# APPLICABILITY AND SENSITIVITY OF FIELD HYDROLOGY MODELING BY THE SOIL PLANT AIR WATER (SPAW) MODEL UNDER CHANGES IN SOIL PROPERTIES

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## HIGHLIGHTS

- Changes to soil properties and precipitation scenarios significantly affect the water balance in agro-hydrology.
- SPAW model is sensitive to simulated runoff and infiltration, but it has limitations in responding to soil compaction and organic matter change.
- Increasing organic matter (1% to 5%) did not significantly affect runoff or infiltration in silty and sandy loam soil.
- Low precipitation generates significantly lower runoff (%) and higher infiltration.

**ABSTRACT.** *Agricultural practices can change soil properties and the amount of runoff generated from a landscape. Modeling results could be significantly different than expected if the web soil survey or other commonly used remote sensing applications are used as model inputs without site verification. This study assessed the applicability and sensitivity of the Soil-Plant-Air-Water (SPAW) Model for simulating the runoff (%) and infiltration (%) components of the water balance for various soil physical properties, cover crop, and weather variables. Soil profiles in 135 combinations were developed with three soil classes (sandy loam, silt loam, and clay), five organic matter levels (1%, 2%, 3%, 4%, and 5%), three levels of compaction (low, medium, and high), and three topsoil layer thicknesses (7.6 cm, 11.4 cm, and 15 cm). Also, three cover crop treatments were simulated by modifying surface cover and evapotranspiration during the non-growing season. Finally, two precipitation regimes were considered (Iowa City, IA, as high precipitation and Brookings, SD, as low precipitation) to simulate runoff and infiltration. In total, 810 scenarios were run, resulting in over 300 million data points. This study confirmed that soil texture, bulk density, and topsoil thickness significantly ($p<0.01$) influence runoff generation and infiltration percentage based on the water balance criterion. Interestingly, the SPAW model had no significant response on runoff (%) and infiltration (%) to organic matter levels changing from 1% to 5%. This simulation demonstrates that runoff estimations can be significantly influenced by soil properties that can change due to agricultural conservation practices (ACPs) or, conversely, by compaction events. Inputs to models must account for these changes rather than relying only on historical or remote sensing inputs.*

***Keywords.*** *Agricultural conservation practices, Conservation agriculture, Field hydrology, Infiltration, Runoff, SPAW.*

Agricultural management practices impact the function of soil's physical, chemical, and biological properties (Connolly, 1998; Franzluebbers et al., 2021; Jangid et al., 2008; Sapkota et al., 2012). No tillage or reduced tillage, crop diversification, and cover crop management are under the agricultural conservation practices (ACPs) umbrella (sharing similarities with soil health principles or regenerative agriculture practices) and are implemented to enhance soil ecosystems (Lal, 2013), increase organic matter (Doran, 2002), reduce bulk density (Sapkota et al., 2012), and build soil aggregate and soil structure (Pagliai et al., 2004). With these changes, the infiltration rate increased and the water holding capacity improved, which reduced runoff. However, this magnitude of change in the water balance depends on soil properties (Bormann et al., 2007) and weather (Bronstert et al., 2002). It is important to determine the extent of the change in water balance parameters due to the change in agricultural practices for commonly used water balance estimation techniques. Researchers observed that several years is required to change soil properties and productivity through continuous ACPs, depending on the weather, soil type, land management, and cropping pattern. Much research is conducted to evaluate ACPs by targeting specific soil parameters or specific soil functions with various lengths of practicing, considering various soil depths, different combinations of soil health adoptions, land management, cropping pattern, and different



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