# A STEP TOWARDS NET ZERO TARGET: SOIL HEALTH CHIP TO REDUCE GHG EMISSIONS FROM AGRICULTURAL FIELDS

Muhammad Salik Ali Khan

Supervisors: Professor Michael Breadmore and Dr. Fernando Maya Alejandro

INTRODUCTION

❑ Chemically produced nitrogen **(N) Fertilisers are vital agricultural inputs.**

❑ However, the indiscriminate use of N fertilisers is a major **contributor to greenhouse gas (GHG) emissions** and causing **CLIMATE CHANGE.**

❑ Additionally, excessive N-fertilisers which are not taken up by plants, either runoff from agricultural fields and load nutrients into oceans hence create **DEAD ZONES** and eventually kill aquatic animals or leach down and result in **GROUND WATER CONTAMINATION**. Therefore, use of **Right Amount o**f N-fertilisers after **Soil Testing** is **essential.**

❑ The conventional laboratory Soil Testing techniques are **COSTLY, TIME CONSUMING** and **LABOUR INTENSIVE** and can not be considered as **Regular Farm Practice**.
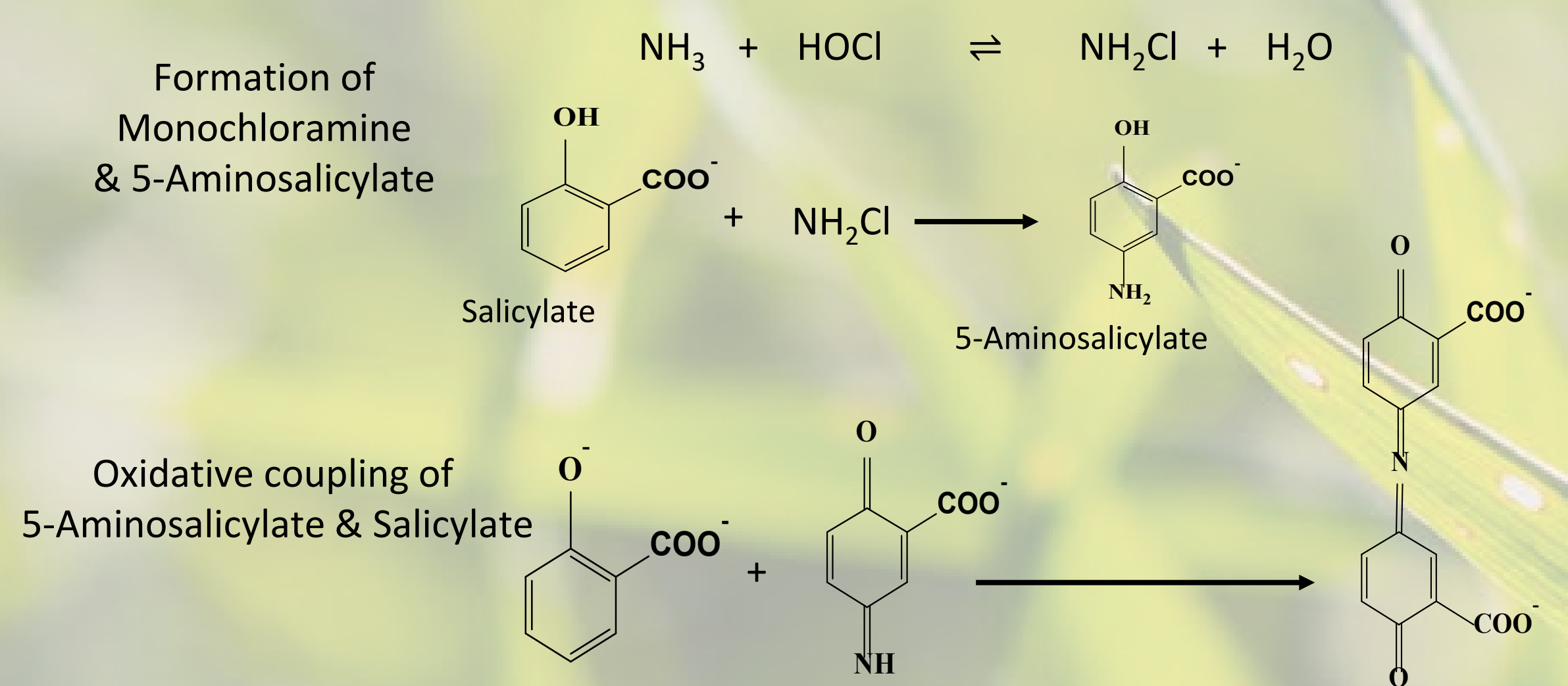

