental quality phenomena create a renewed challenge for conservation tillage researchers. Securing future funds to continue this conservation thrust may be our greatest challenge.

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