Utilizing model averaging to improve the prediction of agronomic soil properties from vis-NIR and pXRF

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Many soil science laboratories are now equipped with technology platforms in portable visible near-infrared (vis-NIR) and X-ray fluorescence (pXRF) spectrometers. These technologies have complementary capabilities, where XRF is known to accurately measure the soil's inorganic elemental concentration, and vis-NIR has the ability to estimate the soil's organic component and mineralogy suites. In this study data mining was used to estimate soil properties from the vis-NIR spectra, and in a novel way from the XRF spectra. Prediction outcomes were combined into a single outcome using formal methods called model averaging. Combining model outcomes derived from spectra using model averaging improves or maintains the prediction status of vis-NIR and XRF models for a wide range of soil properties of agronomic importance. Overall, the relative improvement in %RMSE ranged from 4 to 44%. Weight preference in model averaging was related to the inference of soil chemical and physical properties from vis-NIR and XRF spectra. Based on both the relative improvement in RMSE and RPIQ status, model averaging was found to be suitable for soil pH, soil C (soil organic C and total C), soil texture, CEC and total elements K, Mg, Co, Cr and Mn. Overall, Granger-Ramanathan averaging produced similar or better outcomes compared to variance weighted averaging. This model averaging approach is more simple to compute requiring only to fit a simple multiple linear regression model, unlike the VWA approach in which the weighting is estimated for each soil property. Thus in the interests of parsimony Granger-Ramanathan averaging is recommended as the model averaging technique to be adopted as protocol.