Balance is imbalance
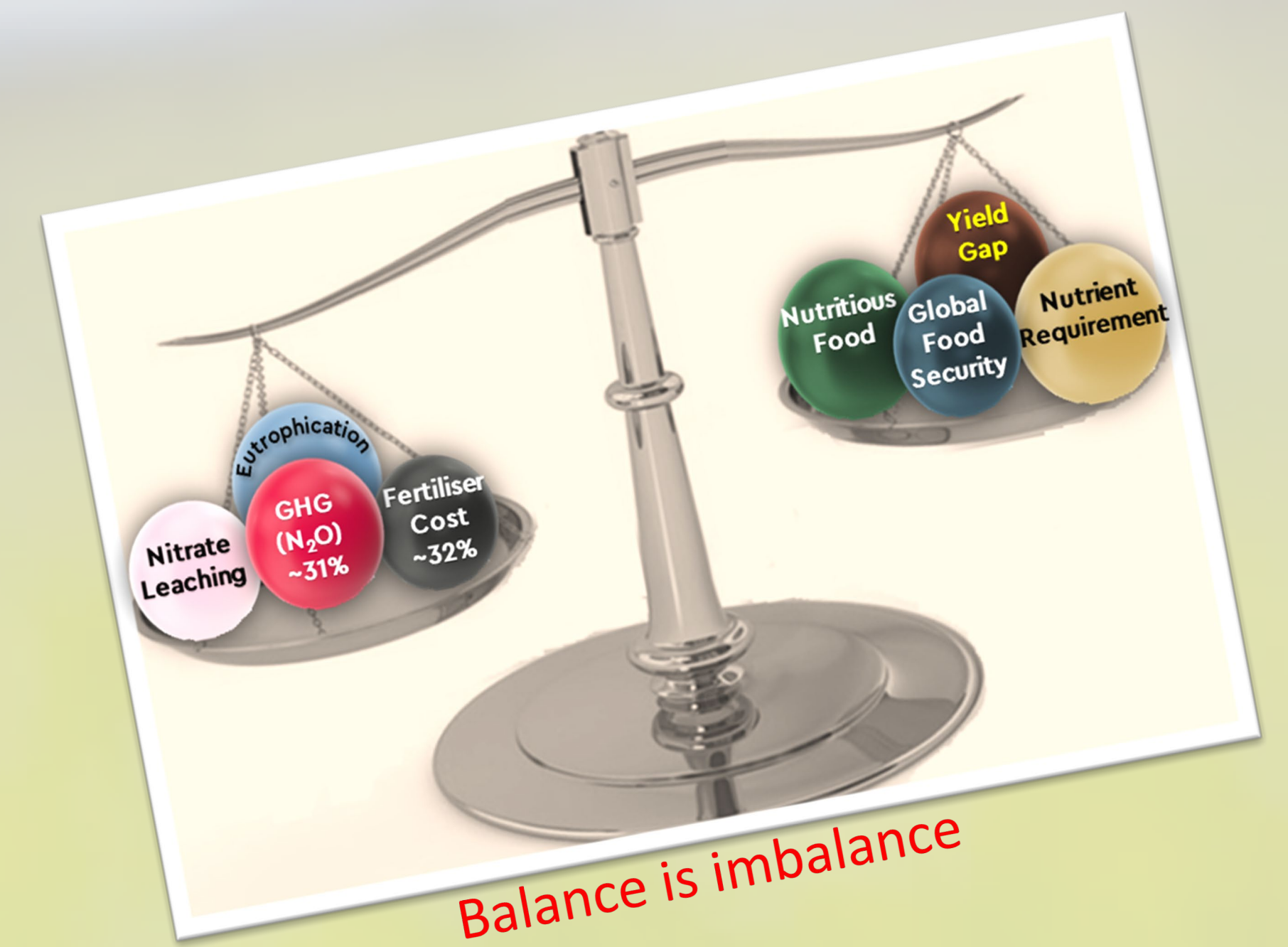
PROJECT AIM

❑ This study is designed to develop a microfluidic 'Soil Health Chip' for precise application of N-fertilisers in agricultural fields, hence reducing cost of production and help achieving net zero GHG emissions target from agricultural fields.

