# Best Oral Presentation at Environ 2023

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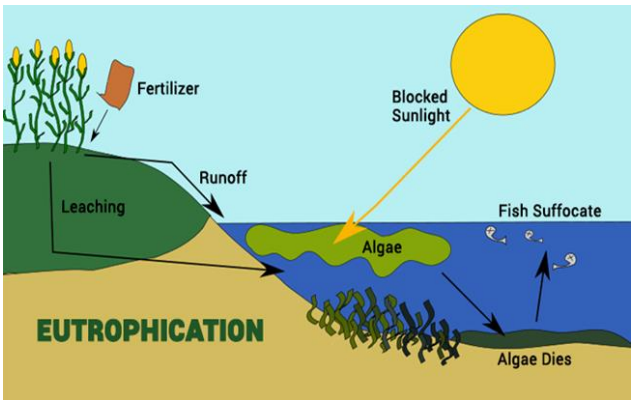
**Development of a low-cost portable system for the simultaneous detection of soil pH and potassium.**

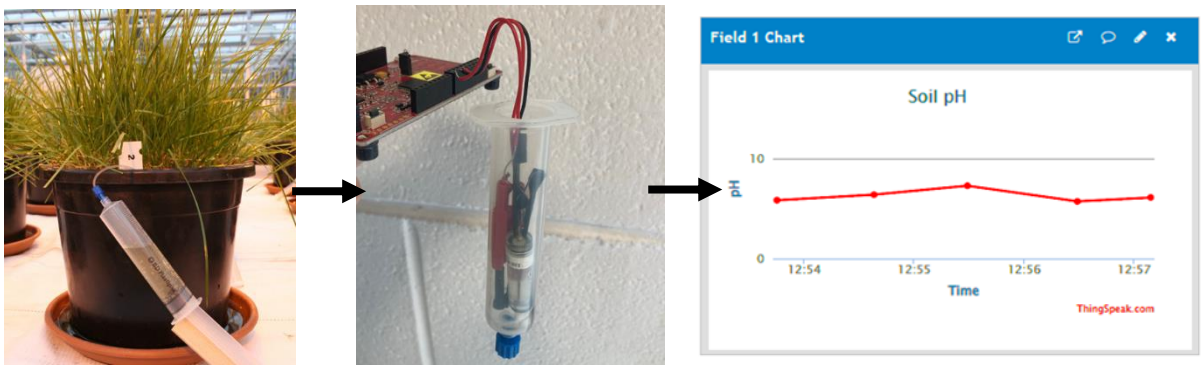
The lack of real time information on nutrient availability in soils has led to excessive use of fertilisers which results in the pollution of groundwaters and waterways. A significant environmental effect from the excessive use of fertilizers is eutrophication which is the over enrichment of water by minerals and nutrients. Soil pH and potassium levels are used to prescribe soil fertilisers as soil pH is a good indicator for the NPK values. A low pH decreases the soils' ability to uptake potassium which increases the need for additional fertilizer or liming for increasing pH. A high potassium soil content affects the way the soils absorb other critical nutrients that are present in fertilizers. High potassium levels also clog clay particle pores which increases the likely hood of runoff and leaching into waterways. Therefore, it is critical to monitor the soils pH and potassium levels as this can improve the uptake of fertilizers by the soil and decrease the excessive use of fertilizers and so reduce eutrophication.




To monitor soils in real time, soil pore water can be used as the sample instead of the solid soil itself. This represents a more accurate in-field test as the soil pore

water represents the immediate source of nutrient uptake by plants and is related to the mobile phase of water in the soil environment and so can predict pollutant fate.

This project uses 3D printed electrodes (3DPEs) as solid-contact ion selective electrodes (SC-ISEs). 3DPEs allow for miniaturization as well as improving the durability of the sensor and the temperature range of its operation. The ISEs convert the activity of $H^+$ and $K^+$ into an electrical potential measured as an output signal. This signal is sent via a USB to a PC using a terminal emulator or wirelessly for remote sensing using Sigfox and ThingSpeak.




The most expensive ISE that is fabricated in the lab costs approximately 5cents and once finished it can be recycled to produce new ISEs. The low cost, portability, ease of use and integration of remote sensing means that mostly everybody can use this device to log samples and so a massive scope of area can be monitored. This can then be used to identify areas that are excessively or inefficiently using fertilizers that are causing eutrophication. Not only is the cost of this device far less than the expensive instruments usually used (Atomic Absorption Spectrometer for $K^+$ and Glass Electrode for $H^+$) it does not require constant calibration or highly skilled operators making it ideal for in-field use. The remote sensing also enables notifications to be sent to the correct personnel if pH or potassium levels are too high or low.

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