Potential of a Low-Cost Color Sensor to Determine Soil Organic Carbon

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Introduction

- Soil analyses are essential for agriculture; they allow for an optimal yield of crops.
- Conventional methods are expensive, destructive, take a lot of time, and cannot be done in-situ.
- Research has followed a trend of looking for faster ways to accurately determine soil characteristics.
- PXRF (Portable X-Ray Fluorescence) spectroscopy is a reliable method for determining multi-elemental soil data on-site, yet the instrument is expensive.
- A study from Clemson university used Nix Pro color sensor to determine and map soil color.
- Color is directly related to soil fertility properties (e.g., organic matter, gypsum and calcium carbonate).

Objective

- Determine the viability of using Nix Pro color data to predict total soil organic carbon content.

Methods

1. 25 soil cores were collected from Romania at a depth of 120 cm, separated at a 10 cm interval, and shipped to TTU. 300 samples in total.
2. The samples were oven dried at 105°C for 24 hours, ground and sieved to pass 2 mm.
3. All samples were scanned with PXRF and Nix Pro sensors and tested for pH and EC.
4. 20 g of each sample were sent to a commercial lab to determine total C and N via combustion.
5. Color and elemental data was processed using XLSTAT. Both Nix and PXRF variables were added to the regression models.

Results

Random Forest

- Predicted Carbon vs Actual Carbon
- $R^2 = 0.7492$
- RMSE = 0.7%

Decision Tree

- Predicted Carbon vs Actual Carbon
- $R^2 = 0.8082$
- RMSE = 0.55%

Linear Regression

- Predicted Carbon vs Actual Carbon
- $R^2 = 0.6499$
- RMSE = 0.78%

Conclusions

- Nix Pro has the potential to predict soil organic carbon when complemented with PXRF data.
- Regressions show promising results for further validation.

Further Research Should Target:

- Predicting other soil properties (e.g., CaCO3, moisture, soil contaminants).
- Creating and validating regressions solely using Nix Pro color data.
- Performing financial analyses to quantify savings for substituting traditional methods with Nix Pro.
- Replicating this study in different types of soils.