❑ The device fulfills the **"ASSURED"** criteria (**A**ffordable, **S**ensitive, **S**pecific, **U**ser-friendly, **R**apid and **R**obust, **E**quipment-free and **D**eliverable to end users) of Point-Of-Care Devices for resource-limited environments set by World Health Organization.

MATERIALS AND METHOD

❑ A blue-coloured dye is formed when dissolved ammonia reacts with the phenolic compound and chlorine-donor compound under alkaline conditions.

❑ The image of colour is captured using a smartphone camera and colour intensity is translated into ammonia concentration in the soil sample.

Formation of Monochloramine & 5-Aminosalicylate

$$NH_3 + HOCl \rightleftharpoons NH_2Cl + H_2O$$

Salicylate + $NH_2Cl \longrightarrow$ 5-Aminosalicylate

Oxidative coupling of 5-Aminosalicylate & Salicylate

Smartphone and RGB Model

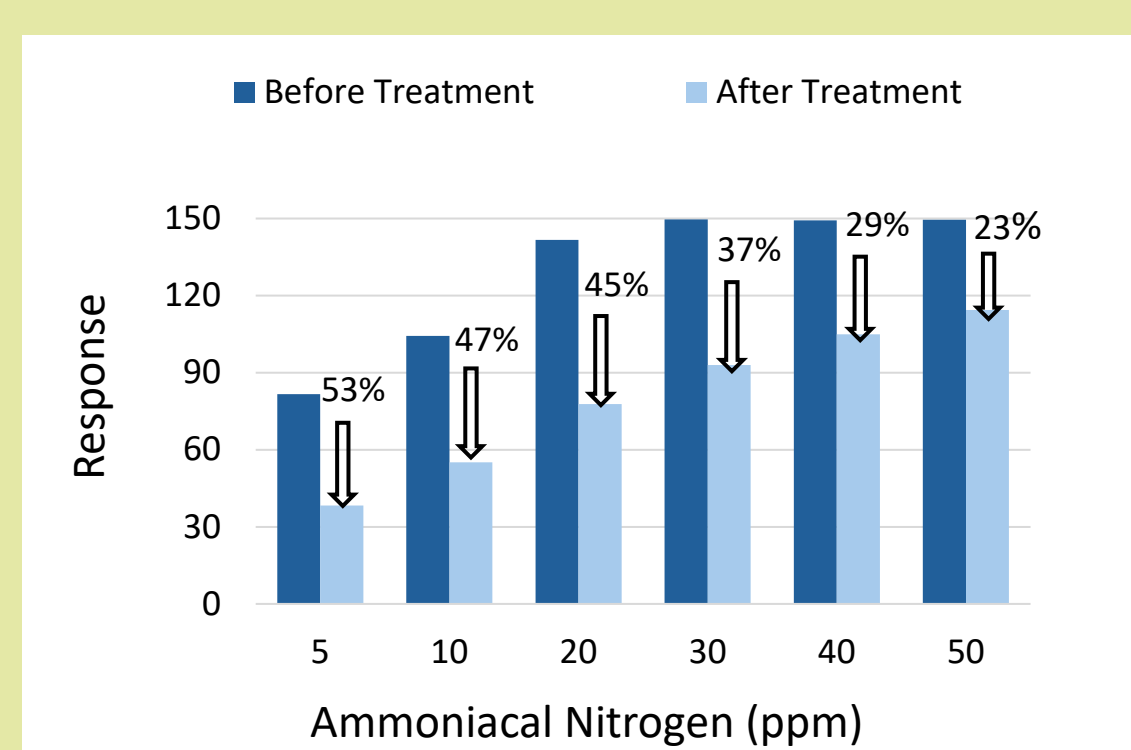| RGB Model	Red (0-255)	Green (0-255)	Blue (0-255)
	255	0	0
	0	255	0
	0	0	255
	255	255	255
	0	0	0

