Economic Development,
Jobs, Transport
and Resources

Sensing Technology for Measuring Crop Nitrogen

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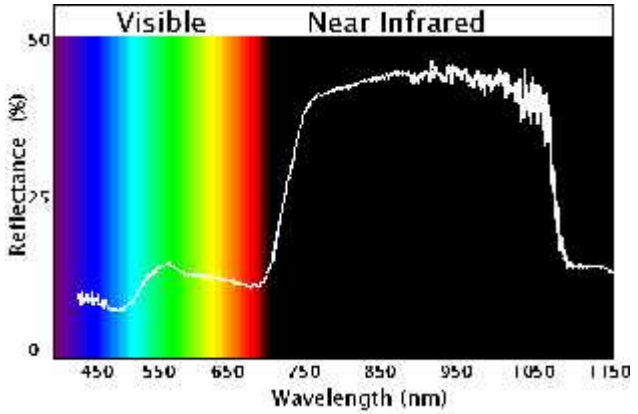
AGRICULTURE VICTORIA

Sensors for N detection

Sensor types

- Multispectral: discrete, non-contiguous
- Hyperspectral: narrow, contiguous
- Fluorescence: discrete illumination and measurement



Considerations

- Active and Passive
- Point, transect and imagers
- Spatial scale (‘grain’ size)
- Proximal vs remote
- Measurement/revisit frequency
- Platforms
- Calibration

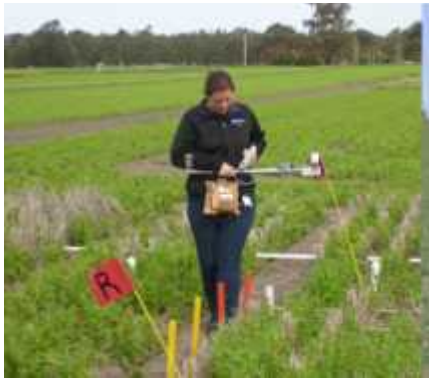
Ghozlen et al 2010

Platforms

Field based (handheld, tractor)

Satellite/light aircraft

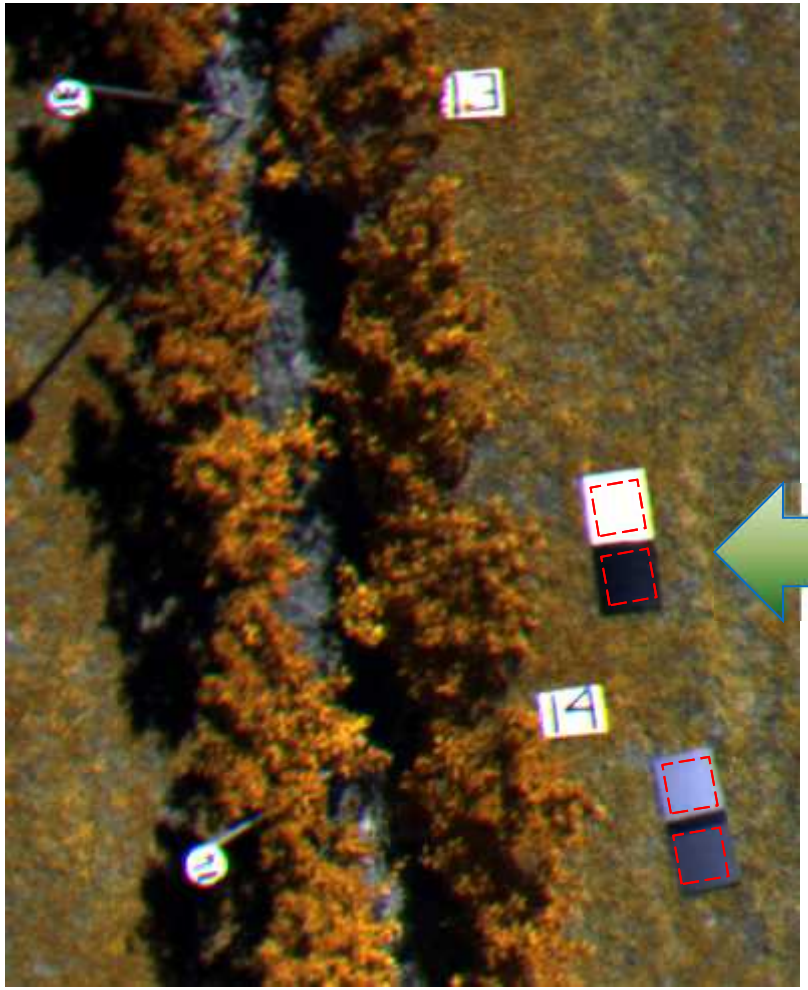
Unmanned Aerial Vehicle (UAV)

