

# SOIL HEALTH CHIP: A Cost-Effective and Portable Device for Precision Agriculture

Muhammad Salik Ali Khan

Supervisors: Professor Michael Breadmore and Dr. Fernando Maya Alejandro

## BACKGROUND

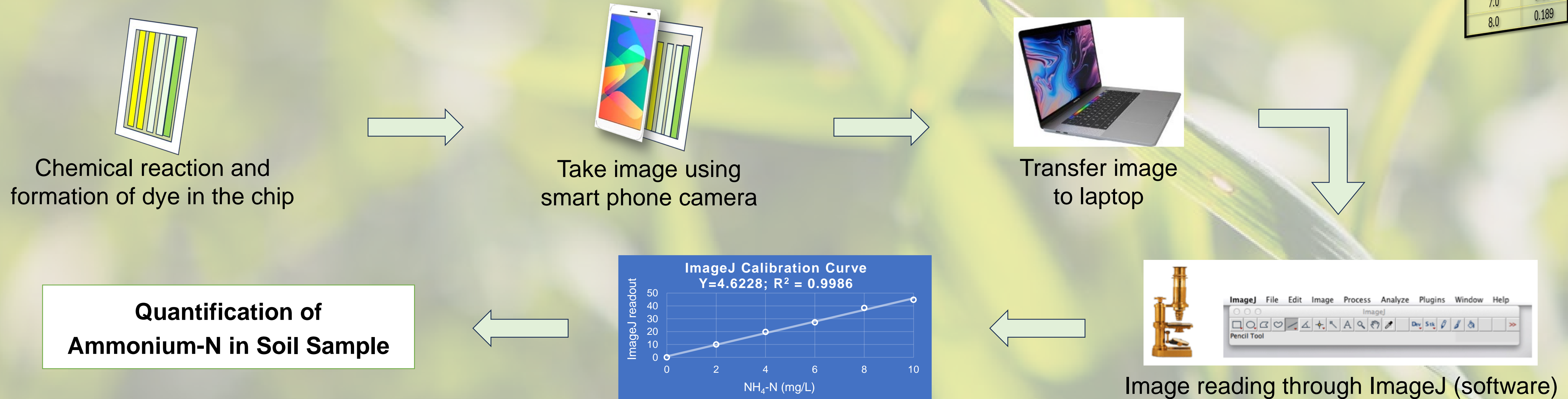
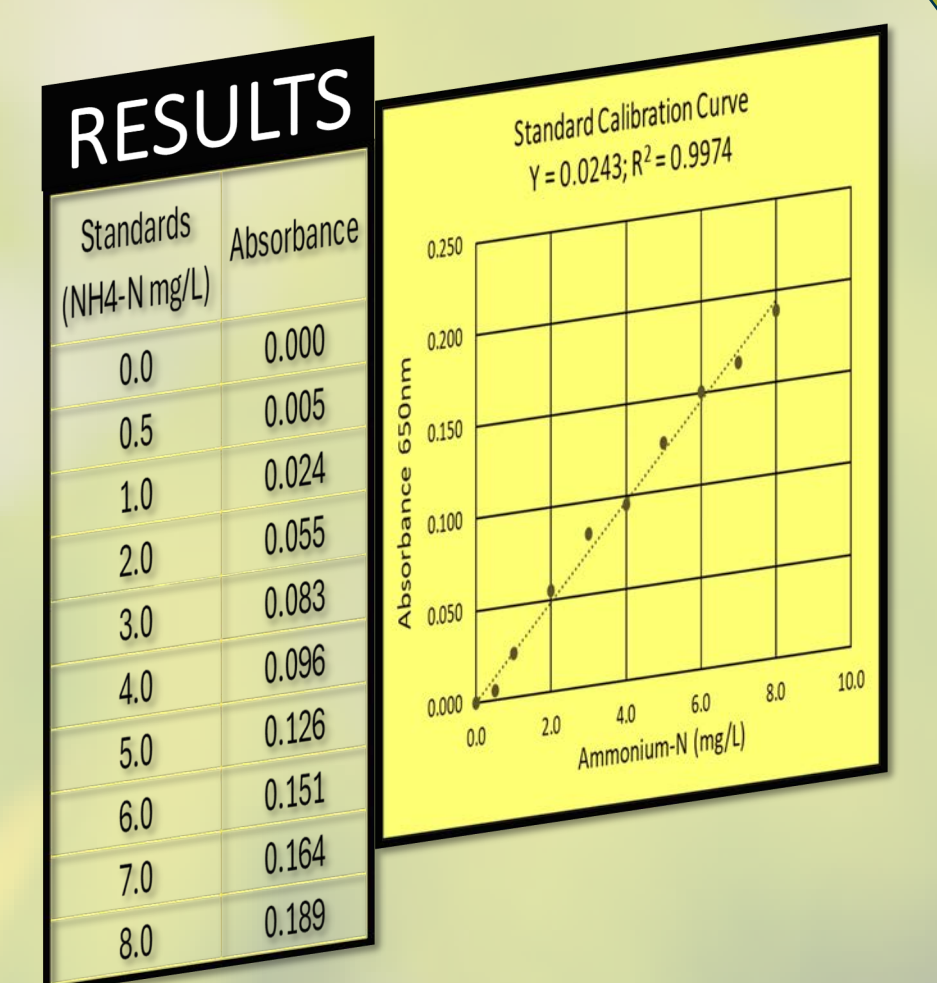
- Nitrogen fertilisers are indispensable:
  - Nitrogen is the 2nd largest essential plant nutrient.
  - Essential for growing high-yielding and nutrient-exhaustive crop varieties.
  - Maintaining adequate soil-N level under intensive cropping systems.
- However, injudicious application of N-fertilisers, without soil-testing, has serious economic and environmental repercussions such as (1) Increase in cost of production, (2) rise in global temperature, (3) algal blooms, and (4) rising of sea-level.
- Conventional soil-testing techniques are costly, time consuming and labour-intensive.

