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Prediction of volumetric water content in conservation agriculture

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The lack of accurate data on soil hydraulic properties limits the use of water and solute transport models as they require water retention and hydraulic conductivity data to be implemented. In order to manage this scarcity of data, pedotransfer functions (PTFs) can be used to predict hydraulic properties. PTFs relate easily available soil properties to properties more difficult to access such as hydraulic ones. It is recommended to restrict their application to dataset similar to the calibration dataset to prevent inaccurate results. Adding soil management data, such as tillage practices or more generally cropping system information has been proposed as a way to improve their accuracy. Indeed, despite significant differences in soil properties between tillage systems, most of the PTFs were established for conventionally tilled soils. With an arising concern of water management in soils, especially water retention and availability for crops, soil properties of conservation tillage systems have to be accurately estimated what could led to adaptation or development of PTFs.

The aims of this study were to (i) to assess the quality of prediction of soil physical properties of numerous PTFs for soils managed with conservation agriculture practices and (ii) to develop functions specifically calibrated with conservation agriculture data.

Thirty one PTFs predicting volumetric water content at fixed matric potential and 8 PTFs predicting parameters from the water retention curve were selected from the literature and applied to the dataset. Simulated data were compared to observed data using 3 quality criteria: the Root Mean Squared Error of Prediction (RMSEP), the Mean Error of Prediction and the Concordance Correlation Coefficient (CCC). In view of these results, a second part of the study consisted in the development of several PTFs. Regression trees methods and multiple linear regression models were used to establish new PTFs which predict volumetric water content at -100 cm, -330 cm, -15000 cm and parameters from the van Genuchten water retention curve.

In a general way, all PTFs found in the literature had poor capacity to predict volumetric water content. The RMSEP varied between 0.046 cm3/cm3 and 0.265 cm3/cm3 for volumetric water content at -100 cm. At -15000 cm, RMSEP varied between 0.043 cm3/cm3 and 0.059 cm3/cm3. According to the MEP, most of PTFs tend to underestimate volumetric water content at -100 cm. At -15000 cm, there was no obvious trend, 11 PTFs underestimating water content and 18 overestimating it. The CCC also revealed poor capacity of PTFs to predict volumetric water content. The 3 quality criteria for the retention curve parameters (based on Van Genuchten model) also gave unsatisfying results. Most of the functions indeed tend to underestimate θs, α and n. As previously suggested, additional information have to be taken into account to improve the accuracy of PTFs. The lack of cropping system information in existing PTFs used in our study is a possible explanation of our results.