

Lab on Land: Lab-on-Chip for In-Field Soil Nutrient Measurement

Reuben Mah Han Yang
Dr. Fernando Alejandro, Asso. Prof.
Richard Doyle, Dr. Marcus Hardie, Liang
Wang, Ying Cheng, Rob Milla, Lawrence
Di Bella, Prof Michael Breadmore

1.

The Issue



- Soil fertility for crop cultivation need expeditious fertiliser interventions
- Current analysis of soil Nitrate is laboratory-based

Reliable	✓	Fast Response	✗
Cost	✗	Real-time results	✗

2.



WE NEED an in-field, hand-held, reliable and low-cost device for real-time measurement with accurate results!!!

Our Solution



- ✓ Hand-held & Compact
- ✓ 3-D printed microfluidic device
- ✓ Multilayered, multichannel, multi data-point
- ✓ Glass-like material & tough
- ✓ Self-calibrating and data noise elimination (using standard addition & varying pathlength depths)



Easy to use

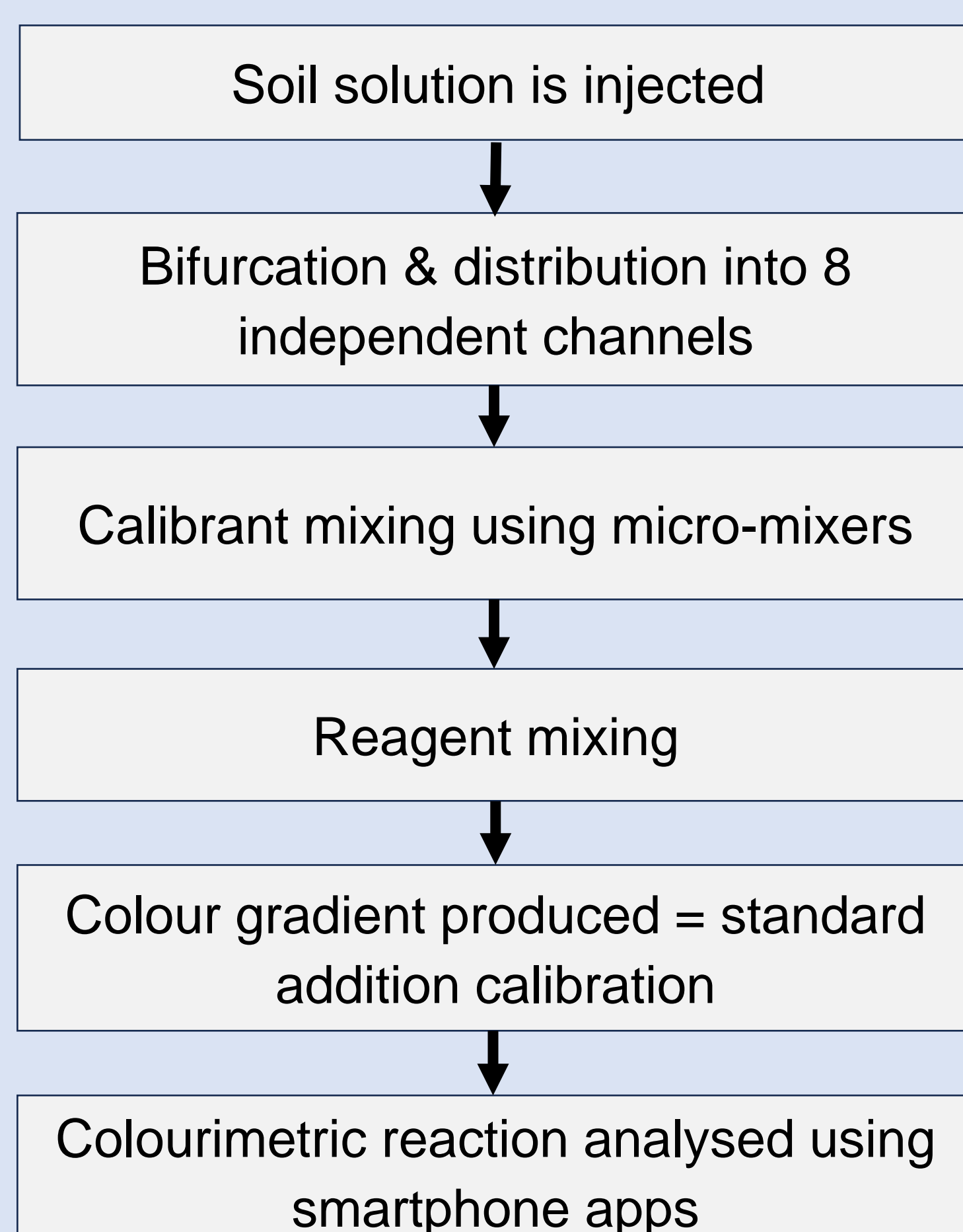
1. Inject sample
2. Close lid
3. Shake
4. Say "cheese"

Our youngest user was only 9 years old!



