Soil moisture & cultivations

Understanding soil moisture is important to improve the effectiveness of cultivations. Wet soil is prone to compaction, but soil moisture is important to soil cohesion, maintaining channel shape at depth when mole ploughing. To reduce damage to soil structure during field operations, soil should be dry on the surface. Dry soil is also more friable, breaking down easily to produce cracking at the required depth during subsoiling.

We have been using soil moisture sensors to help understand how the data generated might inform decisions about timing of cultivations at different depths in the soil profile.

Soil moisture sensors

Soil moisture sensors have been placed in a field at 3 different locations, measuring soil moisture levels to a depth of 40 cm. Data from the moisture sensors show relative moisture, which is useful to compare between depths and over time within one field, but cannot give absolute values for the water content of the soil. The soil moisture meters give instant readings from the field.

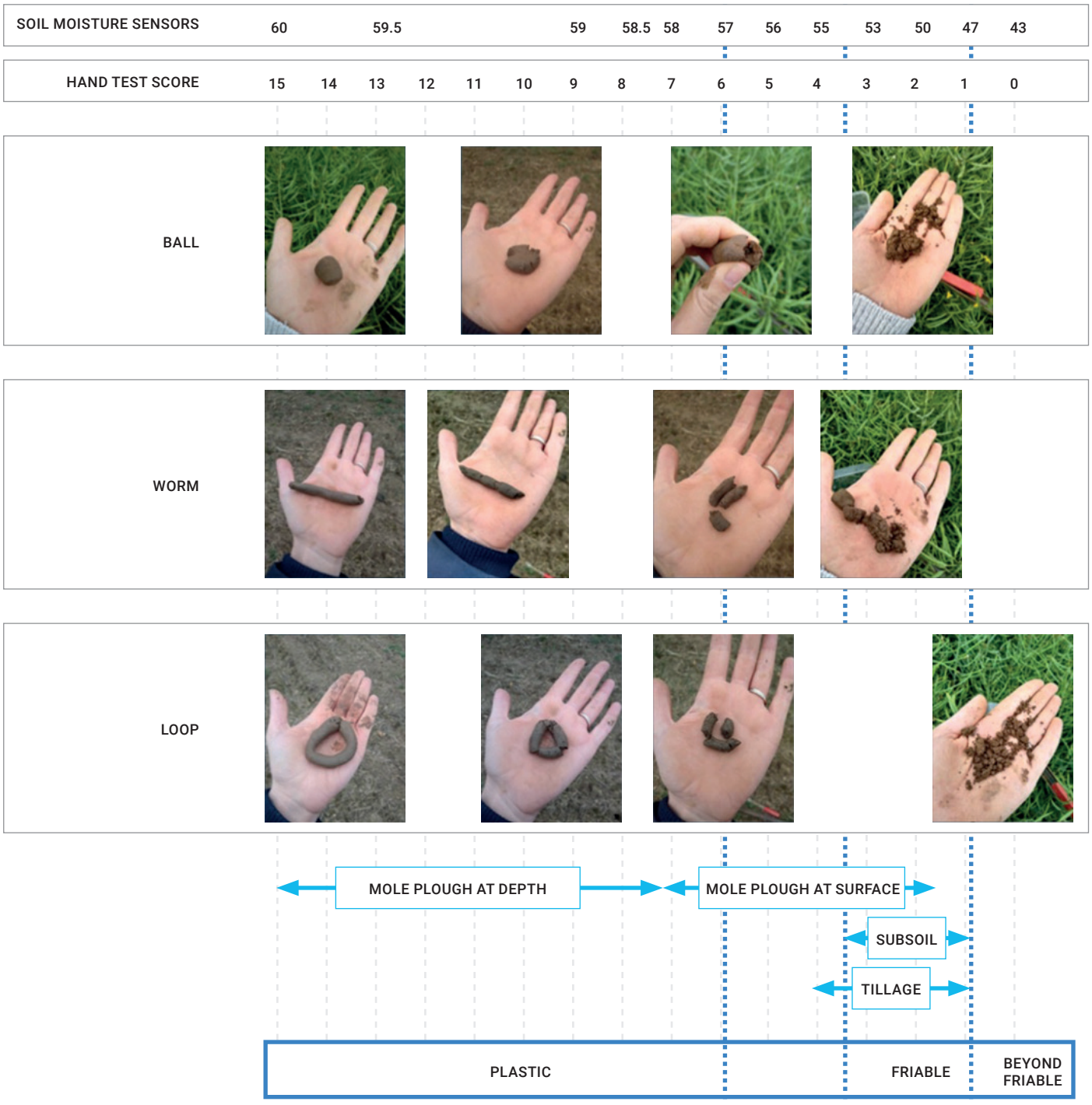
To use these data most effectively for decision making we are using comparisons of the relative soil moisture data from the sensors and traditional soil tests of friability, plasticity and cohesiveness measured by hand.

SOIL MOISTURE SENSOR IN THE FIELD AT THE ALLERTON PROJECT.

