

EGUSPHERE-2024-1587 | Reply to Referee #3

The manuscript presents a comprehensive comparison between two geophysical techniques, Electrical Resistivity Tomography (ERT) and Frequency-domain electromagnetic Method (FDEM), for assessing soil compaction in agricultural contexts. It effectively highlights the strengths and limitations of both methods, with a focus on their resolution and efficiency in characterizing soil structure at various scales. The study offers valuable insights into the applicability of these non-invasive methods for improving soil monitoring in agriculture, contributing to the optimization of geophysical data acquisition and processing. The results are well-supported by traditional soil characterization techniques and validated with traditional soil characterization techniques (penetration resistance, bulk density, volumetric water content), making the findings relevant for advancing agriculture practices and enhancing the understanding of soil-plant-water interactions.

I would like to acknowledge the authors for their contribution to addressing the practical limitations and potential of sensor technologies in soil monitoring. This manuscript is a strong candidate for inclusion in the special issue: Agrogeophysics, as it provides important insights into the performance of geophysical methods in agricultural applications. I recommend a minor revision to further refine the clarity and presentation of the findings. I appreciate the authors for their valuable contribution to setting realistic expectations regarding sensor efficacy. I believe this manuscript is suitable for inclusion in EGU sphere, as it provides important insights into the performance of geophysical methods in agricultural applications. However, I believe that there are some points that can be improved. Therefore, I recommend a major revision.

All the best!

General comments:

1. Please revise the abstract to more clearly reflect the specific objectives, methods and findings of the study.
Thanks for the comment, we rephrased the abstract highlighting the innovative aspects of the work (LL 14-24)
2. Please review and correct the usage of abbreviations throughout the manuscript
We checked and corrected the whole manuscript to be consistent in the use of abbreviations.
3. Please re-check the figures and figure captions.
Thanks for the suggestions. We modified some figures (Fig.1, Fig.2) as already suggested by Reviewer #1 and improved figure captions.

Specific comments:

Comment	Reply
Title – Suggest modifying the title as "Electrical and electromagnetic geophysics for soil compaction assessment"	Thanks for the suggestion, we improved the title to be consistent with the aims and the terminology.
Abstract – Lines 5 – 15: the introduction sentences of the abstract should be specific to the present study	We believe that we have briefly introduced the subject of this study (i.e., soil structure monitoring and specifically soil compaction), in a few lines, and

	placed it in a broader context before describing the highlights of the work. We therefore consider keeping this structure.
Lines 10 – 15 – “agricultural soil”, Please specify the soil – “silt loam”	Corrected, thanks (L 16).
Lines 10-15 – Please refine the objective in the abstract specific to the study	Thanks for the comment, we rephrased the abstract highlighting the innovative aspects of the work (LL 14-24)
Lines 15 – 20 – Please provide an overall methodology statement (one sentence) including the methods of different analysis (correlations, K means clustering etc.)	Added, thanks (LL 16-18).
Lines 20 – 25 – Please include the overall finding of this study in the abstract.	Added, thanks (LL 19-27).
Lines 30 – 35 – “Soil properties, agricultural processes, and moisture dynamics.” Please include state variables as well to represent soil water content and soil salinity.	Added, thanks (L 32).
Lines 45 – 50 – “EC” please define the abbreviation in the first place	Corrected, thanks (L 47).
Lines 60 – 65 – “Soil electrical conductivity (EC)” should be soil EC	Corrected, thanks (L 61).
Lines 60 – 65 – Soil EC is also used to estimate soil water content and soil salinity – please include that as well	Added, thanks (LL 61-62).
Lines 75 – 80 – “with increased electrical conductivity” should be “with increased EC”	Corrected, thanks (L 79).
Lines 80 -85 – “for the assessment of soil surface compaction.” – readers would like to know the depth, if possible, please provide the depth range within brackets.	Added, thanks (L 83).
Lines 80 85 – “The survey was conducted both at the field scale, covering an area of 1.5 hectares, and in detail on individual targeted transects”. Please rephrase the sentence for clarity.	The sentence has been rephrased, thanks (LL 83-84).
Lines 90 -95 – “Results, validated with direct information, show the pros & cons of both FDEM and ERT techniques and how differences in their spatial resolution heavily influence their ability to characterize compacted areas with good confidence.” This content does not fit here. Please remove or modify.	The sentence has been modified (LL 90-91).
Figure 1 – Fig. 1b – “FDR”? Is this “TDR”?	Exactly, corrected (Fig. 1b).