3.

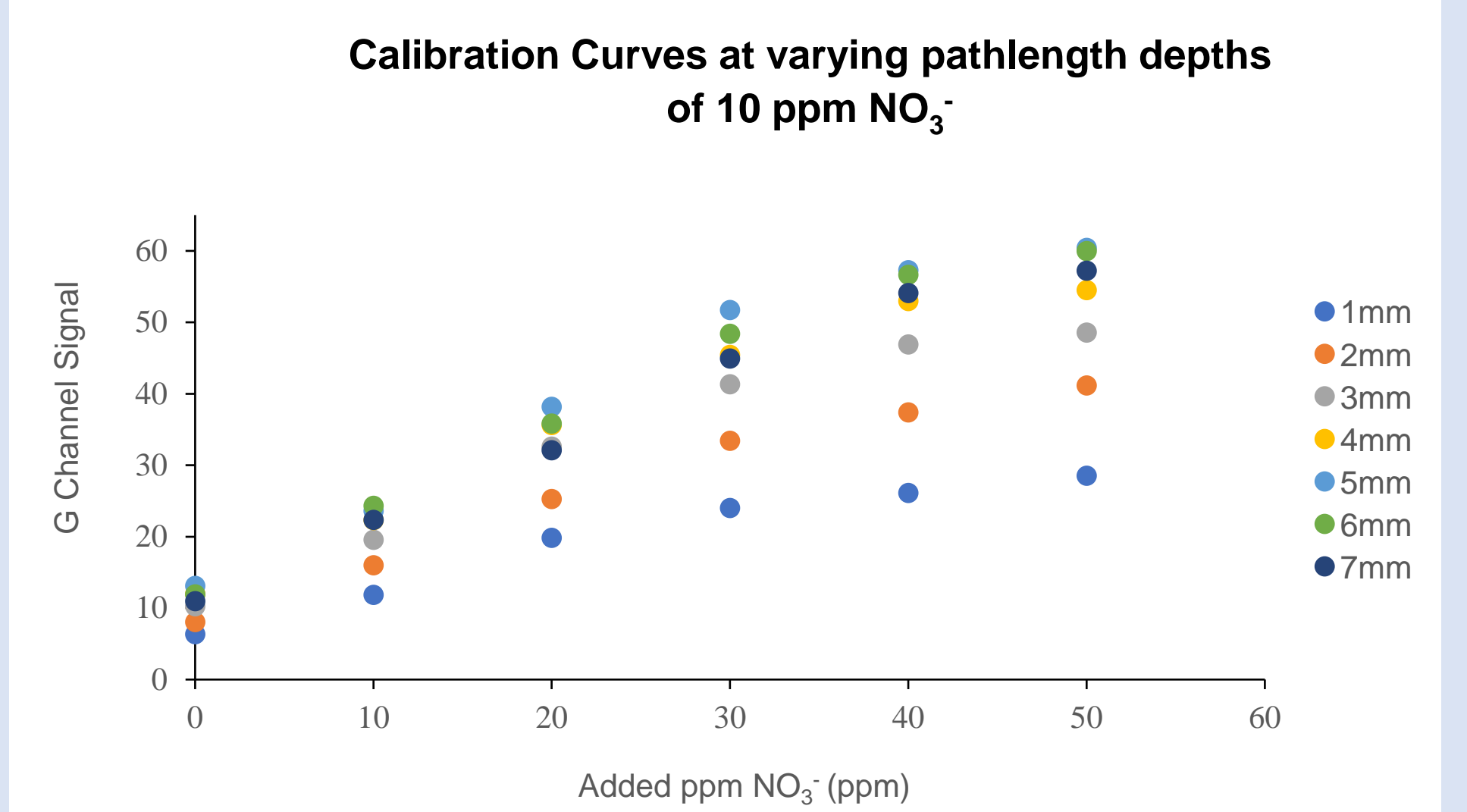
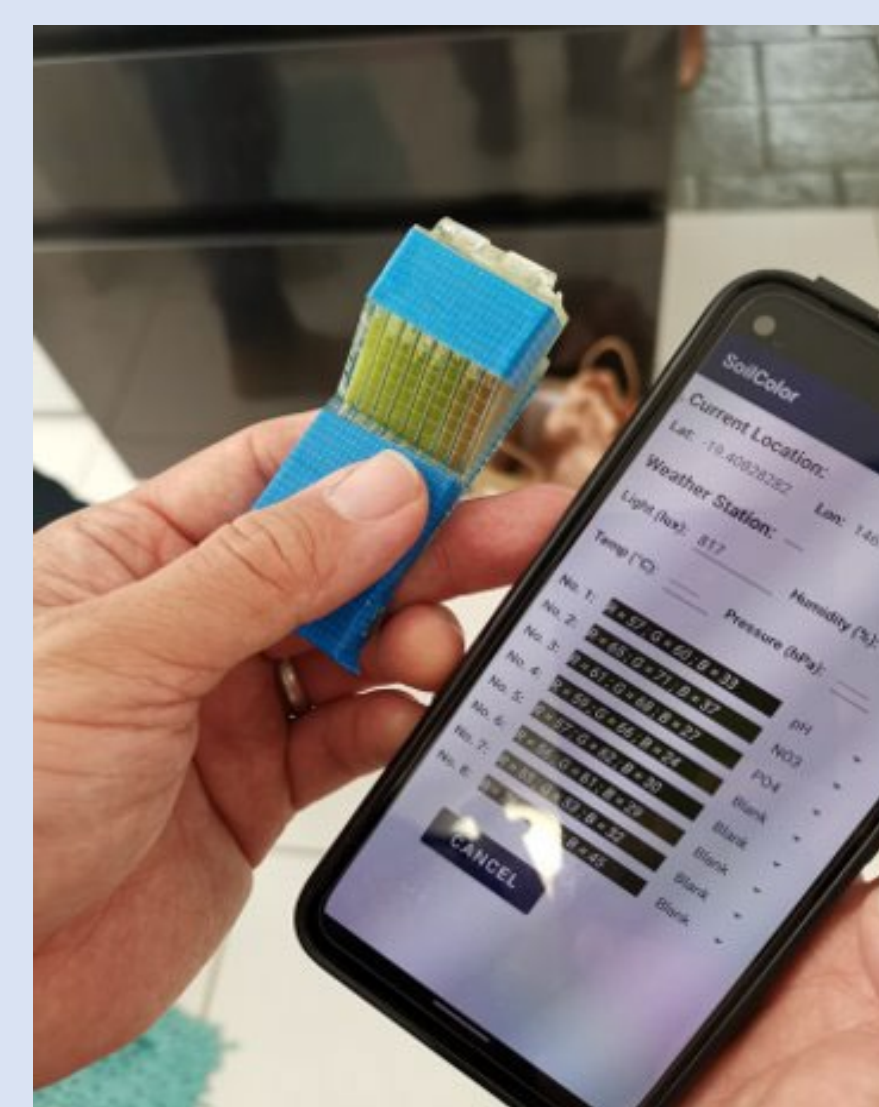
How It Works



4.

In-Chip Calibration

- Appearance of standard addition calibration for various sample types (water, soil, plant matter)



- In-chip RGB calibration curves obtained at varying pathlength depths with 10 ppm sample solution NO_3^-
- Improved RGB analysis accuracy through colour saturation gradient from varying pathlength depth feature

5.

Teamwork Makes the Dream Work!



- Designing and developing with inputs from end-users
- Successful demonstration of microfluidic device functionality
- Positive feedback was received especially on the ergonomics and ease of use.
 - "Can't get any easier" – Bethany Donker 2022 (Extension Agronomist at Herbert Cane Productivity Services Ltd)

6.

Moving Forward

- Comparative analysis performed using
 - Four different soil samples
 - Two KNO_3 sample solutions (10ppm NO_3^- & 50ppm NO_3^-)
- RGB colourimetric data of the samples in the microfluidic device were compared to samples in cuvettes
- Colourimetric data was obtained using camera images quantified by an image processing software (ImageJ)
- **Promising results** – indicative of the right path. High improvement opportunities to close the gap with further studies to identify the "noise" using bigger sample size, process refinement and material customisation
- Next steps are to replicate this capability to include macronutrients Phosphate and Potassium.

