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Taking novel approaches of Ground Penetrating Radar and Computed Tomography to quantity the location and severity of soil compaction in agricultural landscapes

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Agriculture is a dominant part of the UK landscape, composing 70% of the UK area. Of this, 6.3 million hectares is used for crops (28%) and 9.7 million hectares (71%) is permanent grassland. Soil compaction has been attributed to £72 million worth of losses per year. Current methods of testing for soil compaction are predominantly point based methods that lack the ability to quickly evaluate large fields at high spatial resolutions, often with multiple samples required for destructive evaluations of properties. Ground Penetrating Radar (GPR) may provide an alternate method for rapid continuous compaction assessment across large areas, whilst X-Ray computed tomography (CT) techniques may maximise data assessment from single samples. By coupling GPR and CT techniques it may be possible to more quickly evaluate soil compaction over larger areas and at lower costs.

As part of the COMPACT study 6 different land management regimes currently practiced in the River Soar catchment to the east of Leicester, UK were explored. Pastoral management regimes included cattle, sheep and equine grazing land. Arable management regimes were focused on tillage practices, where conventional tillage, minimal tillage and zero tillage regimes were explored. A comprehensive in-field testing and sampling programme was undertaken across all 6 sites, supported by further laboratory testing of samples. This exploration was repeated across the year to explore the seasonal nature of land trafficking and assess any soil health recovery.

The coupled laboratory and field-site study methodology allows for the fine scale evaluation of the role of influencing factors on GPR performance and permit comparisons between physically derived and CT-derived property values. Field-site GPR evaluations were accompanied by a suite of physical in-situ and laboratory tests to assess soil compaction and other influential characteristics, notably soil moisture content. Evaluations of dielectric permittivity and frequency analysis was performed on the GPR data for varying soil moisture content and compaction scenarios.

Initial trials indicated a strong positive correlation between soil bulk density (compaction indicator) and dielectric permittivity. Whilst initial frequency analyses identified trends in peak frequency and soil moisture content. Application of these findings to in-field GPR evaluations will indicate the suitability of GPR for rapid identification of compaction at large spatial scales. Whilst CT evaluations were found to replicate the majority of physical tests yet preserving critical internal soil matrix structures.