Using simple RGB Camera to estimate Nitrogen Uptake, Nitrogen Nutrition Index (NNI) and critical Nitrogen dilution (Nc): A case study of Spring wheat .

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Agri-Ecology

OBJECTIVES

1) To demonstrate the feasibility of digital camera to replace laboratory tests.

2) Use N% and dry matter yield (DM) in order to calculate N-uptake (rather then N%) by wheat as a tool for Decision Support System (DSS)

3) To Determine critical N dilution (Nc) and Nitrogen nutrition Index(NNI) of spring wheat

Definitions

1) N-uptake = %N*DM/100;

2) Critical N dilution (N_c) : The minimum N concentration required for maximum crop growth (Greenwood et al., 1991).

3) Nitrogen nutrition Index(NNI)): Nc/Nc max = $1/[1+(DM/DM_{50})^b]$, where DM and DM_{50} are the DM (kg/ha). when $DM=DM_{50}$ then Nc=0.5 Nc max. Shlevin et al. (2018)

Measurements used to obtain the results of the study:

1) Comparison of N-uptake between camera measurements and standard laboratory analysis.
2) Calculation of N-uptake by wheat:

N-uptake = %N*DM/100.

3) Nc calculation.
4) NNI estimation.

Demonstrate the feasibility of digital camera to replace laboratory tests.

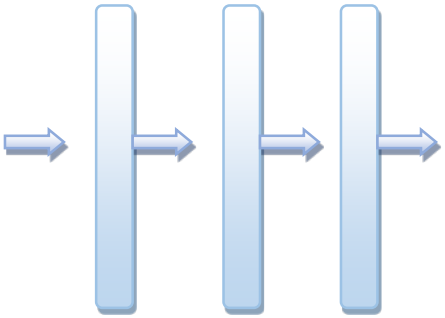
The technology: Fertilization management via digital color imaging (real time monitoring)

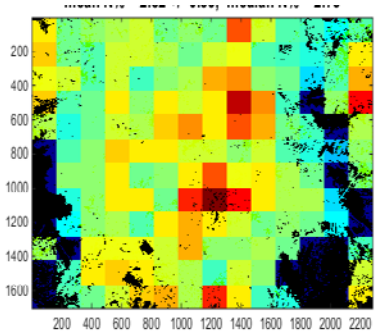
Original Input

Pre-processing & Features extraction

Deep Learning with Neural Network

Nitrogen uptake in the leaves and/or in the field





Layer 1 Layer 2... Layer N

Final Output for Fertilization Management

- **Total nitrogen uptake by plant (kg/ha); Nutrients deficiency: NPK units (kg/ha); NPK application (kg/ha);Fertilizer N-P-K composition;**

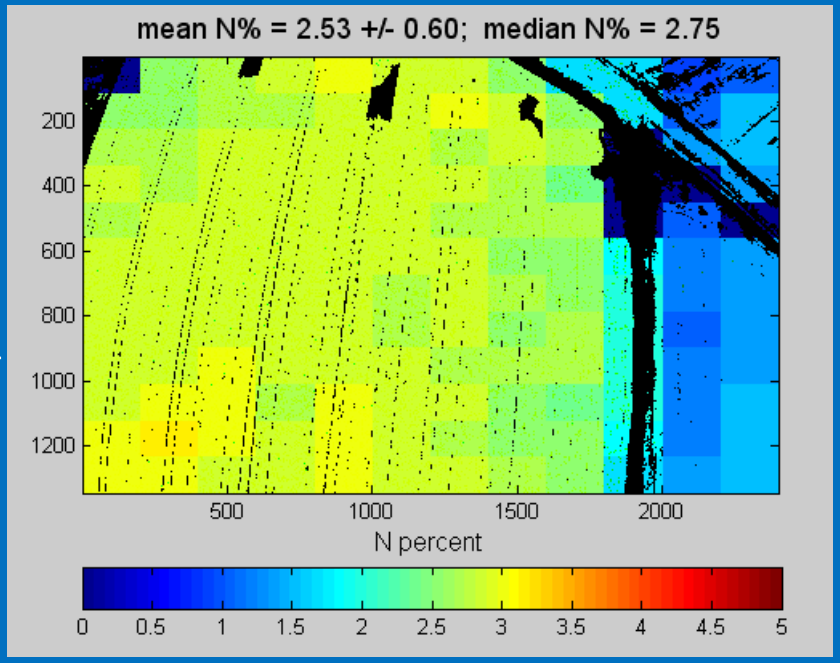
combining Computer Vision and Machine Learning techniques

