# Phenotyping root function in wheat

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# Aims

1. To develop a method to give a rapid estimate for the soil water profile and use it to phenotype root function

2. To compare data from laboratory root phenotyping methods with data from field phenotyping mehtods.

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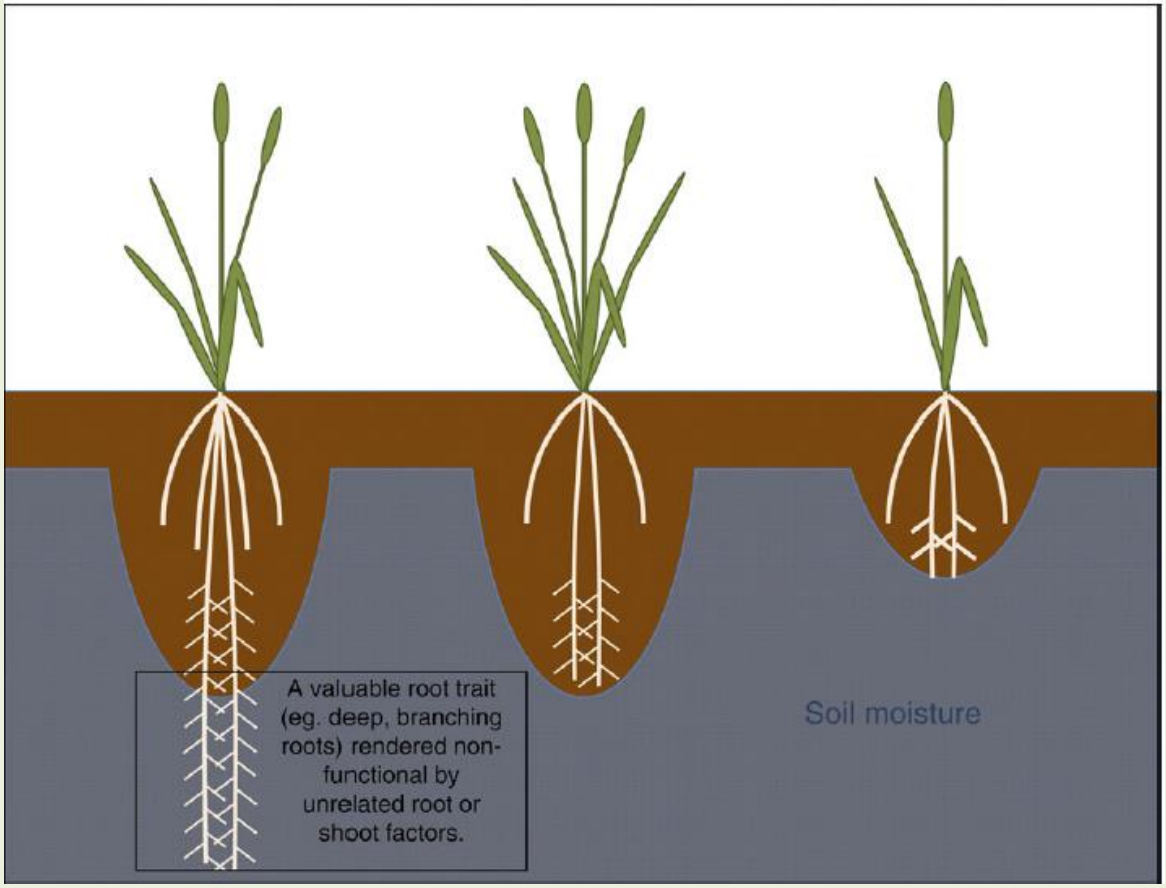
REVIEW PAPER

# Traits and selection strategies to improve root systems and water uptake in water-limited wheat crops

A.P. Wasson[1], R.A. Richards[1], R. Chatrath[2], S.C. Misra[3], S.V. Sai Prasad, G.J. Rebetzke[1], J.A. Kirkegaard[1], J. Christopher[5] and M. Watt[1,*]




