Quantifying Impacts of Precision Agriculture Technologies

Tractor guidance (TG) is a precision agriculture technology that allows for more spatially precise applications of seed, fertilizer, and agro-chemicals when compared with field operations conducted without GPS guidance. This leads to efficiency gains that are difficult to quantify at the systems level. Producer adoption of best management practices is complex, and so decision-support tools that help quantify costs and benefits may assist in technology transfer. Therefore, a decision-support tool, “TG Analysis” (TGA), was developed to quantify environmental and economic impacts of this technology.

In an article recently published in Agricultural & Environmental Letters, a research team evaluated the economic and environmental impacts of TG based on three on-farm scenarios. Researchers found that TG impacts are crop specific, scale dependent, and equipment or input-use specific.

Agricultural sustainability can be improved with TGA by informing users of economic and environmental repercussions of TG. Additionally, TGA can be used to estimate environmental implications (greenhouse gas emissions) of TG, as well as promote more judicious applications of nutrients that may enter water systems when over-application is due to swath overlap in non-TG systems. Further, by providing producers an estimate of both economic and environmental repercussions of TG, adoption of this technology is expected to increase.


Soil Management Shifts Soil Water Spatial Patterns

The spatial patterns of soil water content (SWC) in natural and long-term managed ecosystems are well known and greatly aid in our ability to predict water on those landscapes. However, little is known of how soil and residue management practices can shift these spatial patterns of soil water and how soon shifts can occur after farmers adopt new practices.

In an article recently published in Agricultural & Environmental Letters, researchers report on SWC spatial patterns using semivariograms on five soil series, ranging from sandy to clayey textures, in North Dakota and Iowa. In these fields, a variety of newly imposed, side-by-side cover crop and tillage practices were evaluated on corn, soybean, and barley cropping systems.

The distance of spatial dependence for SWC decreased when cover crops were included in the cropping system, except in a clayey vertisol. The same trend was observed when tillage area (strip till) or intensity (vertical till and no till) was reduced from chisel plowing. These shifts in spatial patterns occurred within two years of implementing the new management practices even though differences in mean SWC were not evident. The researchers attributed these shifts to cover crops creating small and more spatially variable mosaics of soil hydraulic properties as a result of the increased plant density and to tillage causing the exact opposite effect from the mechanical homogenization of soil properties.

The findings have implications for how scaling of SWC is accomplished from point sensors to satellite sensing with subsequent consequences on hydrologic modeling of agricultural landscapes. This is important since many agricultural landscapes have a mosaic of soil and residue management practices that can change often as farmers become more aware of new practices to increase soil and crop health.