Precision Agriculture – A key to Climate Change Resilience in Farming

UROS Funded

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Global temperature has increased by 1.17 ^{o}C since 1880 ***1***, Global population has grown by over 6 billion people since the 1900's and we face food struggles and starvation on a global scale now and for the foreseeable future.

We get 95% of our food, either directly or indirectly, from soils and with the threat of increasing dry periods in both the global and UK's climates we could see catastrophic losses in both soil health and crop yields. ***2***

Extreme weather events such as the heat wave that began 23rd June 2018 are an example of these events and are happening in the UK because of this climate change. ***3*** This extremely dry weather we experienced offered an opportunity to understand the effect hot summers will have on the moisture content of soils. This could lead to the creation of a predictive model of soil moisture analogous to a weather forecast.

Field Work:

39 soil samples were collected in a grid-like pattern across a Lincolnshire field at Riseholme Farm.

The soil here is a Leptosol soil meaning it's extremely stony and very shallow and tends to have a low moisture content due to their limited depth and texture. ***4***

The moisture content was taken using a TDR 300 and the location with a CS20 GPS.

Fig 1. Use of a CS20 GPS to log points to an accuracy of 0.014M

Fig 2. Preparation of samples for Loss on Ignition and X-Ray Fluorescence

Lab Work:

The samples were taken to a lab under which a range of physical and chemical soil parameters was measured.

This included organic matter content from Loss on Ignition tests.

Tests were repeated several times in order to check the reliability of our results.

Data Analysis:

We assessed the differences between all 4 weeks of moisture data using a T-Test (p-value).

The relationships between 2 parameters were compared by using a Pearson's regression coefficient.

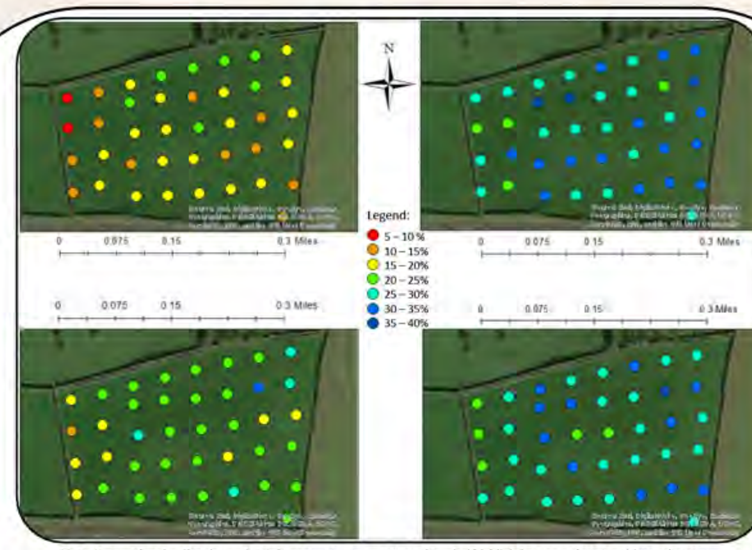


Fig 3. 4 maps showing the change in Moisture content over a 4 week period highlighting areas that stay drier and wetter.

There were significant changes in moisture content between each week over the course of the monitoring. This was largely linked to rainfall and temperature variations.

We found that during drying periods the moisture content strongly correlates with organic matter. However, following weeks of wetting this relationship was far weaker.

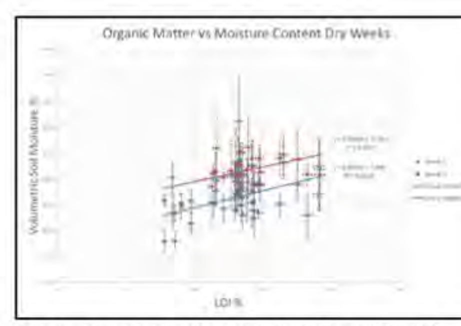


Fig 4. A graph comparing the Moisture Content for Week 1 and 3 (dry weeks) to Organic Matter.

From this, the data implies that organic matter is key for soil moisture retention. Furthermore, soils with high organic matter will be more resistant to droughts.

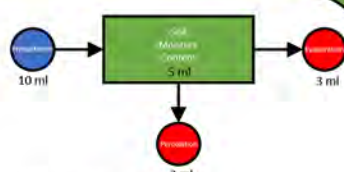
However, following precipitation, we saw the largest change in moisture in the driest regions. Therefore showing no link between moisture and organic matter.

Fig 5. A graph comparing the Moisture Content for week 2 and 4 (wet weeks) to Organic Matter.

We have conducted a detailed examination, across this Lincolnshire field, of how moisture content recovers following a period of drying.

From this study, we have seen that under dry conditions moisture content is greatest in locations where organic matter was highest. Furthermore, we saw that post-rainfall this link was weaker and in the areas lowest in moisture content we saw the highest change in moisture content.

This shows that coupling organic material concentrations to weather forecasting could help in developing predictive models of soil moisture content. Development of precision agriculture from these sort of studies could help tackle the UK's future food production challenges.



$$\Delta MC = fR - fE - fP$$

$$\Delta MC = fR - fE.X - fP.Y$$

$$X \neq OM$$
$$Y \neq GS/OM$$

Fig 6. A basic model looked at as a foundation for understanding MC loss (above) A more complicated model including other factors looked at in this study that could be developed in the future with further research. (below) MC = Moisture Content f = Flux R = Rainfall E = Evaporation P = Percolation .X = Organic Matter .Y = Grainsize or Organic Matter

References:

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3 – Bot, A. and Benites, J., 2005. *The importance of soil organic matter: Key to drought-resistant soil and sustained food production* (No. 80). Food & Agriculture Org

4 - Otto Spaargaren, 2007, Soils of the world and their physical properties, 1867-2, College of Soil Physics