Rate of surface drying

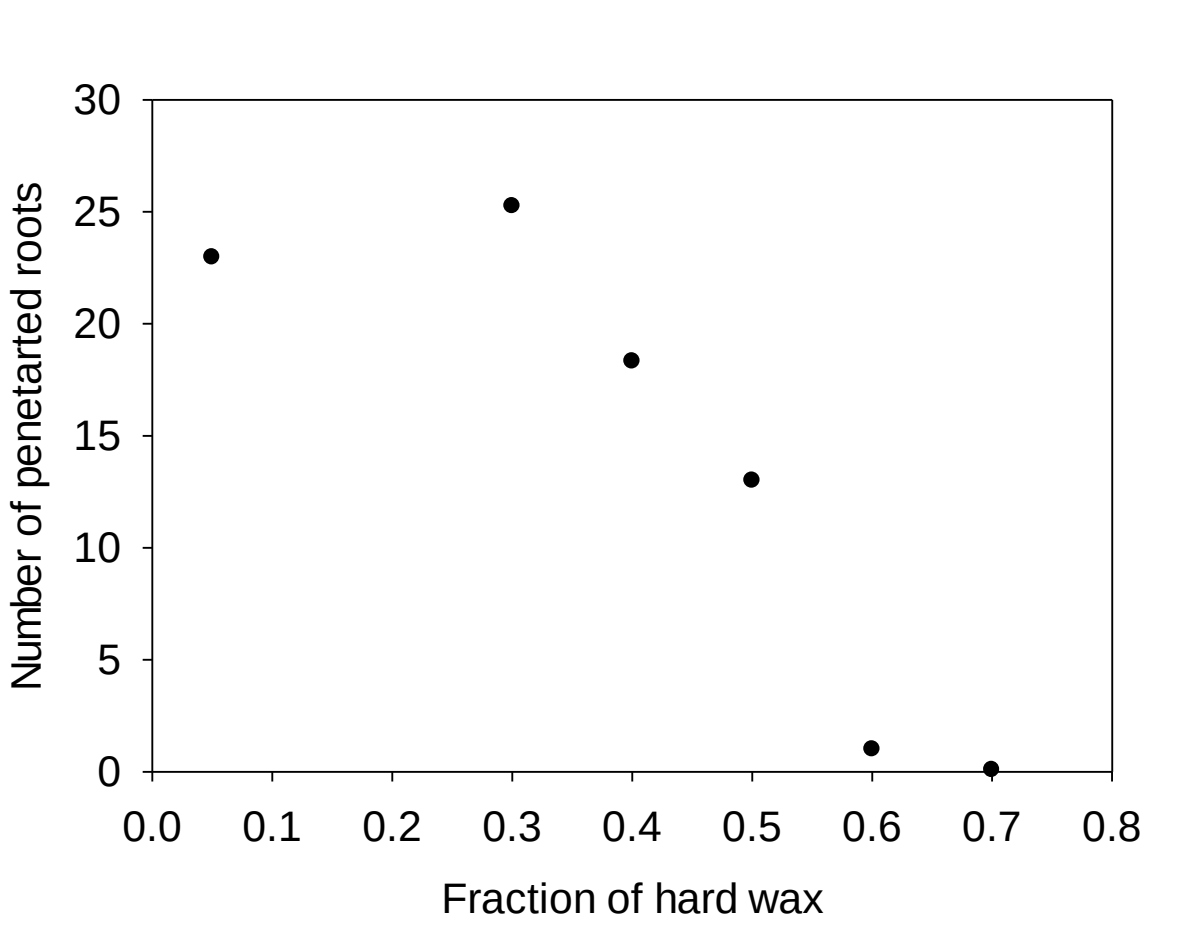
Depth of soil drying detected

# Agreed list

| Entry | Group | Genotype | In common with CIRC photosynthesis project | In common with WGIN2 Drought tolerance UNott project | Kaspar SNP Haplotype available? | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | Woburn set | Battalion | a | | a | | | |
| 2 | Woburn set | Consort | a | | | | | |
| 3 | Woburn set | Gladiator | a | | | | | |
| 4 | Woburn set | Istabraq | a | a | | | | |
| 5 | Woburn set | Robigus | a | | a | | | |
| 6 | Woburn set | Xi19 | a | a | a | | | |
| | | | | | | | | |
| 7 | Rht | Mercia Rhtc | | | | Rht b1a | tall | |
| 8 | Rht | Paragon Rht1 | | | | Rht b1b | semi-dwarf | |
| 9 | Rht | Mercia Rht3 | | | | Rht b1c | dwarf | |
| | | | | | | | | |
| 10 | WUE | Deben | a | | | | | |
| 11 | WUE | Dover | a | | | | | |
| 12 | WUE | Gatsby | a | | a | | | |
| 13 | WUE | Rialto | a | a | a | | | |
| 14 | WUE | Spark | a | | a | | | |
| 15 | WUE | Hobbit | a | a | a | | | |
| | | | | | | | | |
| 16 | AxC | Avalon | a | a | | | | |
| 17 | AxC | Cadenza | a | a | | | | |
| | | | | | | | | |
| 18 | New | Paragon | a | a | a | | | |
| 19 | New | Santiago | | | | | | |
| 20 | New | Grafton | | | | | | |
| 21 | New | Kielder | | | | | | |
| 22 | New | JB Diego | | | | | | |
| 23 | New | Hystar hybrid | | | | | | |
| | | | | | | | | |
| 24 | FALLOW | | | | | | | |

# Wax layer experiment

# Optimizing the strength of the wax layer

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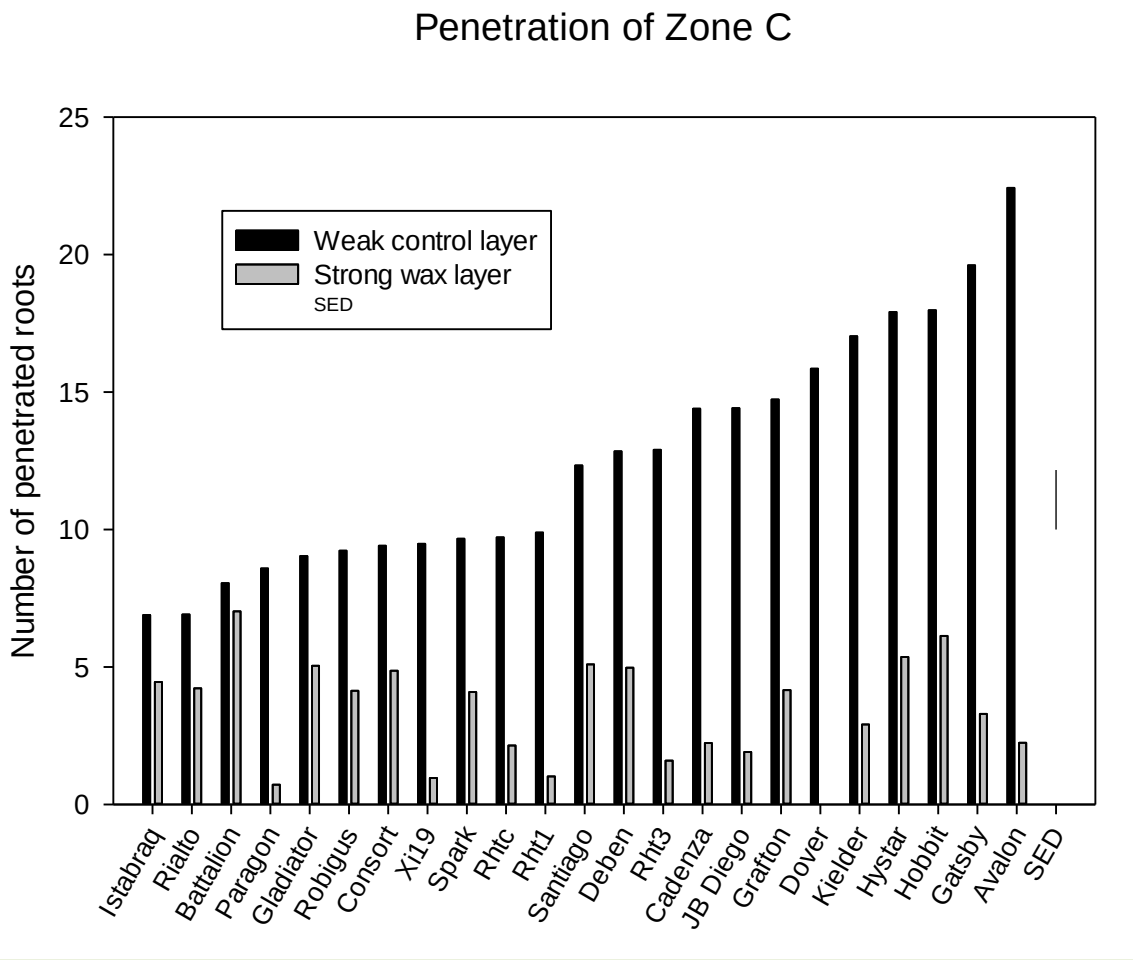
# Wax layer screening of UK wheat lines