RESULTS

**Extended Working Range & Best-Fitting Regression Model**
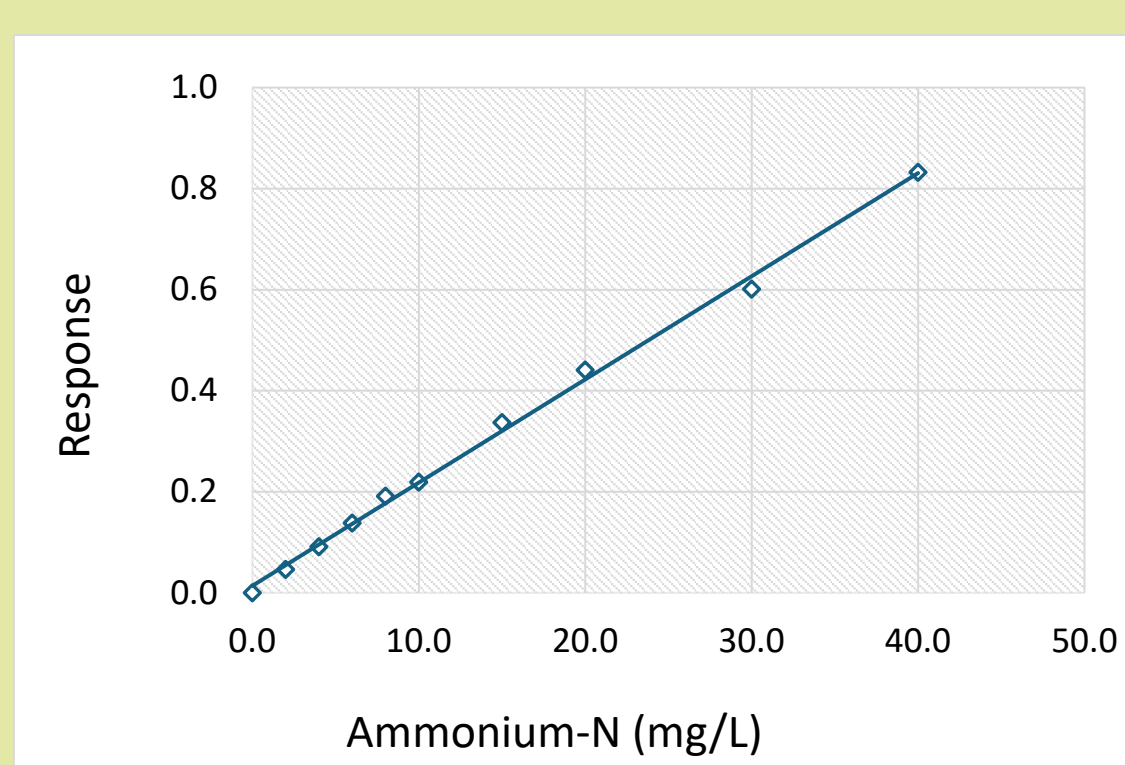
- Extended calibration curve ensures analysis of wide range of ammoniacal-N in samples.
- Best-fitting regression line showed that 99.7% variations in data was explained by model.


Minimal Interferences

- Fertile soils contains significant micronutrients (metals) which interfere and cause turbidity.
- Response was reduced up to 53% after treatment.