Fig. 1c - It is difficult to understand where this matches with Figure 1. B, please modify the figures and clearly show the figure c in figure b.	We improved Fig. 1 and added further information in the description (LL 100-103)
Heading 2.2 – Please remove the abbreviation – already introduced	Removed, thanks (L 115).
Lines 115 – 120 – “Electro-Magnetic” should be electromagnetic	Corrected, thanks (LL 115-120).
Lines 120 – 125 – “electrical conductivity (EC)” already introduced – please use EC	Corrected, thanks (L 120).
Lines 120 – 125 – “can be probed” please replace as “can be obtained”	Corrected, thanks (L 124).
Line 130 – “4m” should be “4 m”; please keep a space between the number and the unit.	Corrected consistently in the whole manuscript, thanks.
Heading – 2.3 – Please remove the abbreviation	Removed (L 150).
Lines 160 -165 – “first few centimetres of the soil”, please provide a number, how many centimetres.	Information provided (L 165).
Lines 165 – 170 – “Q=2%” Please provide what is “Q”?	Explanation was given a few words earlier (LL 169-170), it is basically the minimum percentage difference threshold set by the operator to save the quadrupole during the stacking process.
Lines 175 – 180 – “Both geo-electric and electromagnetic,” Please use a consistency term to represent ERT. For example, “Both electrical and electromagnetic”	Corrected, thanks (L 177).
Lines 175 – 180 – In the Fig. 1C it is difficult to understand the discussed lines in this sentence “an initial areal FDEM acquisition was followed by 3 additional lines to intercept seeder heavy passages, and 8 detailed transects, both FDEM and ERT (4 along and 4 across normal tractor tramlines. Please modify the Fig. 1C for clarity.	We modified Fig. 1C as suggested by the other Reviewers and specified in the caption that it refers to the initial areal FDEM survey (L 228). As described, in Fig. 1 we can understand the arrangement of the 3 lines intercepting the seeders passage (the results of which are in Fig. 6), and that of the 8 detailed transects (the results of which are in Fig. 7 and Fig. 8).
Line 185 – “dij” should be “dih”?	Exactly, corrected (L 186).
Lines 185 – 190 – “For each area, one geophysical detailed survey (i.e. ERT + FDEM) was performed.” Please rewrite this sentence for clarity. One geophysical detailed survey or both surveys (ERT + FDEM)?	Corrected, thanks (LL 190-191).

Lines 190 – 195 – “throughout the 0–80 cm soil layer.” Please provide the soil sampling depth intervals. Same in “0.70 m” as well.	Corrected, thanks (LL 195-196).
Lines 195 – 200 – “bulk density” should be “BD”, “4m” should be “4 m”	Both corrected, thanks (LL 199-201).
Lines 200 – 205 – “22cm” should be “22 cm”	Corrected, thanks (L 204).
Heading 3.1 – What is mean by “First” here	Substituted with “Areal” to be clearer (L 215).
Lines 215 – 220 – Please introduce the abbreviations (VCP0.32 and HCP1.18) in the first use.	Already introduced in LL 128-129
Lines 220 – 225 and Figure 2a - I'm just wondering why the legend of Fig 2a ranges only to 30 mS/m and not 40 mS/m? In the content authors mentioned “In the bottom layer (HCP1.18), a maximum increase of approximately 15 mS m-1 is observed, with values exceeding 40 mS m-1 in the most conductive zones,”	We modified the colorscale range of Fig. 2 to be consistent with the other figures, as suggested.
Figure 2.a – Please rearrange the overlapped labels	Figure 2 has been modified and improved
Figure 3 – “a” should be removed. The sample symbol in the legend is different from the map.	Removed and improved caption, thanks (L 231). The “sample” symbol is a red dot, in each cluster 5 neighboring samples were collected (as shown in Fig. 1C) so it is just the effect of multiple close dots.
Lines 230 – 235 – “FDR” should be “TDR”	Corrected, thanks (L 235).
Figure 4 – VWC please introduce the abbreviation first.	Already introduced in L 198.
Lines 240 – 245, and 255 – 260 – Why the unit for water content in kg/kg. Please correct the unit of volumetric water content to m ³ /m ³ , as similar to the figure 5.	Thanks for the correction, fixed (LL 247-248)
Lines 320 -325 – Please remove the already introduced abbreviations.	Removed to be consistent in the whole paragraph, thanks.
Lines 340 -345 – “In both areal and detailed surveys, the highly compacted portions of the soil are characterized by high electrical conductivity anomalies relative to the context.” What would be the reason for this observation, please discuss.	We previously introduced the relationship between water content and EC, with also positive site-specific correlations (LL 341-347). We then expanded the text, discussing the reasons for our observation (LL 346-347).
Lines 375 – 380 – That would be nice if the authors could mention the most important challenges here. “Despite its potential and widespread application, the use of	Thanks for the suggestion, we improved the text (LL 384-385).

electromagnetic geophysics in agriculture presents challenges such as.....”	
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