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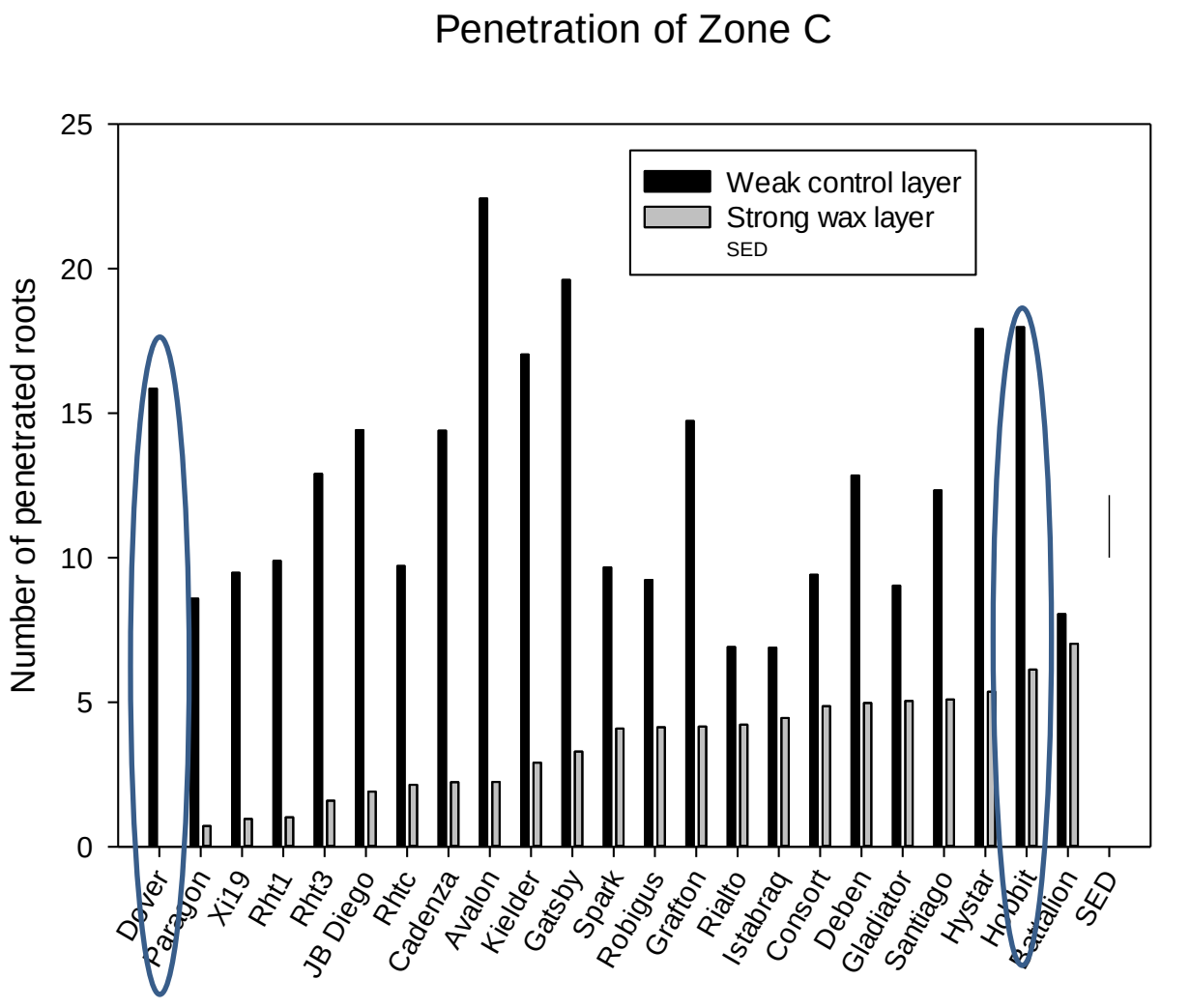


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# Field experiments

Warren field

Butt close

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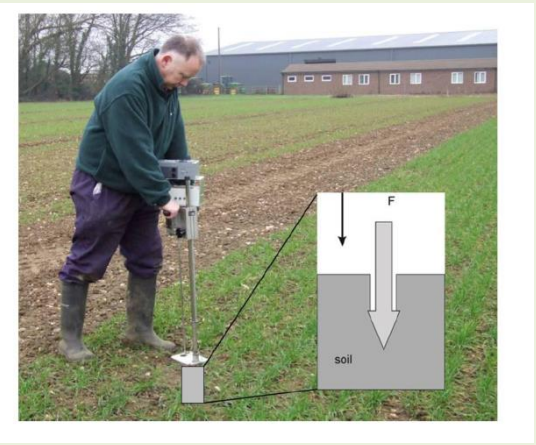
# Methods to be explored

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# Electrical resistivity geophysics

