



HAL
open science

Prediction of volumetric water content in conservation agriculture

Sixtine Cueff, Yves Coquet, Liliane Bel, Jean-Noël Aubertot, Valérie Pot,
Lionel Alletto

► **To cite this version:**

Sixtine Cueff, Yves Coquet, Liliane Bel, Jean-Noël Aubertot, Valérie Pot, et al.. Prediction of volumetric water content in conservation agriculture. EGU General Assembly 2019, Apr 2019, Vienne, Austria. 21, pp. EGU2019-15930. hal-03765214

HAL Id: hal-03765214

<https://hal.science/hal-03765214v1>

Submitted on 5 Sep 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Introduction

- The lack of accurate data on soil hydraulic properties is an obstacle to the use of water and solute transport models
- Pedotransfer functions (PTFs) represent a solution to cope with data scarcity
- PTFs relate easily measurable soil properties to properties more difficult to access such as water retention curve
- They were mostly developed for soils under conventional tillage systems
- The ability of PTFs to predict water retention in conservation agriculture is unknown

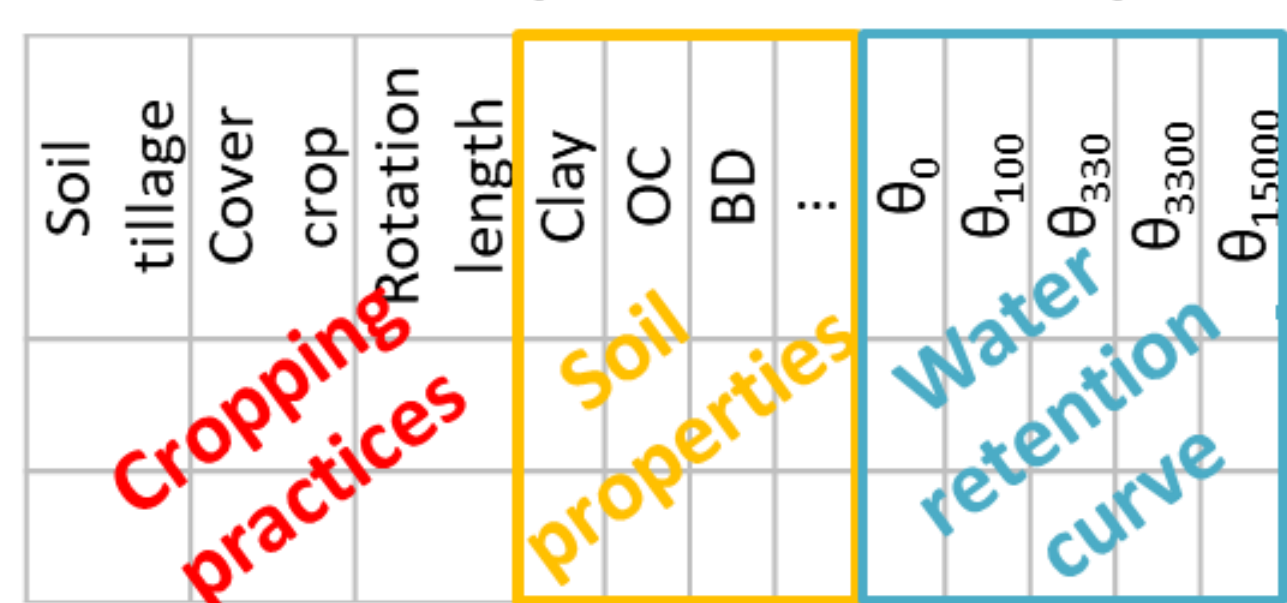
Objectives

- Assess the quality of prediction of soil water retention of different published PTFs for soils managed with conservation agriculture practices
- Develop specific PTFs for soils under conservation agriculture

Materials and Methods

- Evaluation of 29 existing class-PTFs, continuous-PTFs and tree-PTFs using a dataset describing cropping practices, soil properties and water retention curves under conservation agriculture

Dataset (170 individuals)



θ observed



θ predicted

Statistical criteria used to assess the quality of prediction

$$RMSEP = \sqrt{\frac{1}{N} \sum_{i=1}^N [\hat{y}_i - y_i]^2}$$

RMSEP: Root Mean Square Error of Prediction

$$MEP = \frac{1}{N} \sum_{i=1}^N [\hat{y}_i - y_i]$$

MEP: Mean Error of Prediction

$$EF = 1 - \frac{\sum_{i=1}^N [\hat{y}_i - y_i]^2}{\sum_{i=1}^N [y_i - \bar{y}]^2}$$

EF: Efficiency

\hat{y} ; y : predicted & observed values, \bar{y} : mean of observed values, N : number of values

- Development of new PTFs predicting soil water content (θ) at field capacity (θ_{FC} at -100 or -330 cm) and at wilting point (θ_{WP} at -15000 cm), as a function of soil properties and cropping practices, using a regression tree method (recursive binary partitioning with rpart package in R)

- Quality of prediction of the new PTF was estimated by cross-validation considering spatio-temporal correlations

Acknowledgements

Authors are grateful to the Agence de l'Eau Adour Garonne and the Région Occitanie for funding this work as part of the BAG'AGES Project (Bassin Adour Garonne: Quelles performances des pratiques agroécologiques?).