## RESEARCH OBJECTIVE

- This study aims to develop a miniaturised analytical 'Soil Health Chip' using additive manufacturing (3D printing) techniques.
- This chip will help estimate soil Ammonium level and Urease enzymatic activity in the field, quickly, accurately and cheaply.

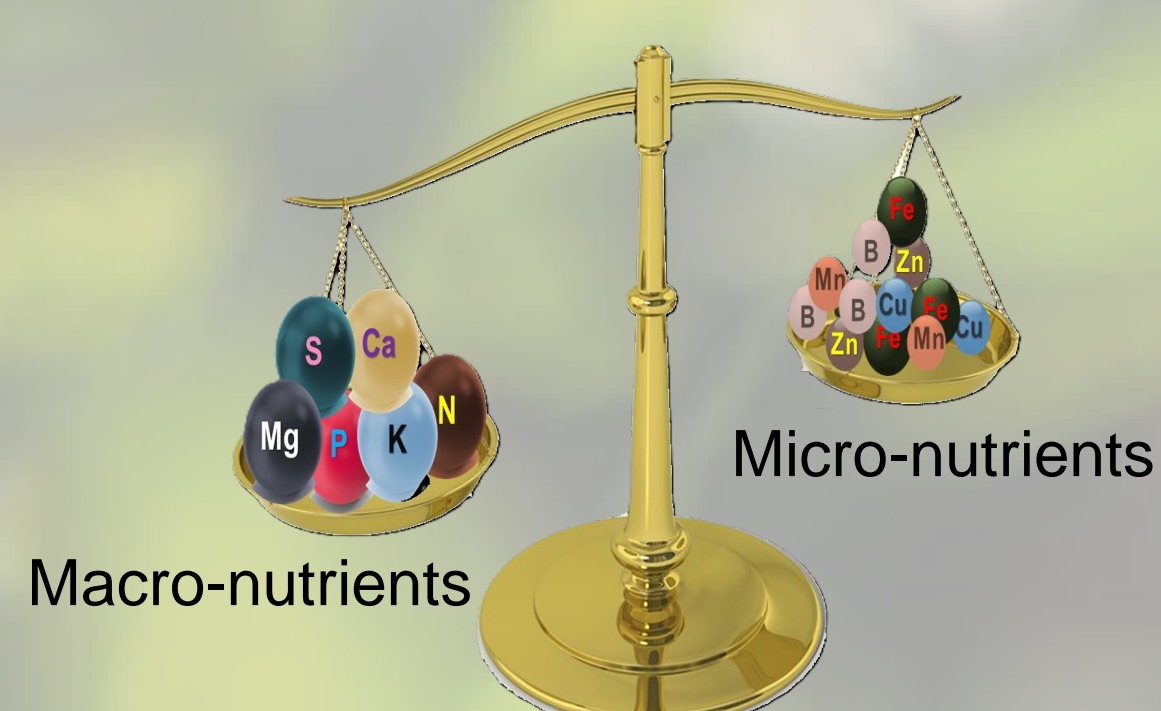
## METHODOLOGY

- A **Modified Berthelot Reaction** will be optimised for the Soil Health Chip. The reaction produces blue coloured dye when dissolved ammonia reacts with phenolic compound & chlorine-donor compound under alkaline conditions.
- The **colour intensity** of dye represents the **concentration of ammonium in the soil sample**.
- Analytical results are reported with ( $\pm$ ) uncertainty value after comparing ImageJ measurements with Spectrophotometric results.