# Electrical conductivity surveys April-August 2013

Butt Close

Warren Field

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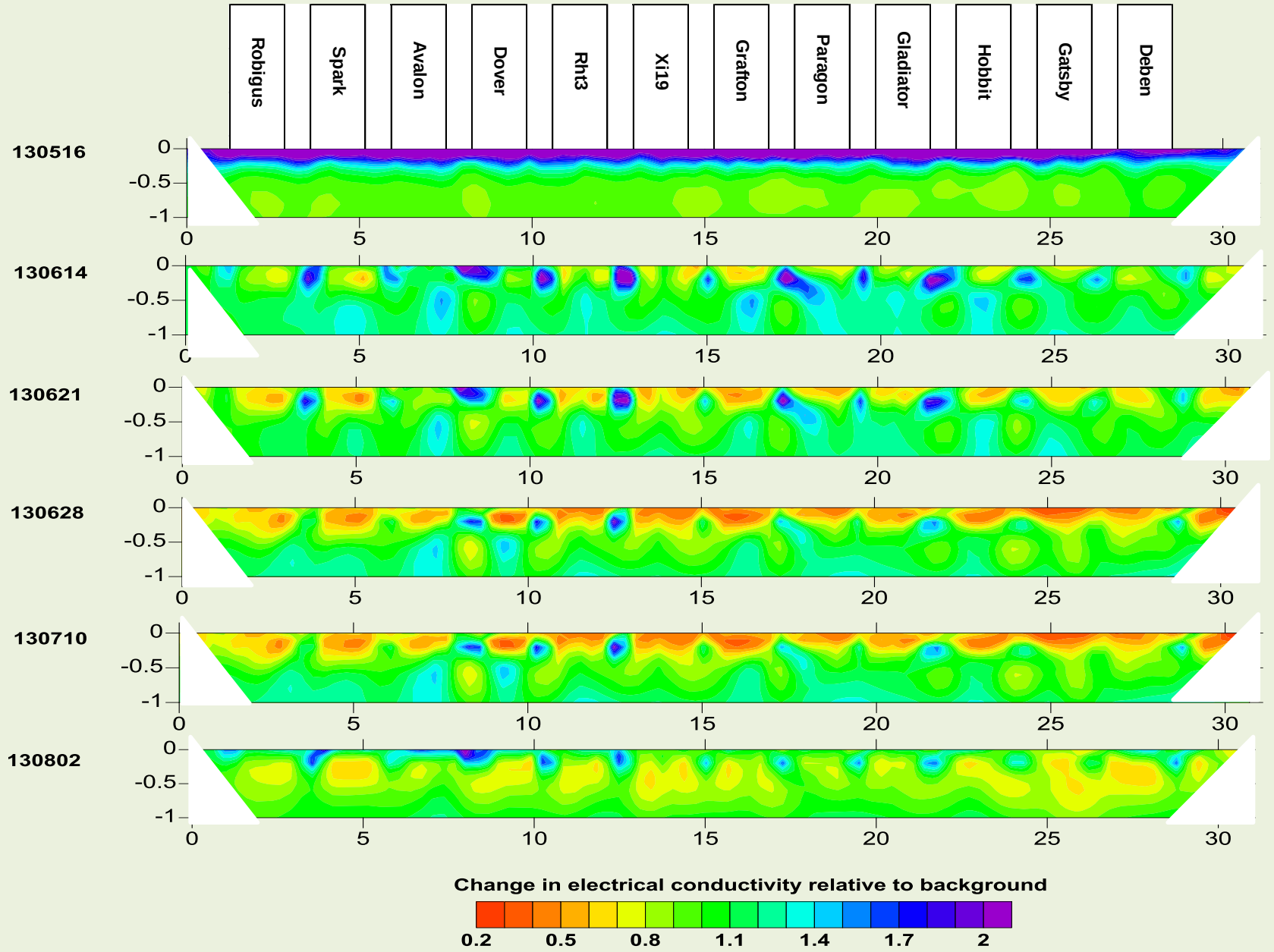
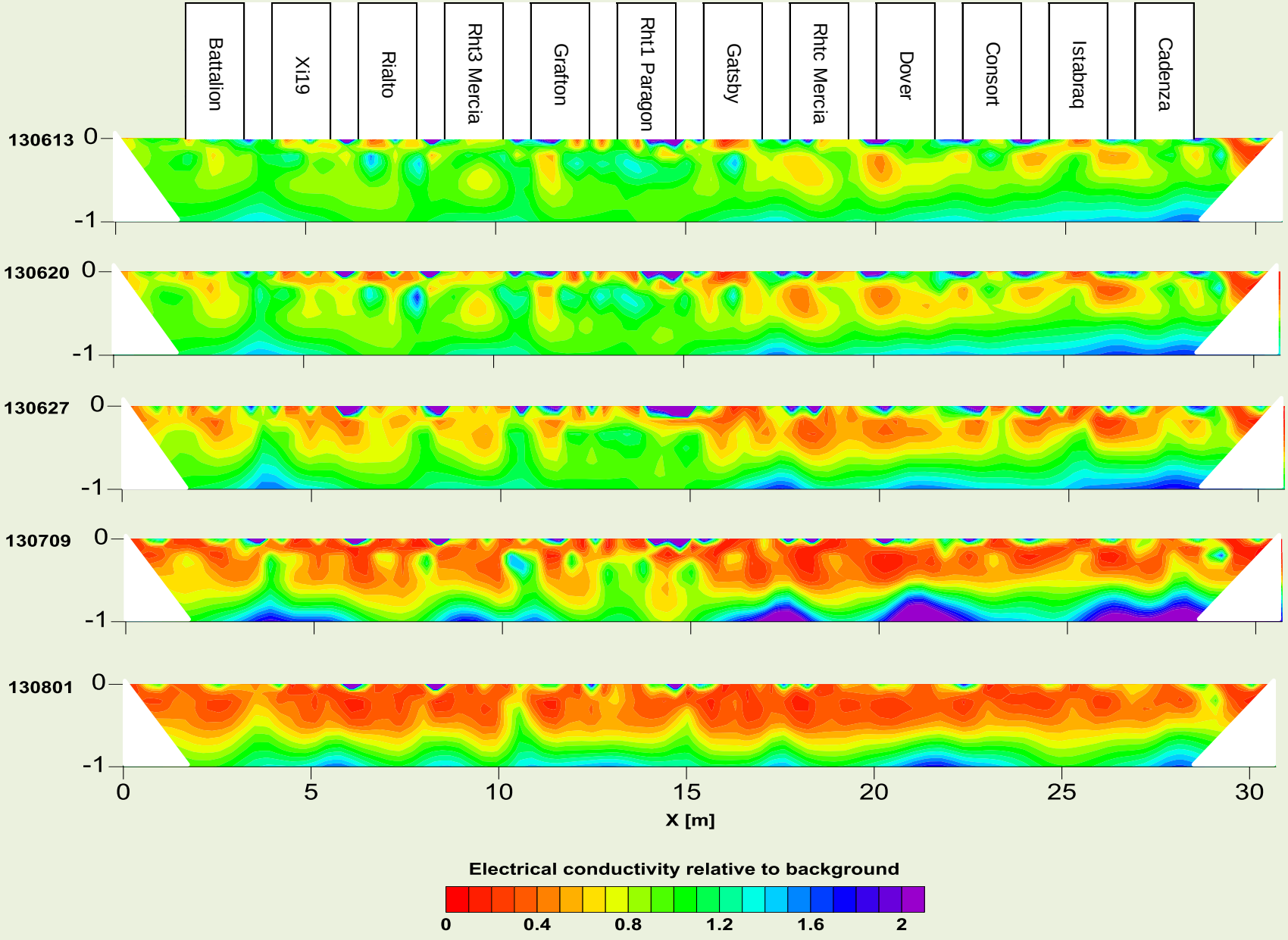
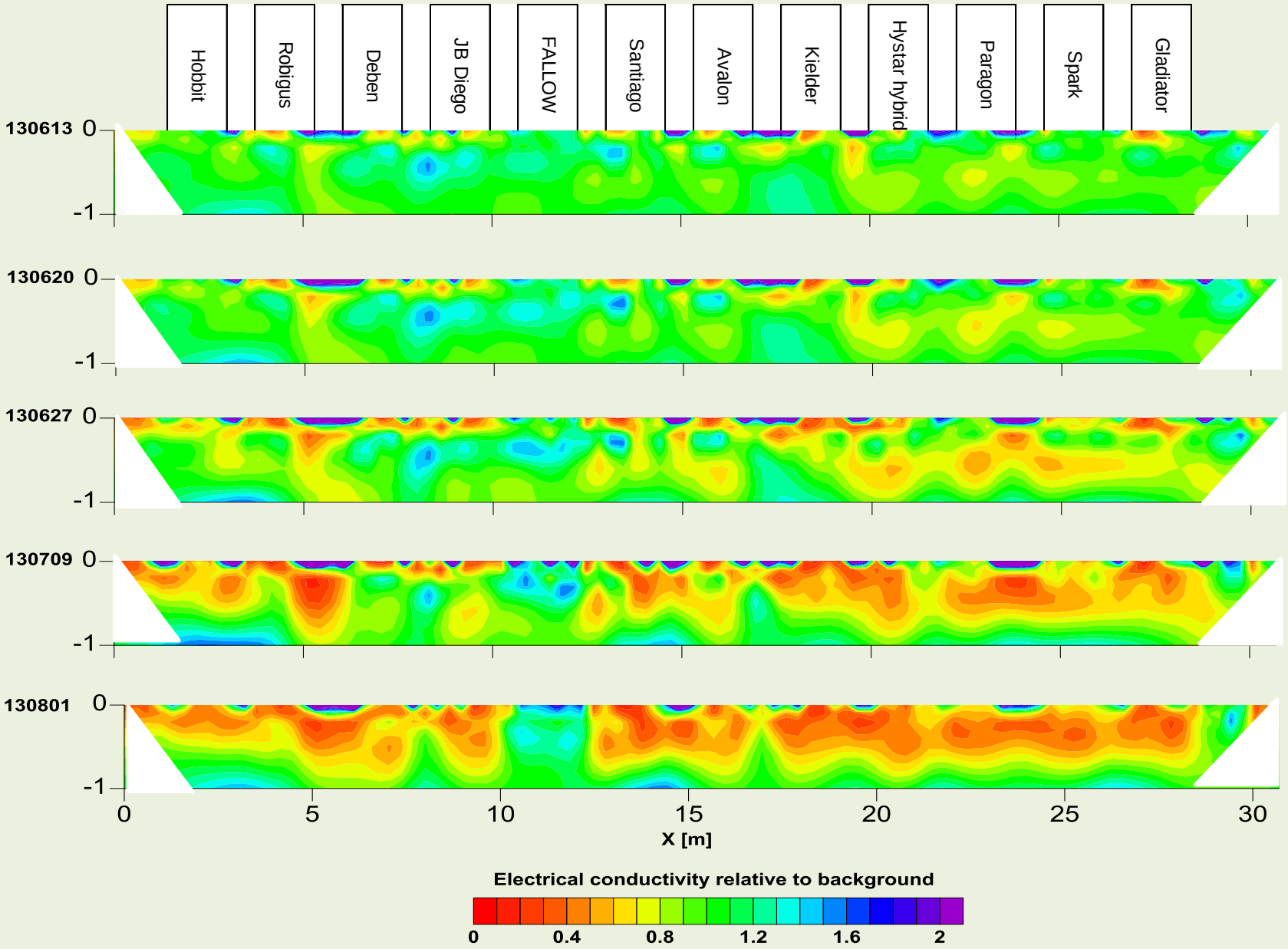
# Butt Close array D – change in electrical conductivity relative to April 2013