Flexible Measurement-Taking Time
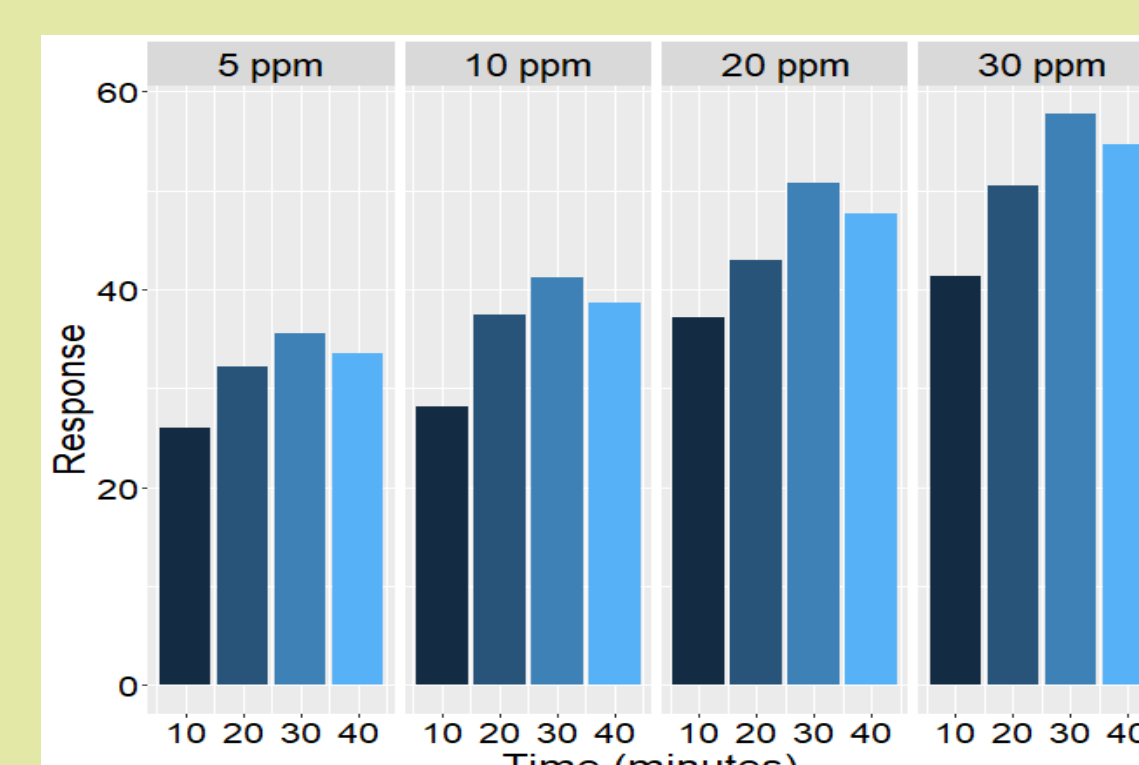
- The optimum measurement-taking time gives consistent and accurate results.
- The optimum time is between 20 to 30 minutes.

Auto-Compensation of Ambient light Variation

Controlled Condition | Sunny day | Cloudy
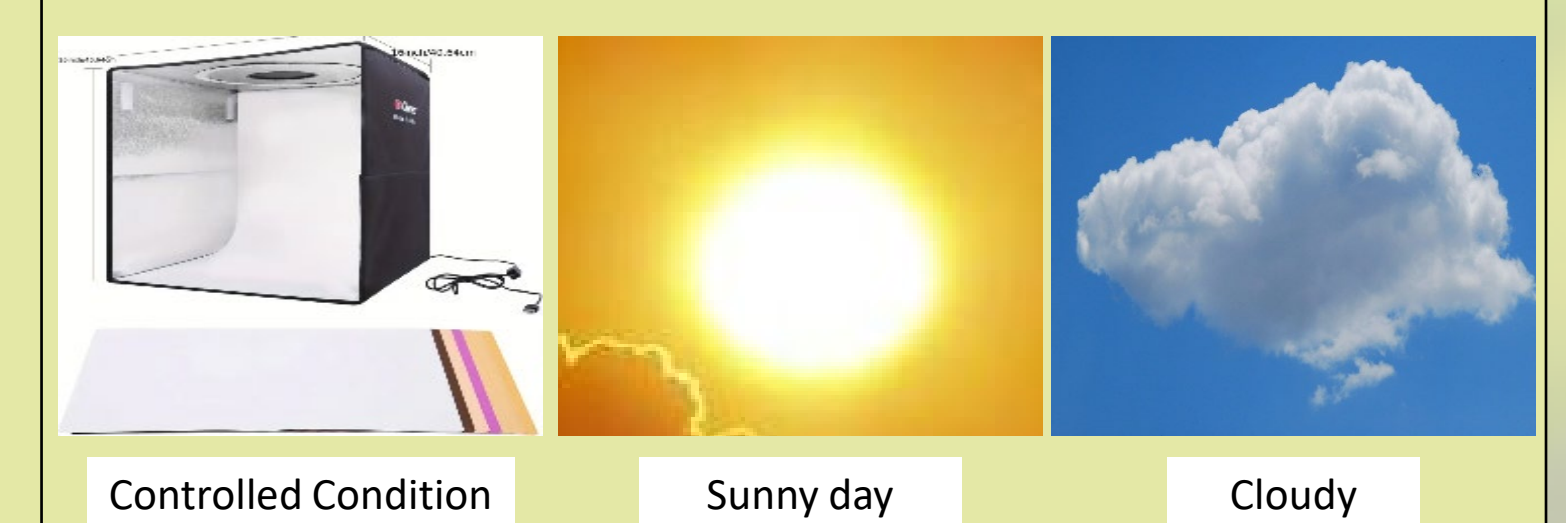
- Take image anywhere, "does not matter".
- Results are independent of various ambient light conditions.

