

Strategic Tillage for the Improvement of No-Till Cropping Systems

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Occasional tillage (OT) of long-term no-till (also called one-time or strategic tillage) might be desired once in more than 5 or 10 years according to need for integrated weed management, fracturing a compaction layer, incorporating a soil amendment such as lime or manure, reducing vertical stratification of nutrient availability, increasing soil organic matter to greater depth, or reducing crop residue accumulation. The type of tillage for OT should be specific to the objective of the OT. Some of the early OT research was done in Nebraska including a 5-year study at the High Plains Agricultural Laboratory (HPAL) near Sidney using moldboard plow tillage and three 5-year trials in eastern Nebraska in which five OT practices were compared. However, there has been much additional study elsewhere during the past decade. Dozens of other multi-year trials have been conducted including trials in Australia, Brazil, Canada, Spain, and Turkey, as well as in Indiana, Kansas, Kentucky, Oregon, Texas, and Wyoming.

Negative, neutral and positive effects

An early concern with OT of no till was that benefits to soil properties and productivity gained from continuous no-till would be lost with a single or infrequent tillage practice. The findings from the above studies consistently show that such negative effects are highly unlikely, generally of less than 1-year duration and of little agronomic significance. The two consistent negative effects of OT are the cost of the tillage and increased risk of erosion until crop canopy or residue cover of the soil is re-established.

Occasional tillage overall has several near neutral or inconsistent effects. It does re-distribute vertically stratified organic matter and any loss in soil organic matter (SOM) is recovered within one year. However, inversion of high SOM surface soil with deeper soil with less SOM does not result in a net gain in SOM. Greenhouse gas emission is little affected by OT. Soil aggregation and soil bulk density may be reduced but the effect is generally not detectable one year later. The effects on water infiltration have been inconsistent and short-lived. Soil microbial biomass and activity generally has not been affected. An exception occurred in eastern Nebraska where mycorrhizal colonization of roots and biomass in the soil were reduced but P uptake by the crop increased with OT.

Some positive effects of OT have occurred with high consistency. It does re-distribute vertically stratified nutrients and pesticide compounds and reduces their loss in runoff. If well planned and targeted, OT is a useful component of integrated weed management and soil compaction management. It does incorporate soil amendments such as lime and manure which may in some cases be advantageous to surface application.

Crop yield

The effect of OT on crop yields was evaluated for two or more years in 35 trials globally with no effect in 72% of the cases, decreased yield in 7% of the cases, and increased yield in 21% of the cases. Crop yield increases were often associated with the correction of a major problem and might have been more frequent if more of the studies had better targeted OT to correct a specific problem. In the 5-year HPAL study, inversion moldboard plow OT to bury seed of downy brome effectively reduced weed numbers and increased wheat yield for the dryland wheat-fallow rotation. In the eastern Nebraska studies, soybean in rotation with corn or grain sorghum had a 3.6% mean yield increase during the 5-year study due to OT with a greater yield benefit following OT with a mini-moldboard plow (Figure 1). The 2.6% mean yield increase over 5 years with OT for corn and grain sorghum was not statistically significant.



Figure 1. A study in eastern Nebraska found more gain in soil C sequestration with mini-moldboard plow compared with no tillage for irrigated continuous corn. Mini-moldboard plow tillage is a conservation tillage practice that leaves significant ground cover and was favorable to soybean yield as an occasional tillage practice for the no-till corn-soybean rotation.

Strategic use of OT

The OT should be in response to some well-identified purpose as there is the added cost of performing OT and there may be a significant risk of erosion associated with OT. Success with OT will require the right choice of type and time of OT for a given problem. The best opportunities may be with weed control and fracturing of compaction layers or hardpans.

The biology of a weed problem needs to be considered. Inversion OT such as with a moldboard plow is needed if seed burial is important as disk and chisel OT is unlikely to sufficiently bury seed to have effects of more than one season. Perennial weeds, as in the case of one study targeting control of a perennial bunch grass (e.g. windmill grass), may be reduced for several years with shallow sweep OT. As a component of integrated weed control, OT might be once in five or more years.

Successful OT for fracturing of compaction layers or hardpans requires good characterization of the problem including the cause, the depth and thickness, and then choosing the OT operation and timing accordingly. Soil dryness is important and there may be an optimum stage of the crop rotation. If the compacted layer is within 8 inches of the surface, the layer may be shattered with a chisel, moldboard or mini-moldboard plow. If deeper, a subsoiler, ripper or paraplow may be appropriate. The OT needs to be done when the compacted layer has a low soil water content which is often in the fall. With management to avoid compaction, such OT would be done only once or very infrequently, such as once in more than 10 years.

The OT may be justified with some combination of lesser benefits such as partial or full incorporation of excess crop residue, deep placement of an applied immobile nutrient or redistribution of vertically stratified P and other immobile nutrients for improved nutrient availability and reduced soluble nutrient runoff, or incorporation of a soil amendment. Such OT is not likely to be justified more frequently than once in more than 10 years.

Other practices may be alternatives or complementary to OT. Controlled traffic to have the majority of land surface with no traffic and avoiding traffic on wet soil is important to minimized compaction and to prolong the benefit of shattering a compaction layer with OT. Well-chosen and managed cover crops can be of value to reduce compaction. Integrated weed management may be improved with weed suppression through competitive and allelopathic effects of cover crops or primary crop rotation choices. Incorporation of a soil amendment (e.g. lime, manure, gypsum) or an immobile nutrient may enhance the benefits of OT. Occasional strip tillage may be an alternative to OT for shallow compacted layers and for deep placement of immobile nutrients.

Conclusion

Overall, most soils are resilient to any negative effects of OT if erosion is controlled. The practice of OT once in 5 to 10 years or more is not likely to adversely affect no-till systems. However, to be beneficial, the OT has to be well-planned and implemented to target a well-characterized problem such as a weed control or compaction problem.

References to Nebraska studies of occasional tillage

Kettler, T.A., Lyon, D.J., Doran, J.W., Powers, W.J., Stroup, W.W., 2000. Soil quality assessment after weed-control tillage in a no-till wheat-fallow cropping system. Soil Sci. Soc. Am. J. 64, 339-346.

Garcia, J.P., Wortmann, C.S., Mamo, M., Drijber, R., Tarkenton, D., 2007. One-time tillage of no-till Effects on nutrients, mycorrhizae, and phosphorus uptake. Agron. J. 99, 1093-1103.

Quincke, J.A., Wortmann, C.S., Mamo, M., Franti, T., Drijber, R.A., 2007a. Occasional tillage of no-till systems: carbon dioxide flux and changes in total and labile soil organic carbon. Agron. J. 99, 1158-1168.

Quincke, J.A., Wortmann, C.S., Mamo, M., Franti, T., Drijber, R.A., Garcia, J.P., 2007b. One-time tillage of no-till systems: soil physical properties phosphorus runoff and crop yield. Agron. J. 99, 1104-1110.

Wortmann, C.S., Quincke, J.A., Drijber, R.A., Mamo, M., Franti, T., 2008. Soil microbial community change and recovery. Agron. J. 100:1681-1686.

Wortmann, C.S., Drijber, R.A., Franti, T.G., 2010. One-time tillage of no-till crop land five years post-tillage. Agron. J. 102, 1302-1307.

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