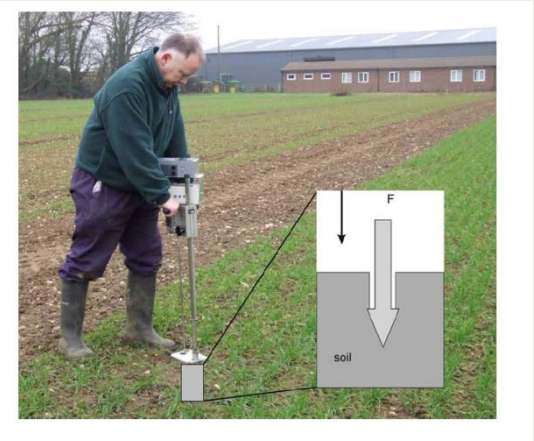


# Warren Field array A – change in electrical conductivity relative to March 2013

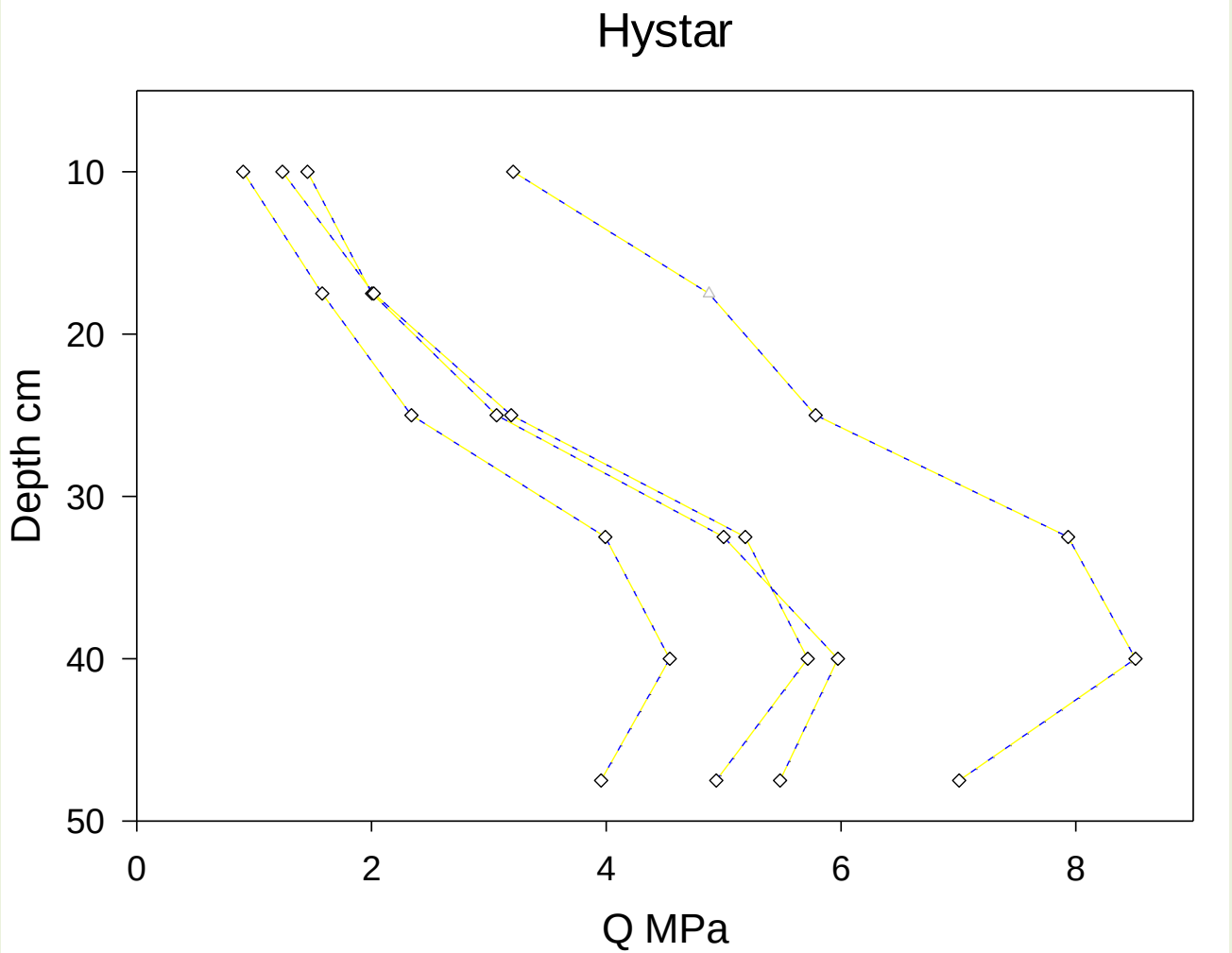


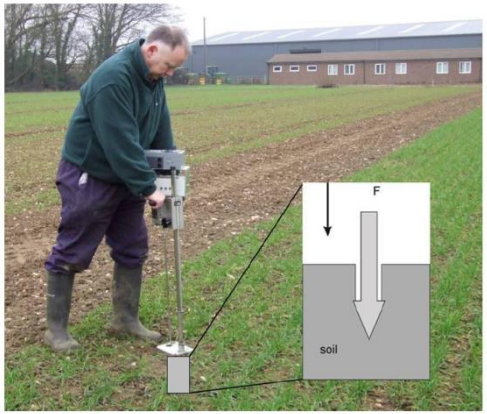
# Warren Field array B – change in electrical conductivity relative to March 2013