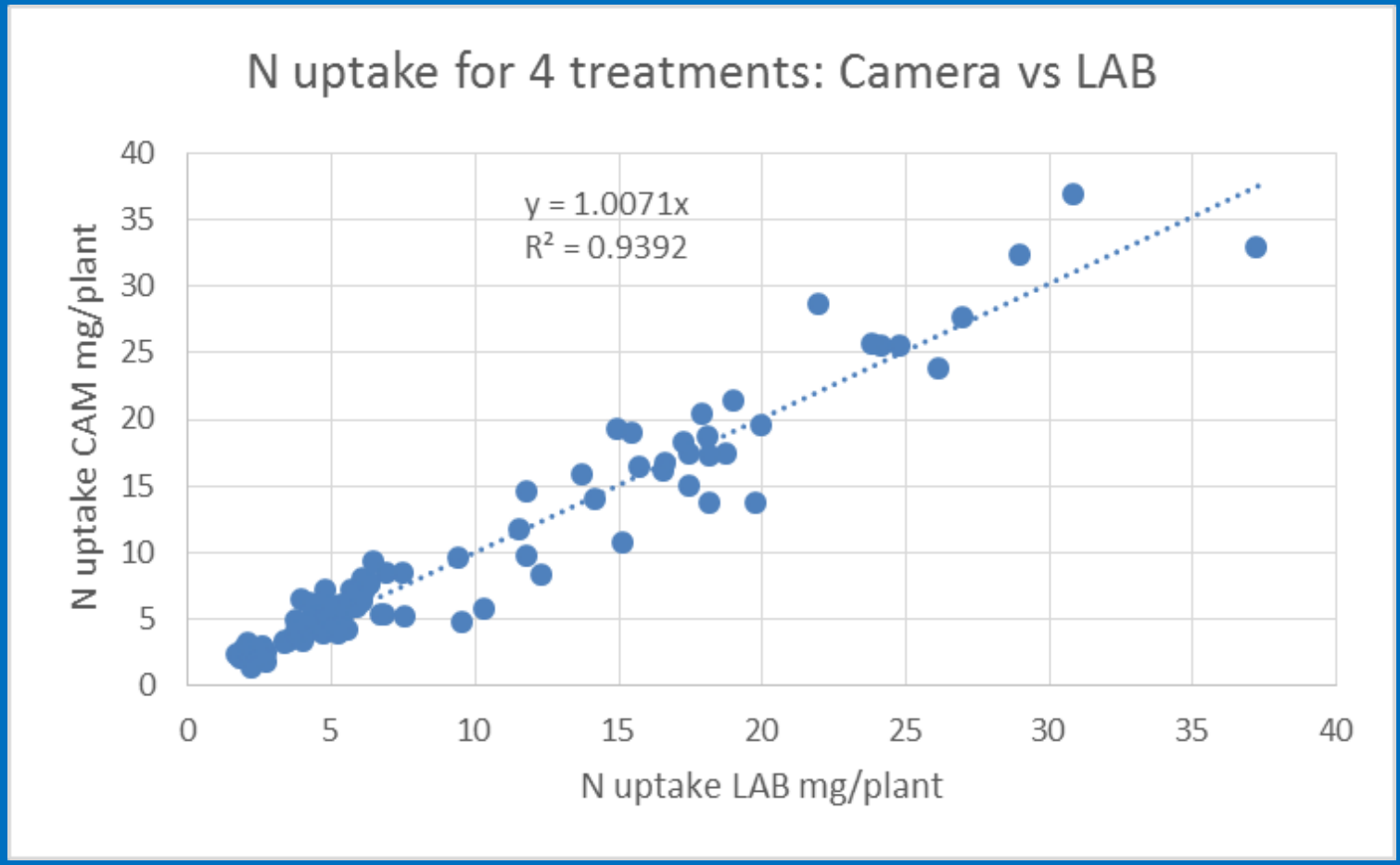
Pre-Processing and final result

Original Image of wheat field

After pre-processing

Estimated N% in wheat field





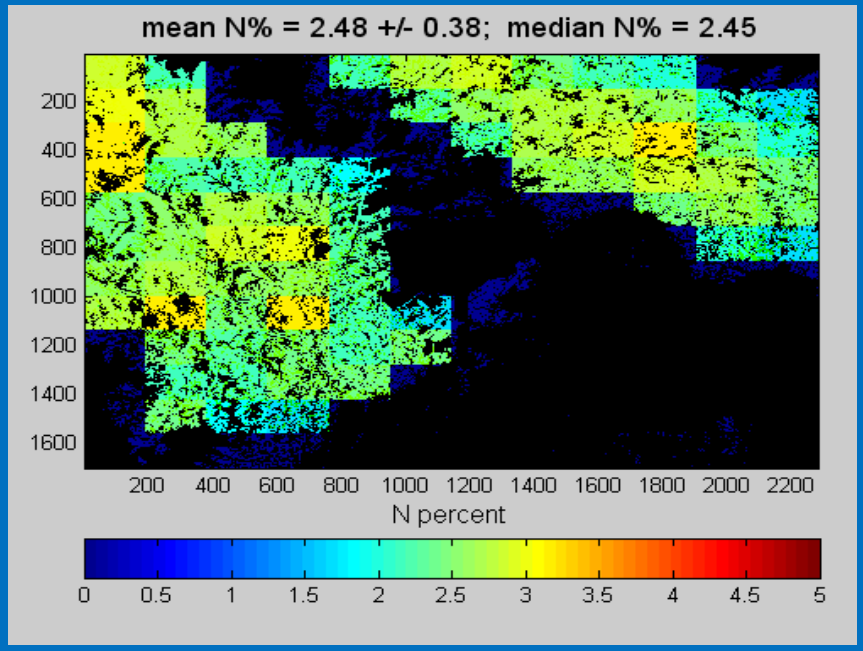
Nitrogen uptake by wheat. Comparisons between laboratory and camera of all data collected (120 data points).

