Mississippi Corn Promotion Board
2016 Progress Report

Project Title: Corn and Soybean Crop Residue Impact on Soil Quality, Yield and Returns

PI: Normie Buehring, Billy Kingery, Wayne Ebelhar, and Larry Falconer

Department: North MS R&E Center, Plant and Soil Sciences, and Delta R&E Center

Project Summary (Issue/Response)

Since soil quality changes occur at a slow rate, a seven year (2011-2017) study is being conducted to evaluate the effects of corn and soybean crop residue management and tillage systems (in a corn-soybean rotation) on soil quality (soil physical, chemical and biological properties), grain yield, crop residue yield and nutrient content, and the economic returns associated with these crop production systems in irrigated (Stoneville) and non-irrigated (Verona) environments.

Crop residue management [burn (corn only) and no-burn] and tillage treatments [no-tillage (old beds), bed-roller, disk (2x) + in-row subsoil-bed-roll (TerraTill®), a one-pass operation implement) and subsoil-bed-roll alone] are on the same site for the duration of the study. The year 2016 was the fifth year data was collected. The 2016 soil's buffer capacity, nutrient content, microbial biomass, respiration, water holding capacity, bulk density, soil resistance measurements and the crop residue/biomass fertilizer nutrient content analysis have not been completed for both locations.

Except for corn grain yield and economic returns at Verona, crop residue management (burn and no-burn) at both locations had no significant impact or interactions on all the variables analyzed. The burn corn crop residue (2012 and 2014), management system corn yield was 16.5 bu/acre lower yield and $55/acre lower return above total specified costs, than no-burn corn crop residue (2012 and 2014) management system. No-tillage March ground cover at both locations was higher than all other tillage treatments. TerraTill ground cover at both locations was higher than the disk (2x) + TerraTill. There were no population and plant spatial differences, and only minor corn crop residue yield and 100 seed weight differences at both locations. No-tillage and bed-roller grain yield and returns at Verona (non-irrigated) were lower than TerraTill. At Stoneville (irrigated) TerraTill, bed-roller and the disk (2x) + TerraTill yields were not different but greater than no-tillage. TerraTill and bed-roller returns were higher than the disk (2x) + TerraTill and no-tillage. The disk operations at both locations did not increase yield or returns. Bed integrity at both locations for no-tillage (old beds) lasted two cropping seasons and had to be reshaped in the spring of 2014 and 2016.

Project Results/Outcomes

Except for corn grain yield and returns at Verona in 2016 (year 5 of data collection), both locations indicated crop residue management [burn corn stubble and no burn] had no effect or interactions for corn population, early season growth, plant spatial differences, grain yield and net returns. At Verona, the burn corn stubble (2012 and 2014) had 16.5 bu/acre lower yield and $63/acre lower return than the no-burn (corn stubble). March ground cover for no-tillage was 96% for Verona, which was greater than all other tillage treatments. The disk (2x) + TerraTill had the least ground cover of all treatments. Due to the wet soil conditions that delay tillage operations until March at Stoneville, ground cover readings were very low (28 to 45%). Ground cover plays an important role in dissipating the raindrop's energy on impact which results in less soil erosion. As the study progresses over time, we expect the fewer tillage trips

Project Results

and not burning the corn crop residue in the long term to have a positive impact on soil quality, yield and returns. The year 2015 was the first year soil quality factors (soil aggregate stability, soil water holding capacity, soil microbial biomass and soil respiration) indicated differences among tillage systems. In the irrigated environment (Stoneville), all soil quality factors was greater for no-tillage than bed-roller, TerraTill and disk (2x) + TerraTill. In the non-irrigated environment (Verona), no-tillage had a greater percent aggregate stability and soil respiration than bed-roller, TerraTill and disk (2x) + TerraTill. No-tillage and TerraTill soil microbial biomass was not different but greater than disk (2x) + TerraTill. There were no tillage treatment differences for soil water holding capacity.

Early season number of leaves per plant populations and plant spatial differences indicated no differences between tillage systems at both locations. TerraTill and disk (2x) + TerraTill grain yields at Verona (non-irrigated) of 215 and 209 bu/acre, respectively, were not different but greater than no-tillage and the bed-roller yields of 194 and 199 bu/acre, respectively. At Stoneville (irrigated), bed-roller, TerraTill and disk + TerraTill yields of 191 to 201 bu/acre were not different but were greater than no-tillage yield of 180 bu/acre. Irrigation at Stoneville was applied 6/30/16 and 7/18/16. The disk (2x) operations at both locations did not increase yield or returns. Kernel weight and crop residue yields for all tillage treatments at both locations only showed minor tillage differences. Bed integrity at both locations for the no-tillage (on old beds) system lasted two crop production seasons, and then had to be re-bedded in 2014 and 2016.

The economic analysis for Verona and Stoneville indicated crop residue management had an effect on returns above total specified costs at Verona but not at Stoneville. There were no other crop residue management by tillage treatment interactions. At Verona, the no-burn corn stubble (2012 and 2014) had $55/acre greater return than where corn stubble had been burned (2012 and 2014). At Verona, TerraTill ($234/acre) had higher returns than no-tillage ($173/acre), bed-roll ($188/acre) and the disk (2x) + TerraTill ($196/acre). At Stoneville, the bed-roller ($182/acre) and TerraTill ($197/acre) returns were not different but greater than no-tillage ($147/acre) and the disk (2x) + TerraTill ($148/acre) net returns. Both locations indicated the disk operations did not increase yield or returns. Returns were based on the corn price for the week of corn harvest date ($3.32/bu for Verona and $3.23/bu for Stoneville) for each location, with the direct and fixed expense priced on values from the Mississippi State University, Department Agricultural Economics Budget Report 2016-05. Some items were intentionally left out of these cost calculations e.g., costs for land or land rent, taxes, insurance, general farm overhead, and expected income from government payments or insurance payments, as they vary widely between operations.

Project Impacts/Benefits

Since soil quality improvement processes occur at a slow pace, this 7-year (2011-2017) research study when completed will provide producers the necessary information to make an informed decision regarding the economic returns associated with these crop residue management-tillage systems in irrigated and non-irrigated environments. It will provide information regarding their positive or negative impact on yield, soil quality and fertilizer nutrient use efficiency. Results from these studies will also provide needed information on the level of soil quality enhancement or degradation (soil organic matter, soil aggregate stability, bulk density, soil microbial biomass, soil respiration, etc.) from these crop residue management-tillage practices on both alluvial delta and prairie coastal plain soils in Mississippi. The outcome of this research will provide Mississippi growers the information that will enable them to understand how they can develop "Soil Quality Enhancement Activities" meeting the requirements for NRCS's Conservation Stewardship Program. The economic analysis using current and/or projected production costs and grain pricing also will allow us to measure the net return above total specified costs for these crop residue management tillage systems in the near- and long term.

Project Deliverables

Journal Publications

Shanmugam, S.G., N.W. Buehring, M.W. Ebelhar, M.S. Cox, J.L. Oldham, D.G. Peterson and W.L. Kingery. 2016. Short-term effects of tillage treatments on soil microbial biodiversity under soybean-corn rotation. International Journal of Agriculture and Environmental Research 2: 1277-1303.

Professional Meetings (3)

Grower Meetings (2)