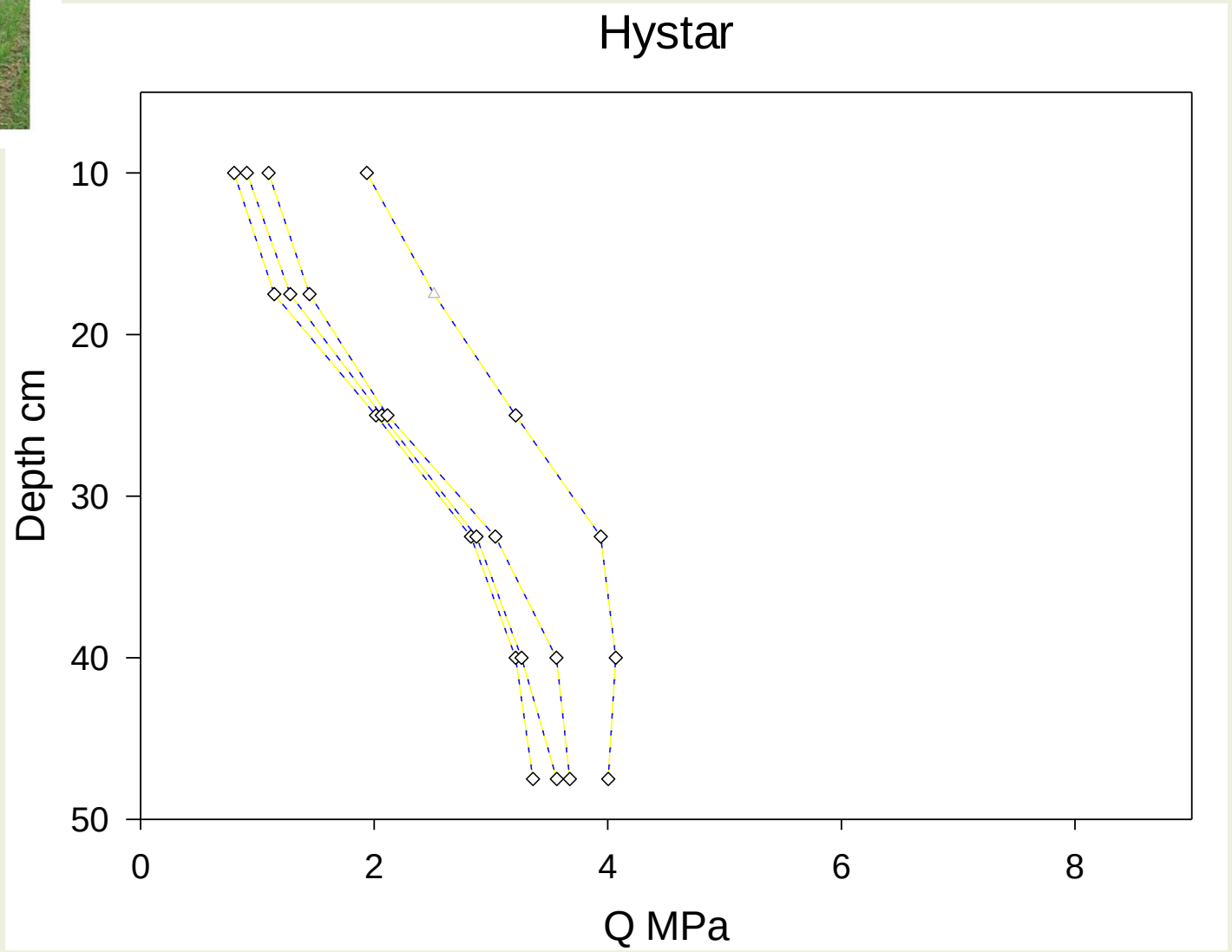



# Butt Close

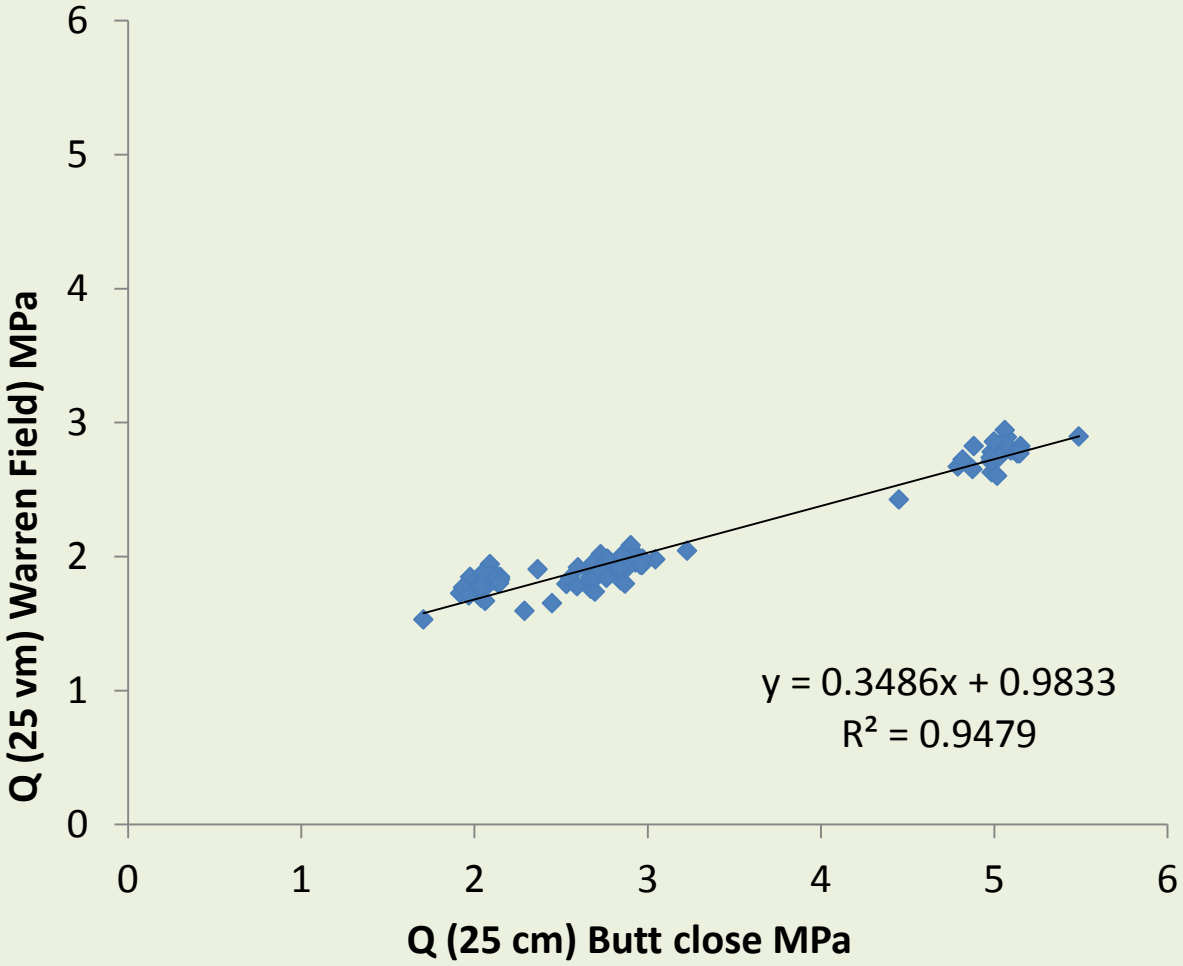




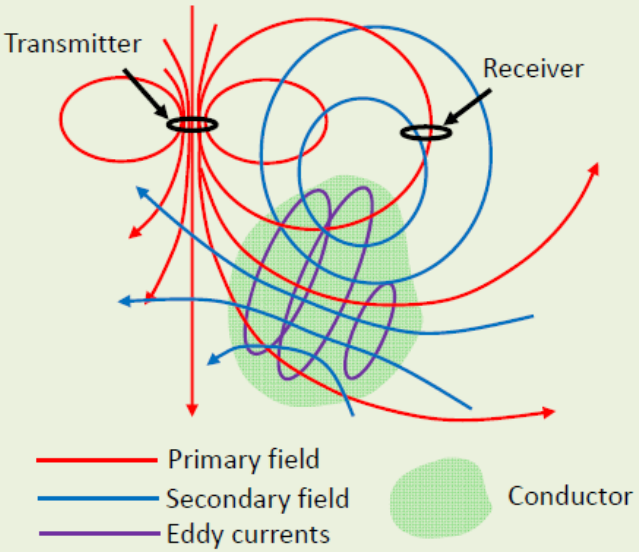

# Warren Field

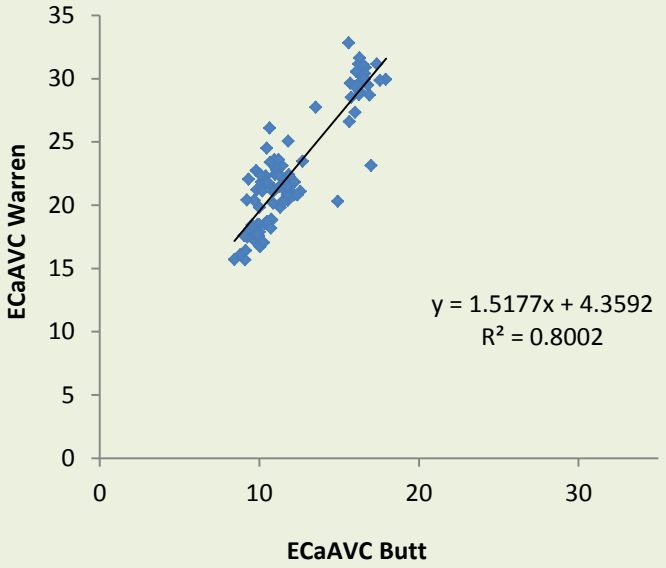


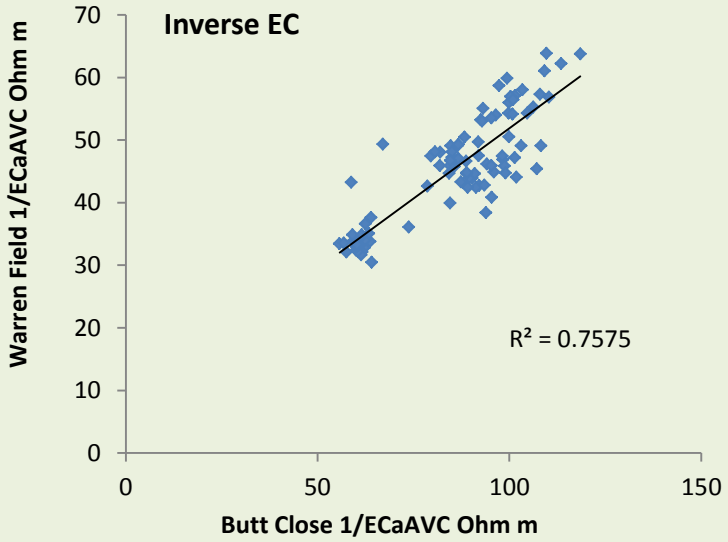
# Comparison across sites



# EMI


Transmitter
Receiver
Primary field
Secondary field
Eddy currents
Conductor


ECaAVC Warren
ECaAVC Butt
y = 1.5177x + 4.3592
R² = 0.8002
0
5
10
15
20
25
30
35
0
10
20
30


Inverse EC
Warren Field 1/ECaAVC Ohm m
Butt Close 1/ECaAVC Ohm m
R² = 0.7575
0
10
20
30
40
50
60
70
0
50
100
150

# Comparison of ranking between Q25 and inverse conductivity at Warren field

| wheat | iECaAVC | | wheat | Warren Q25 |
|---|---|---|---|---|
| **FALLOW** | **0.043234** | | **FALLOW** | **2.424249** |
| **Avalon** | **0.047416** | | **Avalon** | **2.601769** |
| **Deben** | **0.049044** | | **Deben** | **2.627641** |
| Cadenza | 0.053505 | | Hobbit | 2.650384 |
| Spark | 0.053996 | | Battalion | 2.669956 |
| Istabraq | 0.054113 | | Paragon | 2.709316 |
| Gladiator | 0.054259 | | Spark | 2.7225 |
