EFFECTS OF CONSERVATION TILLAGE ON CROP YIELDS AS INFLUENCED BY CROP, REGION AND ENVIRONMENTAL FACTORS

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SUMMARY

Farmers are always looking for new ways to decrease costs and increase yields. No-tillage could be a viable option to help achieve this goal. No-tillage is a farm management practice where no tilling is done to the soil with seeds planted directly into the unprepared soil, and weeds and competing vegetation are controlled with herbicides (Phillips et al. 1980). No-tillage on many occasions has been found to have multi-faceted advantages. Some of those advantages include reduced fuel consumption, lowered maintenance and repair costs and lowered labor costs (Deen and Kataki 2003; Lankoski et al. 2004). No-tillage has also been found to reduce erosion, decrease moisture evaporation, sequester soil organic carbon and increased land use by being able to produce on highly erodible land (Lal 2004; Phillips et al. 1980).

Much research has been done as to how different methods of tillage affect crop yields. However, no clear consensus has been reached; many reports indicate higher yields with the use of no-tillage compared to conventional tillage (Endale et al. 2008; Smiley & Wilkins 1993; Wagger & Denton 1989). There are just as many reports stating the opposite (Graven & Carter 1991; Halvorson et al. 2006; Hammel 1995) as well as just as many stating there is no real significant difference in yields between conventional and conservation tillage (Archer & Reicosky 2009; Barnett 1990; Kapusta et al. 1996).

A review of literature indicates that an evaluation of the performance of conservation tillage yields relative to conventional tillage yields across the United States is needed to help better inform farmers if no-tillage is a good option for them. Therefore, the objective of this paper is to evaluate the impacts on mean crop yields of switching from conventional or reduced tillage practices to no-tillage as explained by factors such as time since conversion to no-tillage, crop, precipitation, soil texture and geographic region. This study evaluated the potential factors that influence differences in no-tillage and tillage crop yields. A dataset of paired tillage experiment from the *Soil & Tillage Research* journal was collected by Maithilee Kunda and Tristram West of the Oak Ridge National Laboratory (Kunda and West 2006). Of that data only the one's pertaining to the contiguous U.S. were used. Additional data was then collected from two other refereed journals, *Agronomy Journal* and *Journal of Production Agriculture*. These datasets allowed us to evaluate crop yield differences when comparing conventional and reduced tillage to no-tillage as explained by such factors as time since conversion from tillage to no-tillage, crop, precipitation, soil texture and geographic region. Data from corn, soybeans, cotton, oats, wheat and sorghum tillage experiments were incorporated in the analysis. The experiments were conducted across the United States, with data ranging from 1964 to 2005. Studies like this have been done before, for example DeFelice et al (2006), but their study only pertained to corn and soybeans with all experiments in the eastern United States. This study differs in that it

incorporates six different crops from all across the U.S. looking at many different variables like precipitation, soil texture, geographic region and time.

A meta-analytic approach was used to normalize the yields from each experiment which will make it possible to analyze more efficiently the paired experiments from the dataset (Miguez and Bollero 2005). This was obtained by creating a simple proportion of the strategy yield divided by the control yield. For example, the proportion was created by dividing the no-tillage yields by the conventional tillage yields.

The data were evaluated using PROC MIXED procedures. The results showed that when comparing conventional and reduced tillage yields to no-tillage yields, that no-tillage sorghum and wheat yielded more than conventional tillage sorghum and wheat, but no-tillage oats yielded less. One explanation for this could be the amount of residue left behind by each crop. Wheat and sorghum leave more residue on the ground than corn. Wheat averages 100 lbs. per bushel of grain of residue and sorghum averages 70-80 lbs. per bushel whereas corn only averages 60 lbs. per bushel (McCarthy et al. 1993; Smith 1986). Oats on the other hand leave a lesser amount of residue at only 50 lbs. per bushel; this could explain why its yields were less than corn (Hofman 1997). This result could imply to a certain extent that with no-tillage, the more residue left behind, the higher the yield since the more residue left behind would translate into less erosion and nutrient runoff, more water conservation and increased organic matter. This would fall in line with what Wilhelm et al. (1986) found. They found corn and soybean yields to be linearly related to the amount of residue on the surface. When residue was removed, yields decreased. Too little residue can result in stunted growth, stress and decreased yields caused from lack of soil water, poor canopy development and high surface temperatures (Doran et al. 1984).

The results also showed that soil texture plays a part in how well no-tillage performs, indicating no-tillage did not perform well under finely textured soils, such as silt, where no-tillage yields were 12% lower than conventional tillage. These results coincide with previous research that no-tillage performs better in coarse, well-drained soils, but does not produce as well under fine, poor-drained soils (DeFelice et al. 2006; Hairston et al. 1990). No-tillage crop yields were also found to perform better relative to conventional tillage yields in the Southern Seaboard ERS Farm Resource region which represents a good portion of the southeastern United States, but poorly in the Basin & Range region when both were compared to the Heartland region. All experiments that took place in the Basin & Range region were in the upper northwest corner of the United States. This coincides with previous studies that show no-tillage performs better than conventional tillage in the warm southern climates of the United States with conventional tillage performing better in northern climates (DeFelice et al. 2006). One possible reason for this is because of soil temperature. Colder temperatures coupled together with the crop residue left behind with no-tillage can delay crop emergence and development resulting in reduced yields (Halvorson et al. 2006). High amounts of precipitation resulted in lower no-tillage yields compared to conventional tillage. This corresponds with previous work that found no-tillage to perform better under dry conditions because of its moisture conservation ability, but did not perform as well as conventional tillage during cooler and wetter conditions (Eckert 1984; Herbek et al. 1986).

In conclusion, no-tillage could be a viable option to replace conventional tillage methods for a farmer. No-tillage yields relative to conventional tillage were higher in warmer, drier southern climates under a well drained coarse textured soil. A farmer's decision to implement no-tillage should be on a case by case basis where factors such as precipitation, region, soil texture and crop are all considered.