Pre-Processing and final result

Original Image of carrots

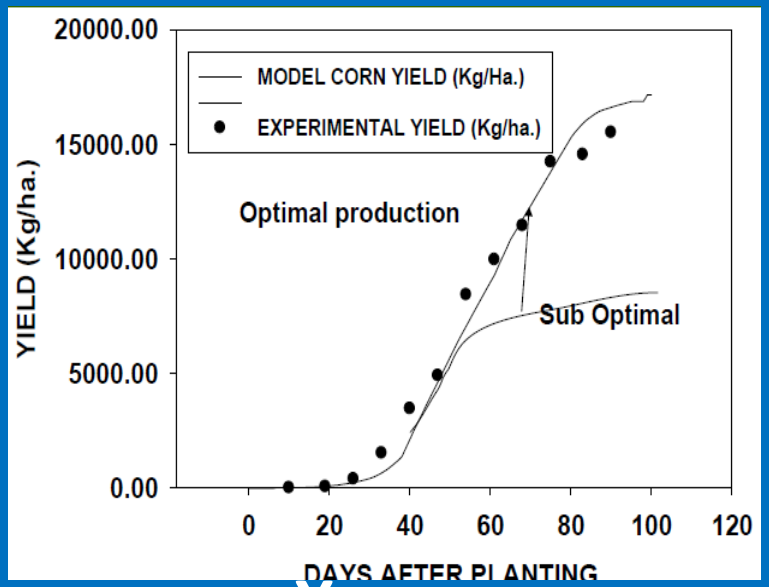
After pre-processing

Estimated N%

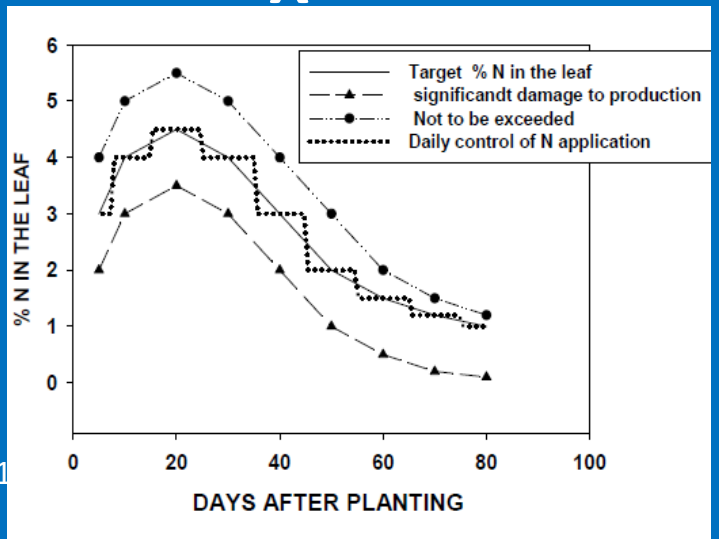


Use N% and dry matter yield (DM) in order to calculate N-uptake (rather then N%) by wheat as a tool for Decision Support System (DSS)