| Dover | 0.054259 | | Gladiator | 2.735716 |
| Consort | 0.055066 | | Santiago | 2.735716 |
| Rht3 | 0.055249 | | Grafton | 2.735716 |
| Hobbit | 0.055991 | | Cadenza | 2.742336 |
| | | | | |
| Grafton | 0.056433 | | Rhtc Mercia | 2.768896 |
| Battalion | 0.056786 | | Kielder | 2.768896 |
| Gatsby | 0.05685 | | Rht1 | 2.775556 |
| Paragon | 0.056948 | | Rht3 | 2.778889 |
| Rialto | 0.057078 | | Istabraq | 2.7889 |
| Rht1 | 0.057307 | | Robigus | 2.798929 |
| | | | | |
| Rhtc Mercia | 0.058005 | | Consort | 2.8224 |
| Kielder | 0.058685 | | Xi19 | 2.8224 |
| Santiago | 0.059844 | | Rialto | 2.839225 |
| Xi19 | 0.061013 | | JB Diego | 2.8561 |
| JB Diego | 0.062228 | | Dover | 2.89 |
| | | | | |
| **Hystar hybrid** | **0.063735** | | **Hystar hybrid** | **2.893401** |
| Robigus | 0.063857 | | Gatsby | 2.941225 |

| Spearman's rank correlation coefficient | Fallow excluded |
|---|---|
| | |
| Correlation 0.477, adjusted for ties 0.476 | |
| Sample size 23 | |
| Exact probability 0.005 (approximate as ties ignored in calculation) | |
| t approximation 2.48 on 21 d.f., probability 0.022 | |