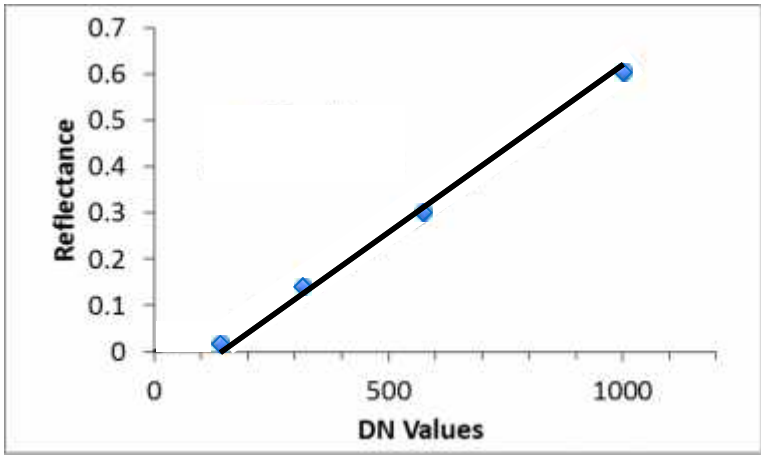


Calibration and validation

Considerations

- Quantification vs relative measures



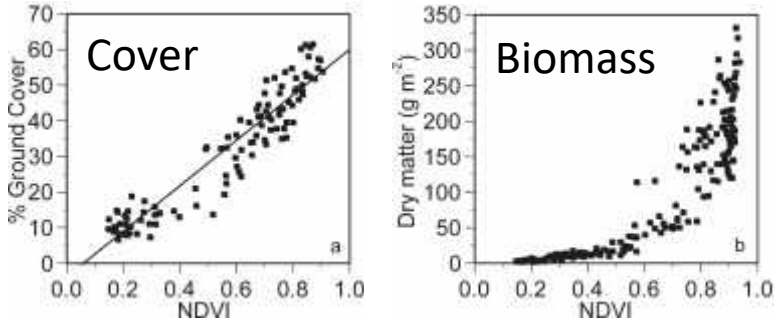


$R_{550} = DN*3.37\ 10^{-4} + DN^2*2.73\ 10^{-7}$

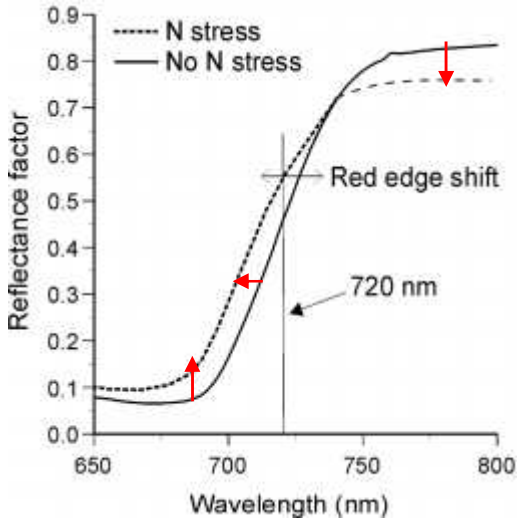
‘Best’ wavelengths for quantifying N

Match physiology with sensor spectrum

NDVI: Canopy cover



Red-edge: Stress



Red edge indices

MCARI = $[(R_{700}-R_{670})-0.2*(R_{700}-R_{550})*(R_{700}/R_{670})$, (Daughtry et al., 2000)