Decision Support System – optimal fertilization using digital color imaging



X



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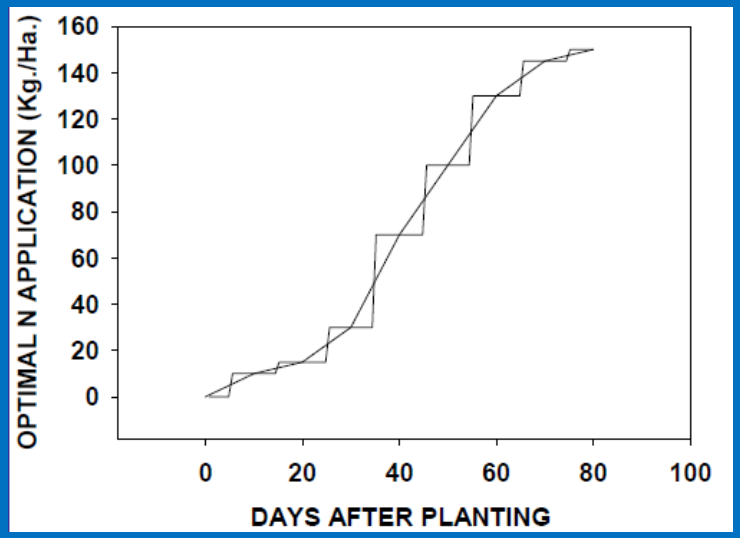