SIGNIFICANCE

- **Environmental Benefits:** The Soil Health Chip will help reducing N-leakage to environment by improving N-fertiliser use efficiency.

- **Financial Benefits to Economy:** The fertiliser cost per hectare crop production was estimated to be 32% in 2009. Precise application of N fertilisers through use of Soil Health chip could reduce cost of production and positively impact the national economy.

- **Social Benefits:** The real-time information of soil N and eventually timely application of N fertilisers could increase grain protein level (quality) and yield (quantity). Thus, increase profitability.
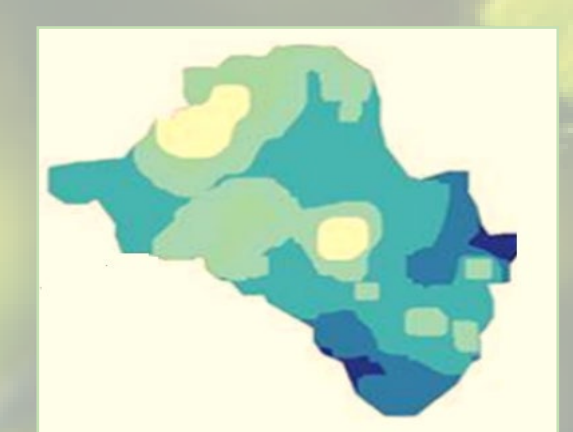
(1) Cheap technology to adopt soil testing as a regular farm practice

YIELD PROPHET
Smart N Decisions
(Nitrogen Fertiliser Calculator)
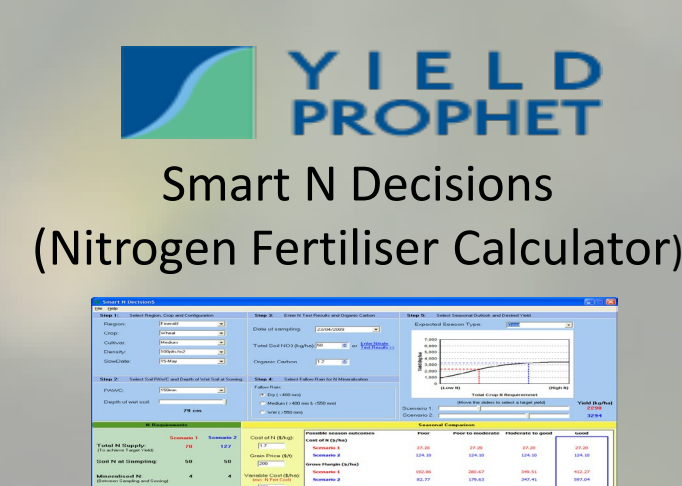
(2) Primary source of information for yield prediction models

(3) Real-time diagnosis of Nitrogen deficiency/disorder & timely management

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