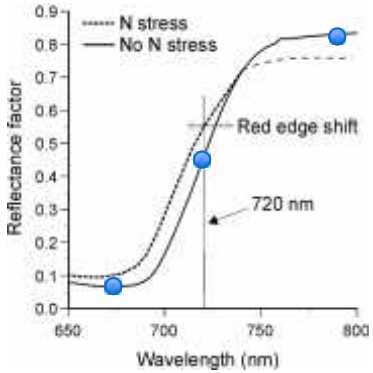
REP: $\lambda_{rep} = \lambda_{700}+(\lambda_{740}-\lambda_{700})*[(((R_{670}+R_{780})/2)-R_{700})/ (R_{740}-R_{700})]$, (Guyot and Baret, 1988)

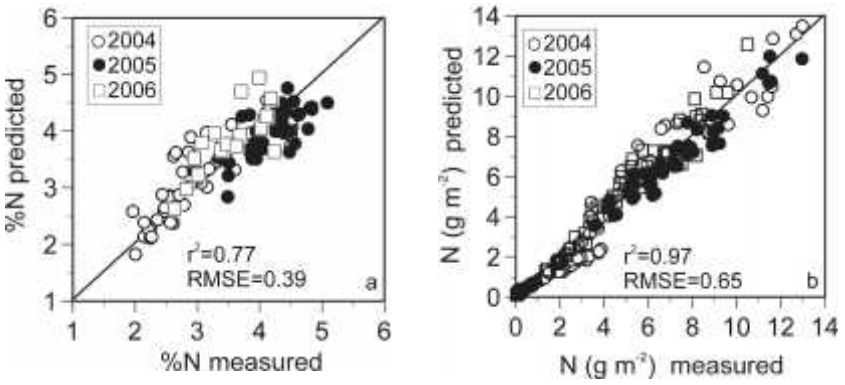
MTCI = $(R_{754}-R_{705}) / (R_{705}-R_{681})$, (Dash & Curran, 2006)

CCCI = (NDRE-0.34*NDVI)/(0.27*NDVI),

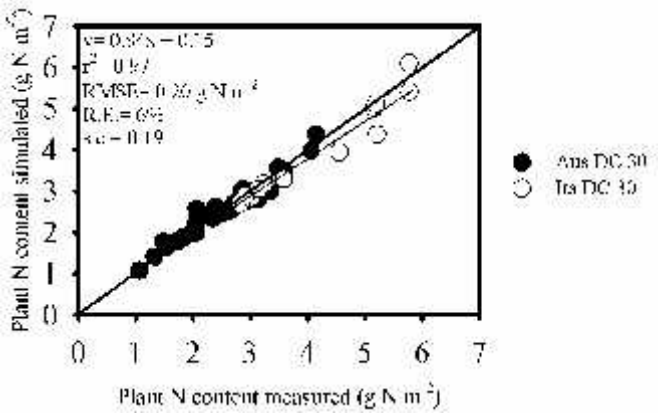
NDRE = $(R_{790}-R_{720}) / (R_{790}+R_{720})$

NDVI = $(R_{790}-R_{670}) / (R_{790}+R_{670})$, (Barnes et al., 2000)