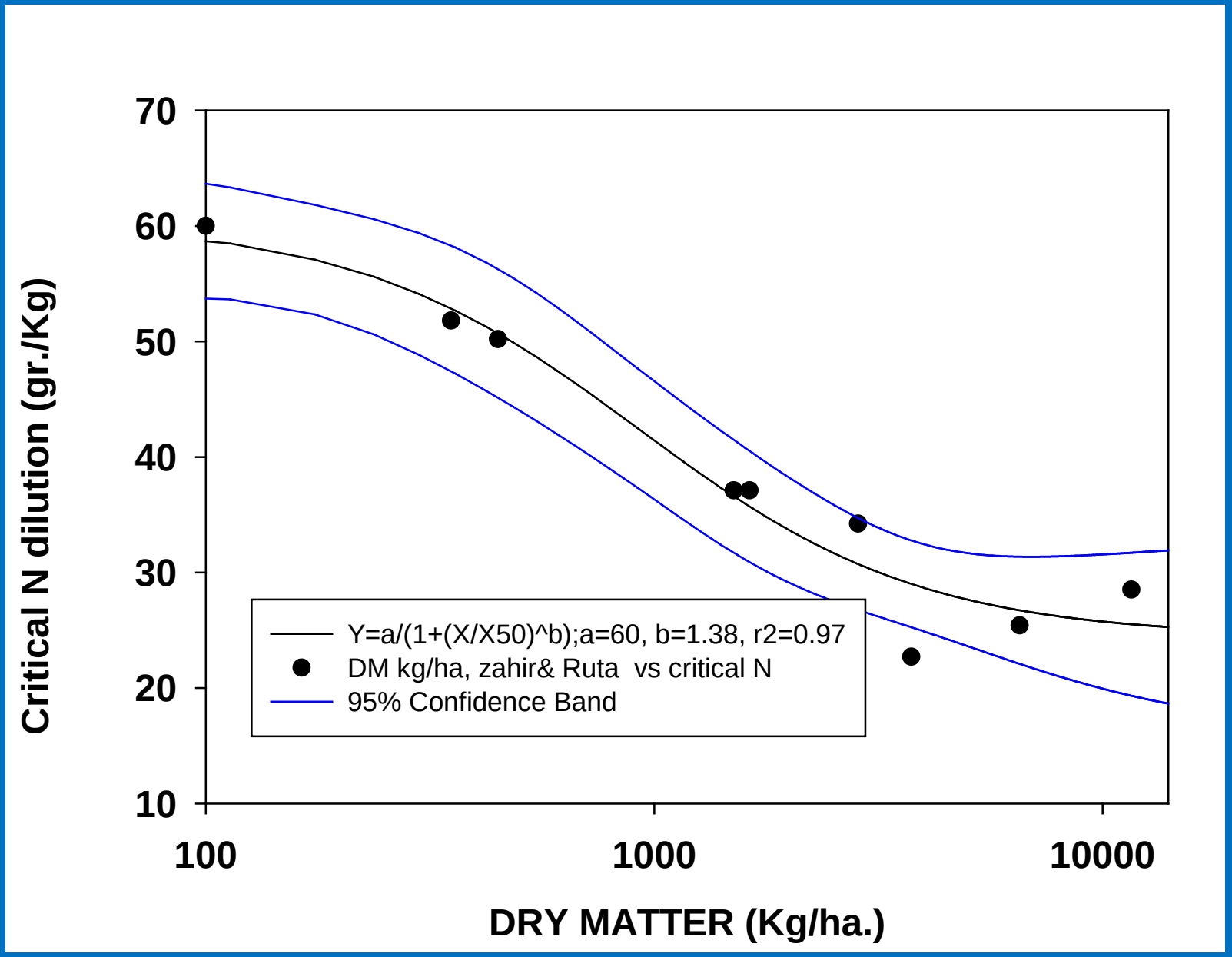
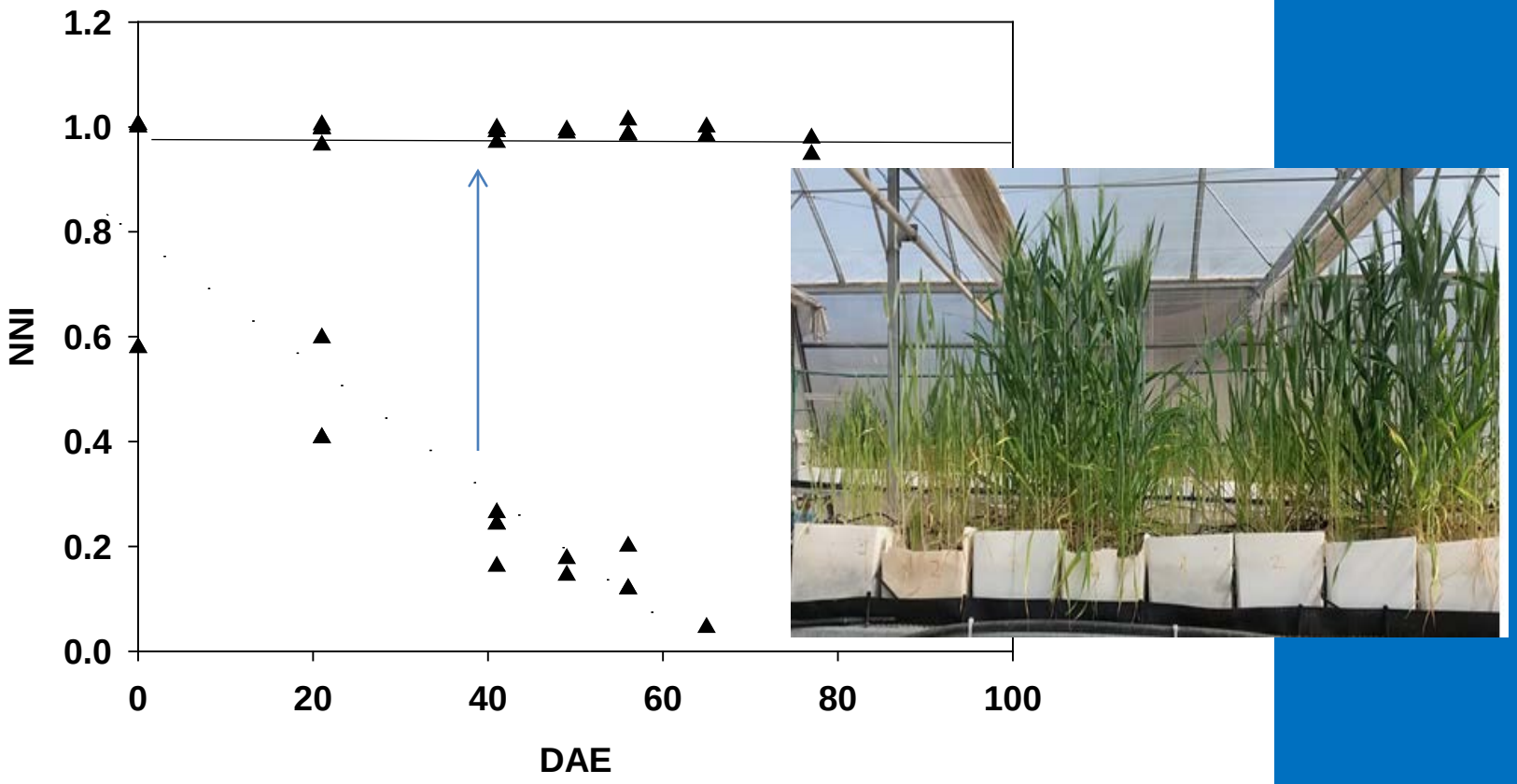
Translating target % N in the leaf to kg/ha N application in the field