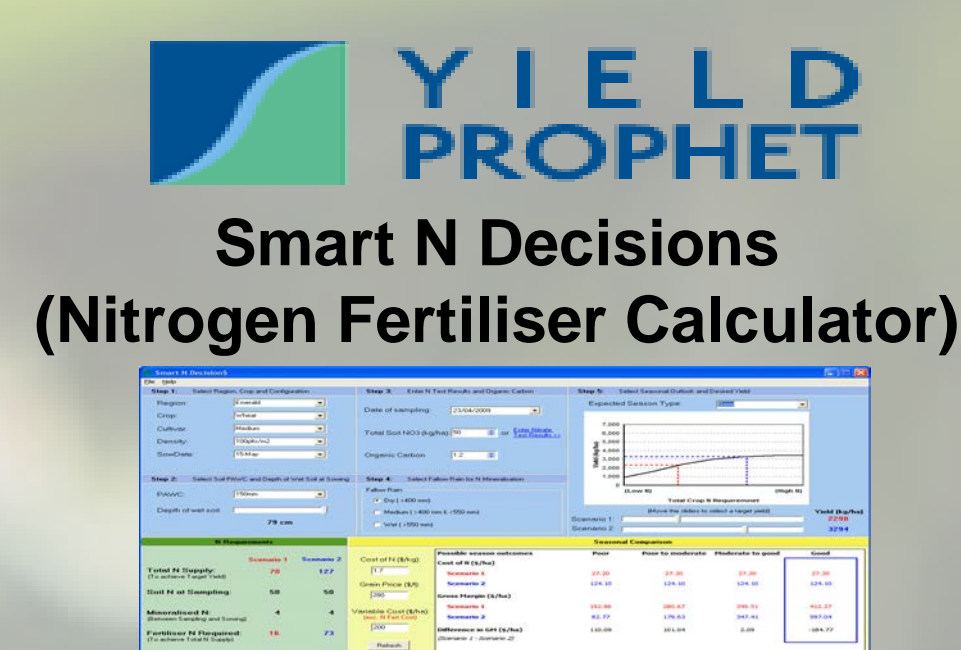


## SIGNIFICANCE

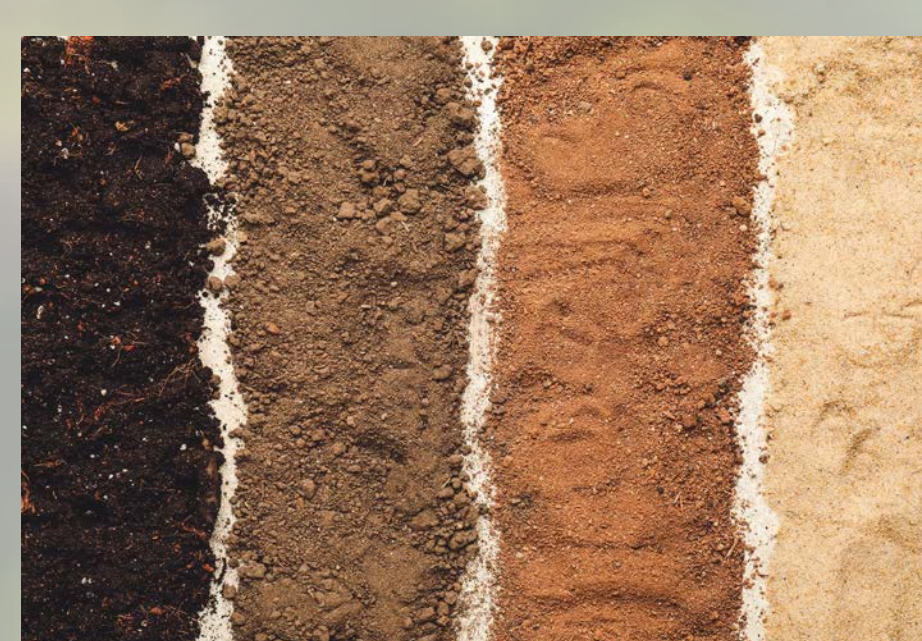
- **Financial Benefits to Economy:** The fertiliser cost per hectare crop production was estimated to be **32%** in 2009. Precise application of N fertilisers could reduce cost of production and positively impact the national economy. There is also potential of commercialising the technology.
- **Social Benefits:** The real-time information of soil N and its timely application would increase grain protein level (quality) and yield (quantity). Thus, increasing profitability and improving living standards of farming communities in regional areas.
