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Within-field Soil Management Recommendations Based on Soil Spatial Variability Assessment; Example of A Belgian Polder Field

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We study the influence of the spatial variability of soil properties on yield and quality of sugar beet crop and provide recommendations for soil management practices to increase farm income at a polder sugar beet field in Belgium. The objectives of our work are: (i) to characterize the soil spatial variability across a 10ha sugar beet field; (*ii*) to determine its influence on the yield and quality of sugar beet (*Beta vulgaris ssp. vulgaris L.*); and (*iii*) to recommend physically based within-field soil management practices to farmers, taking into account soil variability features.

A directed sampling scheme with 78 soil sample locations is implemented on the basis of apparent electrical conductivity (ECa) data gathered from Dual dipole electromagnetic sensor (EM38DD) on-the-go. The topsoil (0-40cm) and subsoil (50-80cm) samples are analyzed for their texture, carbonates ($CaCO_3$), soil organic carbon (SOC), soil pH, and soil moisture content at -1.5 MPa (θg). The spatial distribution of the sampled properties is characterized by large coefficients of variations (*CVs*) in both layers, with the largest values attained in the subsoil showing higher variability in the deeper layer. Moreover, comparatively lower range of spatial dependence and lower Mean Cross-correlation Distances (MCD) of the subsoil properties confirmed the presence of heterogenic subsoil. However, the topsoil was less heterogeneous because of the mixing due to frequent agricultural practices.

Principal components analysis (PCA) suggests that field ECa information accounts for most of the soil spatial variability. Fuzzy k-means classification with ECa leads to identifying two separate zones (termed as potential management zones) with distinctive differences in subsoil texture ($i.e.$, zone 1: loamy area and zone 2: sandy area) as ECa is mostly influenced by highly heterogenic subsoil. The nitrate-nitrogen content and the gravimetric moisture content (the two major beet quality determiners) are always higher in the loamy area than in the sandy area throughout the crop cycle. The loamy part is characterized by the lowest Quality Index of the roots. However, the total root mass yield is larger than that associated with the sandy part. This explained the subsoil textural heterogeneity between the zones influenced the quality and quantity of sugar beet yields hence the gross farm income.

We conclude that soil spatial variability can be easily and quickly assessed with EM38DD in a non-invasive way. Identification of potential management zones, differential input treatment ($e.g.$, split nitrogen application in sandy area) and better SOC management between the zones and avoiding deep tillage in the sandy area are recommended to increase gross farm income and to reduce negative environmental impacts.

Keywords: Spatial variability, Apparent Electrical Conductivity (ECa), Geostatistics, Principal components analysisPlease fill in your abstract text.