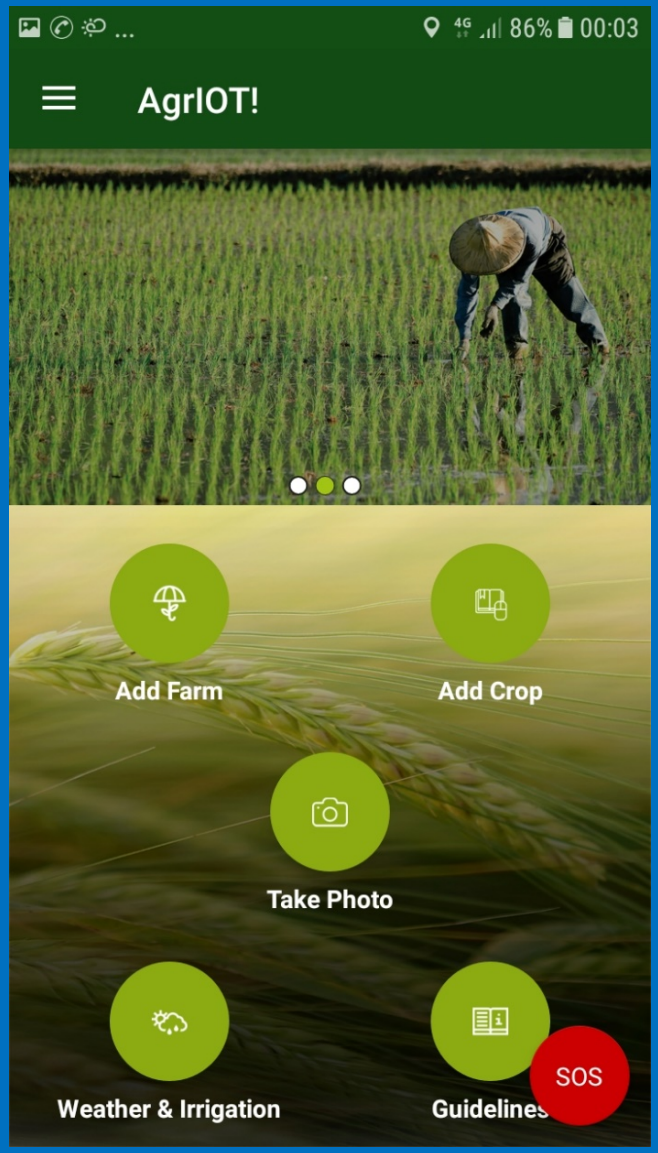
Optimal N consumption for maximal yield (expressed as cumulative application)