- **Environmental Benefits:** The study will help reducing leakage of N to environment by improving N fertiliser use efficiency.
- **Knowledge Advancement:** The study will evaluate the feasibility of 3D printing in the field of Soil Science.



(1) Balanced nutrition & right amounts of fertilisers for crops



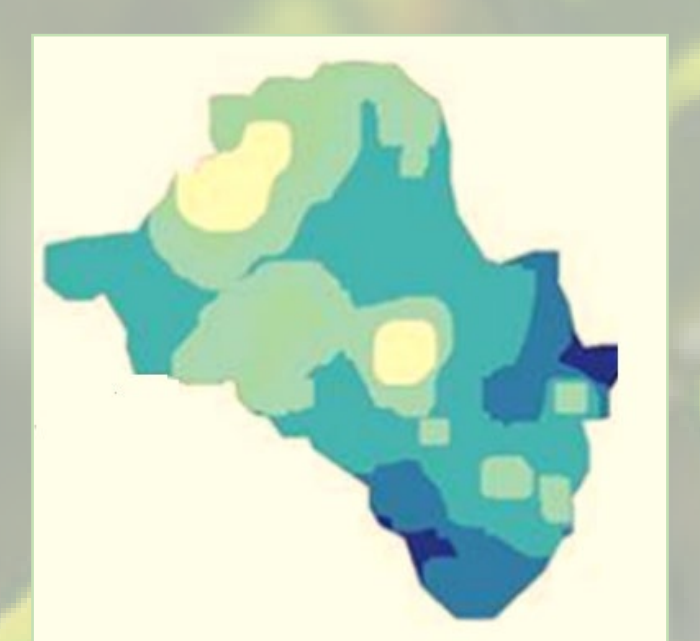
(2) Primary information source for yield prediction models



(3) Cheap technology for adopting soil testing as a routine practice



(4) Quick diagnosis of nutrient deficiency/disorder & timely management



(5) Feasible for intensive soil testing & adopting variable rate fertiliser application