References

- Al Majou, H. et al. (2008) 'Prediction of soil water retention properties after stratification by combining texture, bulk density and the type of horizon', Soil Use and Management, 24(4), pp. 383-391.
- Román Dobarco, M. et al. (2019) 'Pedotransfer functions for predicting available water capacity in French soils, their applicability domain and associated uncertainty', Geoderma. Elsevier, 336(September 2018), pp. 81-95.
- Al Majou, H. et al. (2007) 'Comparaison de fonctions de pédotransfert nationales et européennes pour prédire les propriétés de rétention en eau des sols', Etude et Gestion des Sols, 14, pp. 103-116.

Results

1. Quality of prediction for $\theta_{FC_{100}}$ (2 out of 26 functions are shown)

BEST CLASS AND CONTINUOUS FUNCTION	RMSEP	MEP	EF
Class: texture FAO (stratification) [1]	0,049	-0,03	-0,23
Continuous: $a + b \times \text{clay} + c \times \text{sand} + d \times \text{BD}$ (stratification) [2]	0,057	-0,046	-0,67

- Among all PTFs, RMSEP ranged from 0,034 cm³/cm³ to 0,192 cm³/cm³
- Almost every PTF tends to underestimate $\theta_{FC_{100}}$ (MEP<0)
- One function led to a correct EF but it requires both θ_{WP} and $\theta_{FC_{330}}$



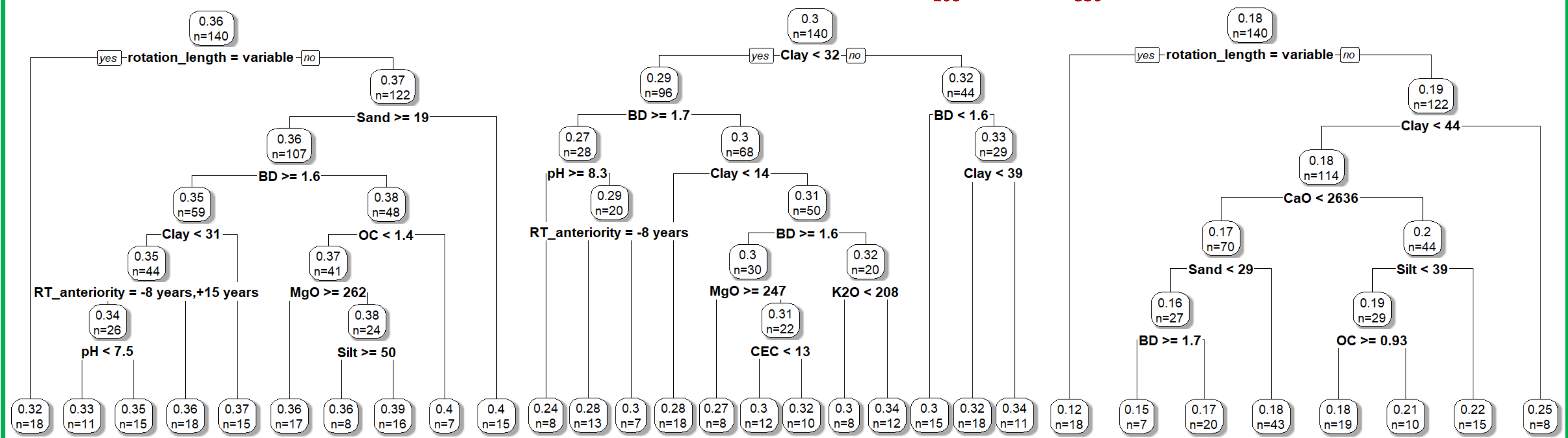
Field under conservation agriculture practices

2. Quality of prediction for θ_{WP} (2 out of 29 functions are shown)

BEST CLASS AND CONTINUOUS FUNCTION	RMSEP	MEP	EF
Class: texture FAO and BD [3]	0,042	0,002	0,18
Continuous: $a + b \times \text{clay} + c \times \text{sand}$ [2]	0,034	0,003	0,45

- RMSEP ranged from 0,034 cm³/cm³ to 0,051 cm³/cm³
- Error represents a higher proportion of water content than for $\theta_{FC_{100}}$ prediction
- 2/3 of the PTFs underestimated θ_{WP}
- EF were globally better than for $\theta_{FC_{100}}$ prediction

3. Regression trees to predict volumetric water content at field capacity ($\theta_{FC_{100}}$ and $\theta_{FC_{330}}$) and wilting point (θ_{WP})



- Length of rotation is the first predictor splitting the dataset in $\theta_{FC_{100}}$ and θ_{WP} trees
- Anteriority of reduced/no tillage appears in $\theta_{FC_{100}}$ and $\theta_{FC_{330}}$ trees

4. Quality of prediction of the developed regression trees

Cross-validation	$\theta_{FC_{100}}$	$\theta_{FC_{330}}$	θ_{WP}
RMSEP	0,036	0,041	0,041
MEP	0,002	0,003	0,001
EF	-0,08	-0,24	0,03

- The $\theta_{FC_{100}}$ tree has a better predictive quality than published PTFs: smaller RMSEP and MEP. However, EF remains low
- The θ_{WP} tree performed equally or even worse, as compared to published PTFs

Conclusions & Perspectives

- Existing PTFs did not have a good quality of prediction of our water retention dataset
- New tree-PTF has a better ability to predict soil volumetric water content at field capacity ($\theta_{FC_{100}}$)
- Variables describing cropping practices were found to be important in order to predict soil water retention in conservation agriculture
- Their role in the development of PTFs needs further investigation