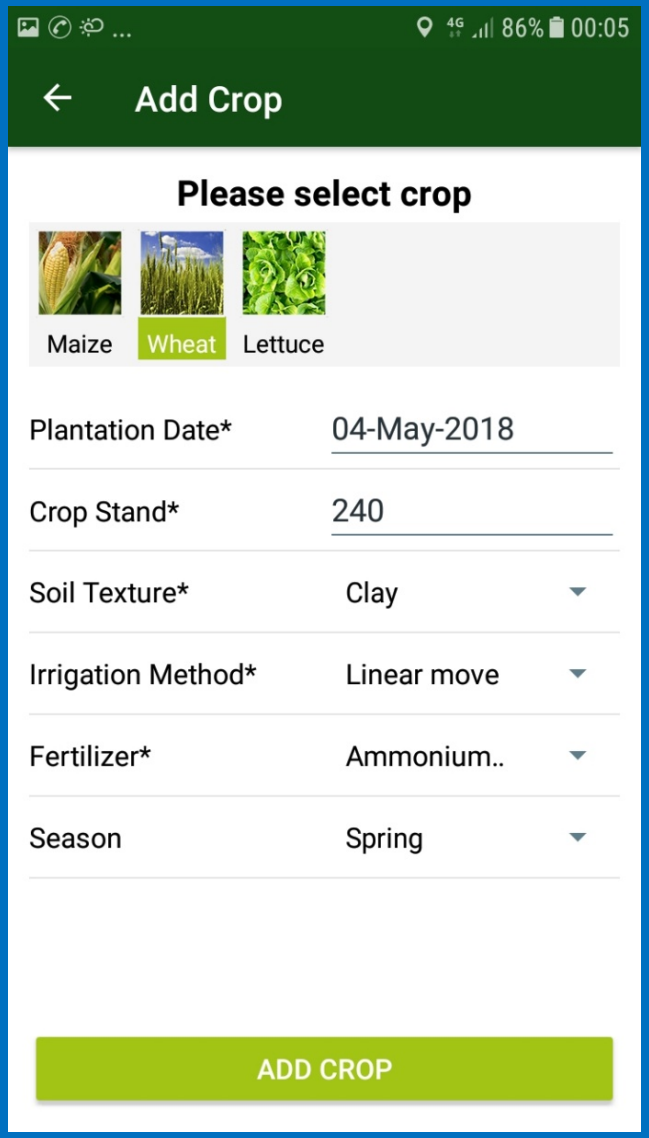
Determine critical N dilution (Nc) and Nitrogen nutrition Index(NNI) of spring wheat

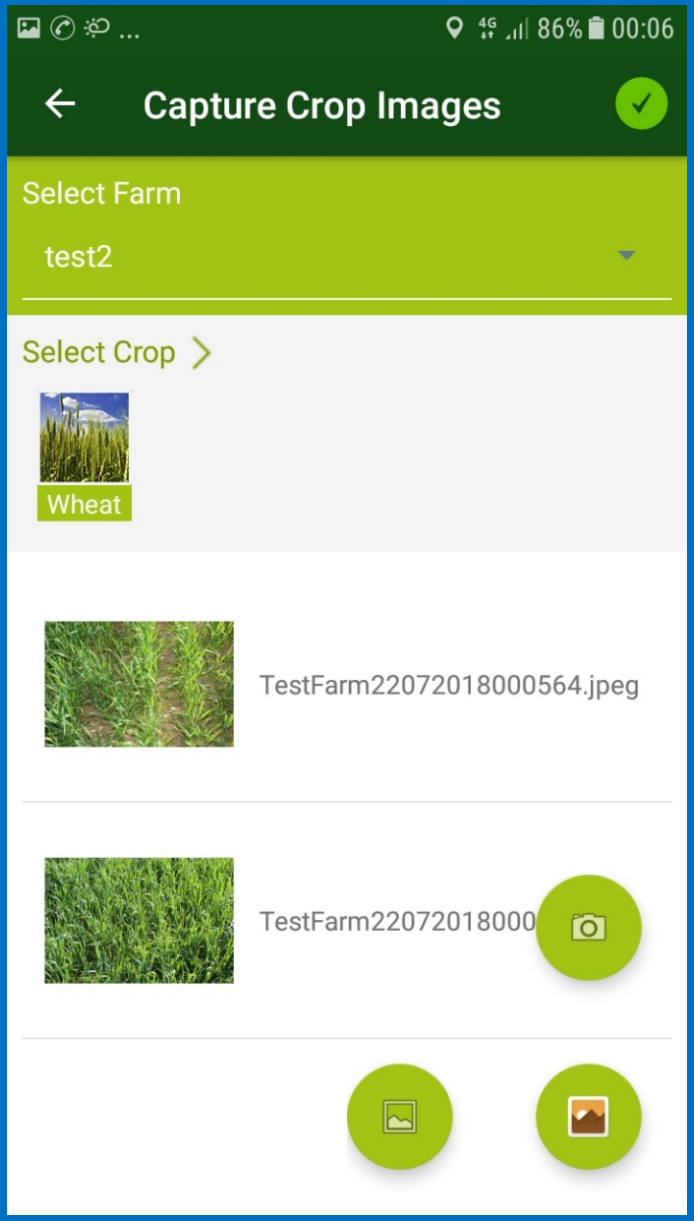

Critical N dilution (gr./Kg)
70
60
50
40
30
20
10
100
1000
10000
DRY MATTER (Kg/ha.)
Y=a/(1+(X/X50)^b);a=60, b=1.38, r2=0.97
DM kg/ha, zahir& Ruta vs critical N
95% Confidence Band