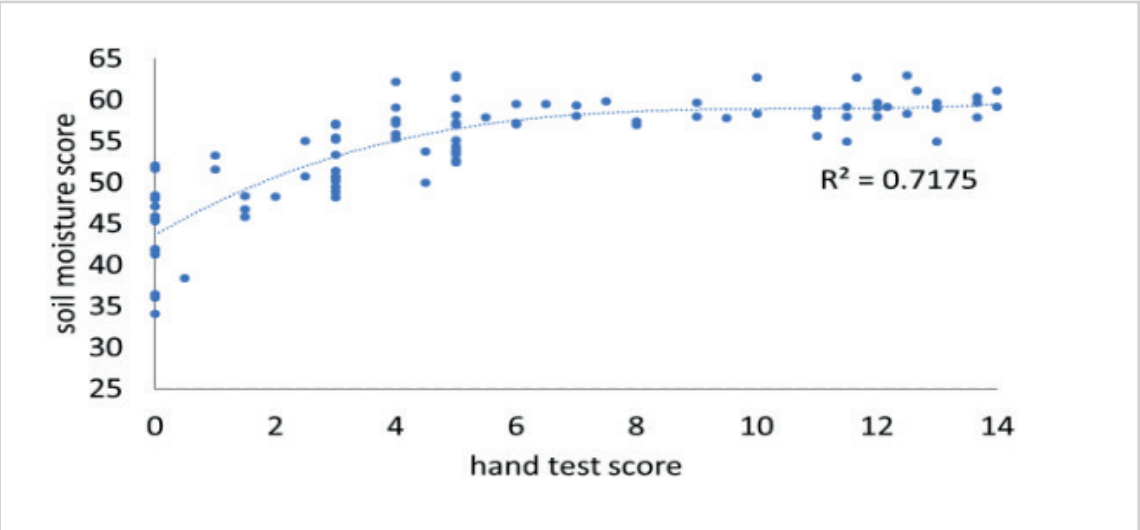
Soil ball & worm test

If a soil can be easily moulded into a ball by hand then it is a plastic soil. These soils are highly sensitive to compaction. As a soil dries out it will be harder to mould into a ball and if it quickly crumbles apart, the soil is in a friable state and more tolerant of traffic and suitable for cultivations such as subsoiling.

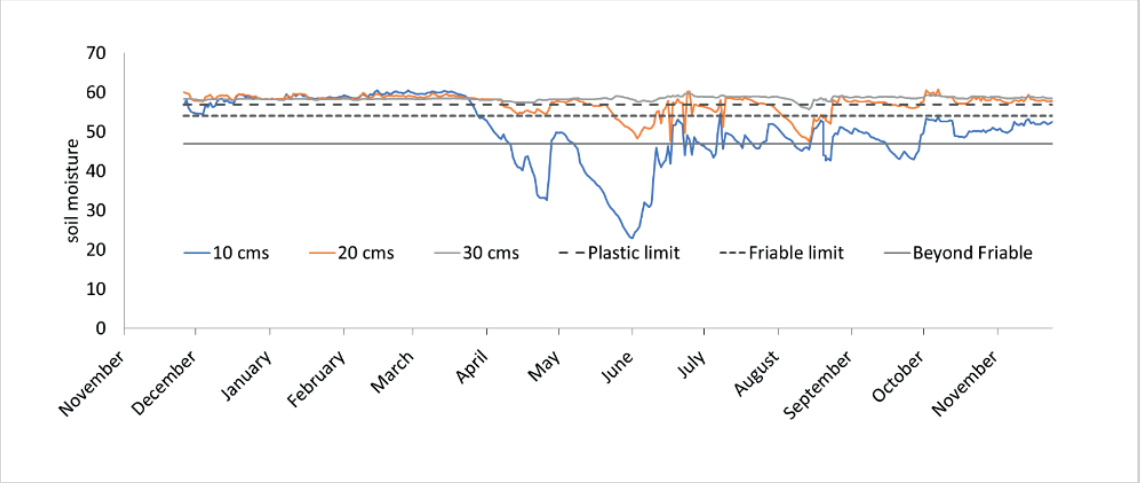
A further test is to form the soil into a worm, 4 mm wide and 50 mm long. If the worm forms easily then the soil is moist enough to be in a plastic state, and is susceptible to compaction by traffic. Bending the worm into a loop can show how cohesive the soil is. If no cracks form when the soil is being bent, it is highly cohesive. When moisture levels are high, soils are more plastic and cohesive, and more sensitive to compaction. However, at depth, this can be useful for mole ploughing. The ball, worm and loop test were all given a score (1-5) and these were added together to give a total score out of 15 for the hand test.



A good relationship was found between the soil moisture sensors and the hand soil test, which means we can identify which soil moisture scores are related to changes in soil plasticity and cohesion. The sensitive range of soil moisture measured by the sensors was 43-58 SFU (Scaled Frequency Units). This is the range in which the soil goes from friable to plastic. Using the hand soil test we can tell that anything scoring below approximately 54 SFU on the soil moisture meter is friable and suitable for subsoiling. Anything scoring above approximately 57 SFU would easily form a ball or worm, showing that it has enough plasticity to hold shape when mole ploughing. A score lower than around 43 SFU means the soil was very dry and could be described as 'beyond friable'. In this state the soil is too dry for clods to break down, so cultivation would not be effective, but the soil is very resilient to trafficking, so this state can be appropriate for some field operations.



Field conditions



Looking at data from the soil moisture meters, we can see the wet 2019 autumn / winter, which made it difficult to cultivate or drill winter crops. The top layer of the soil started to dry out in April, but with enough moisture at depth to keep the soil plastic, showing a soil condition suitable for mole ploughing. As the soil at 20 cm depth starts to dry out in April and later in June, the soil is friable enough for cultivations such as subsoiling. This demonstrates how the soil moisture meters can be used the help understand the suitability of the soil for cultivation. However with a difficult year like 2019 / 2020, it also highlights periods in which soil is not in a suitable state to cultivate.

This work was funded by the Environment Agency and carried out in collaboration with Agrii. We are grateful to Philip Wright (Wright Resolutions Ltd) and Professor Jane Rickson (Cranfield University) for improvements to an earlier draft.