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Using the Rasch model as an objective and probabilistic technique to integrate different soil properties

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Soil apparent electrical conductivity (ECa) is one of the simplest, least expensive soil measurements that integrates many soil properties affecting crop productivity, including, for instance, soil texture, water content, and cation exchange capacity.

The ECa measurements obtained with a 3100 Veris sensor, operating in both shallow (0-30 cm), ECs, and deep (0-90 cm), ECd, mode, can be used as an additional and essential information to be included in a probabilistic model, the Rasch model, with the aim of quantifying the overall soil fertililty potential in an agricultural field. This quantification should integrate the main soil physical and chemical properties, with different units. In this work, the formulation of the Rasch model integrates 11 soil properties (clay, silt and sand content, organic matter -OM-, pH, total nitrogen -TN-, available phosphorus -AP- and potassium -AK-, cation exchange capacity -CEC-, ECd, and ECs) measured at 70 locations in a field.

The main outputs of the model include a ranking of all soil samples according to their relative fertility potential and the unexpected behaviours of some soil samples and properties. In the case study, the considered soil variables fit the model reasonably, having an important influence on soil fertility, except pH, probably due to its homogeneity in the field. Moreover, ECd, ECs are the most influential properties on soil fertility and, on the other hand, AP and AK the less influential properties.

The use of the Rasch model to estimate soil fertility potential (always in a relative way, taking into account the characteristics of the studied soil) constitutes a new application of great practical importance, enabling to rationally determine locations in a field where high soil fertility potential exists and establishing those soil samples or properties which have any anomaly; this information can be necessary to conduct site-specific treatments, leading to a more cost-effective and sustainable field management. Furthermore, from the measures of soil fertility potential at sampled locations, estimates can be computed using, for instance, a geostatistical algorithm, and these estimates can be utilized to map soil fertility potential and delineate with a rational basis the management zones in the field.

Keywords: Rasch model; soil management; soil electrical conductivity; probabilistic algorithm.