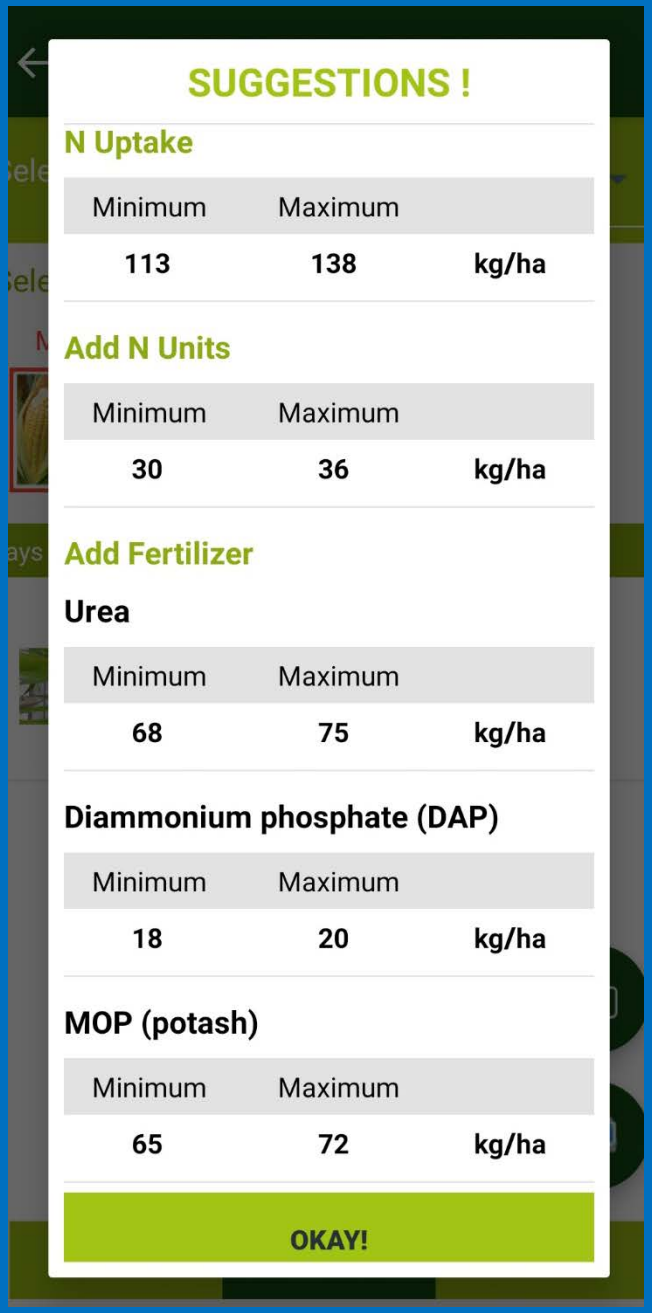


The course of NNI during the growing stages of spring wheat in the green house. Dashed line No N application Solid line Critical N application


86% 00:03
AgrIOT!
Add Farm
Add Crop
Take Photo
Weather & Irrigation
Guidelines
SOS


86% 00:05
Add Crop
Please select crop
Maize
Wheat
Lettuce
Plantation Date*
04-May-2018
Crop Stand*
240
Soil Texture*
Clay
Irrigation Method*
Linear move
Fertilizer*
Ammonium..
Season
Spring
ADD CROP


86% 00:06
Capture Crop Images
Select Farm
test2
Select Crop
Wheat
TestFarm22072018000564.jpeg
TestFarm22072018000


SUGGESTIONS !
N Uptake
Minimum Maximum
113 138 kg/ha
Add N Units
Minimum Maximum
30 36 kg/ha
Add Fertilizer
Urea
Minimum Maximum
68 75 kg/ha
Diammonium phosphate (DAP)
Minimum Maximum
18 20 kg/ha
MOP (potash)
Minimum Maximum
65 72 kg/ha
OKAY!

The novelty of our approach

Its ability to estimate Nutrients uptake (NPK)
To support agronomic decisions(DSS)

Increasing use of computer to perform high precision irrigation and fertilization tasks.

The uniqueness of our method :

- Simplicity: Sensorless control;
- Cheapness: No request to invest by the grower;
- Availabity: Smartphones and application are readily available to anyone and for every farming size
- Monitoring and DSS rather then sampling

Thank you for your attention.