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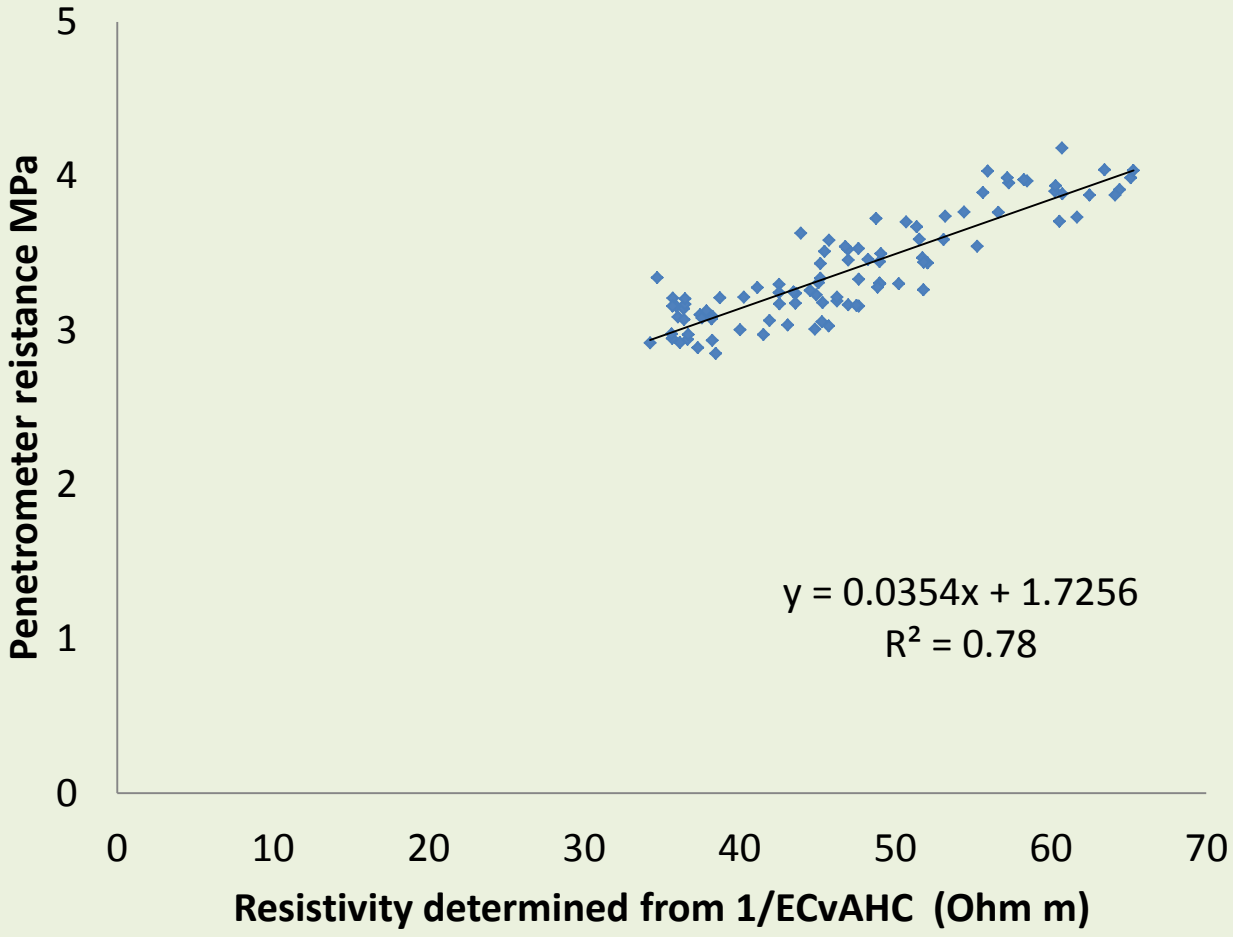
# Comparison between penetrometer and EMI

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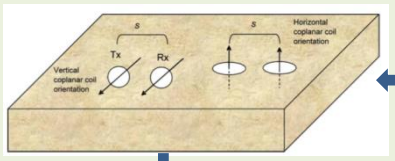
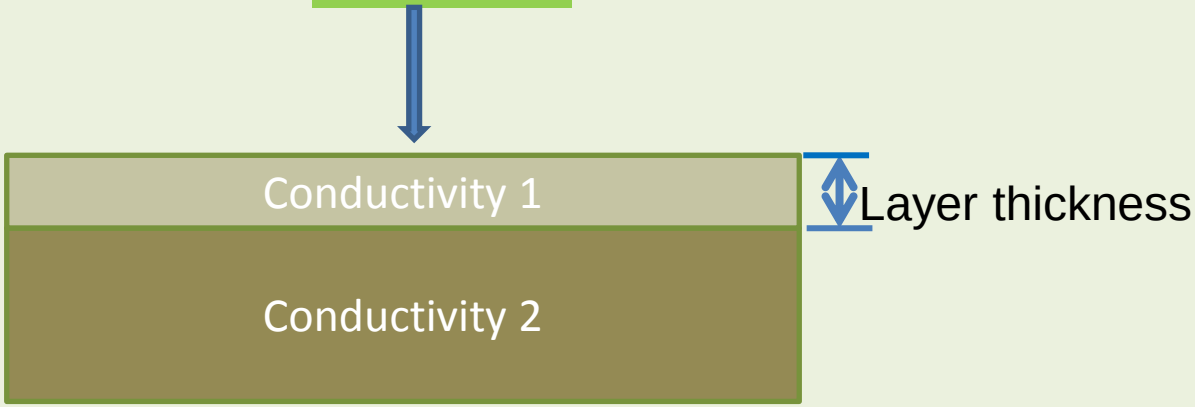
# Electromagnetic Induction (EMI) – *the next steps*




Six conductivities

Inversion programme



# Summary

1. Optimised protocol for the use of EMI as a tool for phenotyping roots under field conditions.

2. The penetrometer and EMI can both be used to assess soil drying by roots. They both have the advantage of high replication compered to installed soil moisture probes.

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