



Between two Furrows: Soil bulk density from Non-Invasive Seismology

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Soil is a critical resource for global food security, yet conventional physical soil analyses, remote sensing and geophysical methods are often labour-intensive and time-consuming. This study explores the potential of ultra-high-frequency (>500 Hz) hammer-source seismology to characterise soil physical properties at the decimetre scale.

Field experiments were conducted within a long-term trial near Harper Adams University (UK) comparing Conservation and Conventional agricultural practices. Two 1.5 m transects were surveyed in each treatment using 16 geophones, with soil samples collected at matching horizontal resolution. P-wave velocity (v_p) was estimated in the upper 40 cm of the soil profile and compared with bulk density derived from physical samples.

Results show a strong and statistically significant correlation between v_p and bulk density. This relationship is consistent throughout the depth profile, with good agreement between seismic velocity images and interpolated bulk-density measurements from soil cores. The findings demonstrate that ultra-high-frequency seismic methods can reliably resolve small-scale soil structure relevant to agricultural management.

Our results indicate that ultra-high-frequency seismic analysis is a promising and cost-effective approach for estimating soil bulk density. This technique has clear potential to support agronomic and land-management decision making.