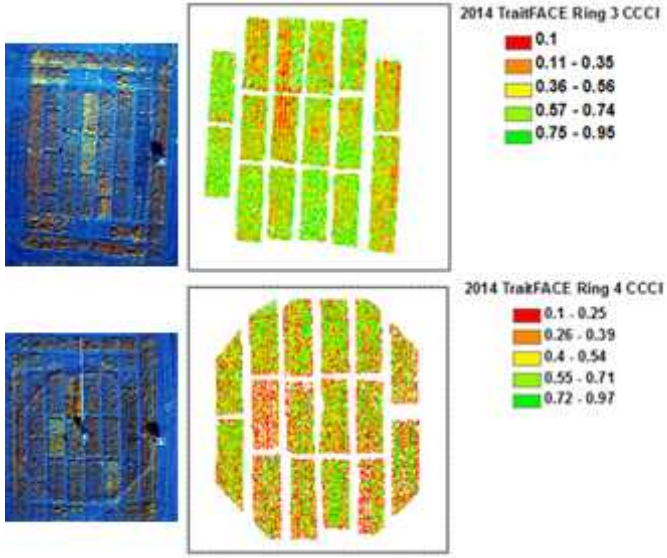
Fitzgerald et al., 2010



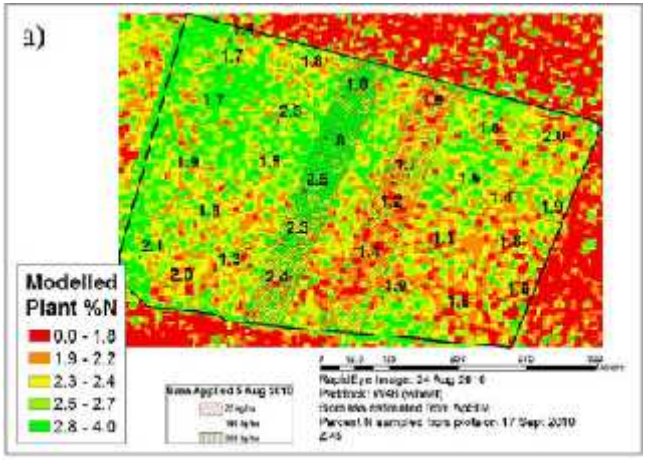
Cammarano et al., 2011

Mapping N with CCCI

- Satellite or Unmanned Aerial Vehicle (UAV)



Felderhof and Gillieson, 2011

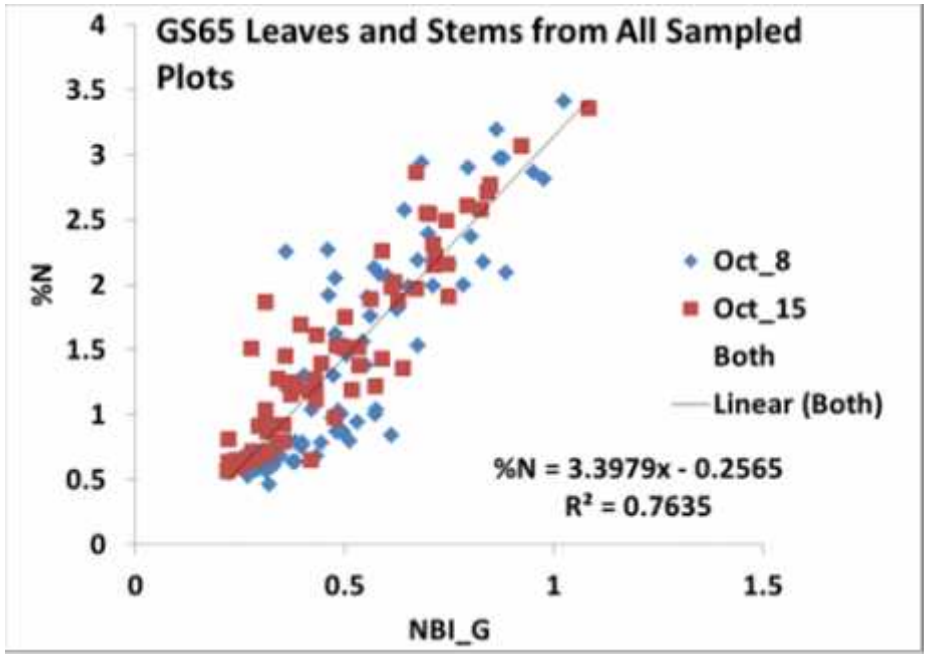


Perry et al., 2012

Fluorometer: Canopy N in wheat

Fluorescence

- Multiple indices
- NBI_G worked best

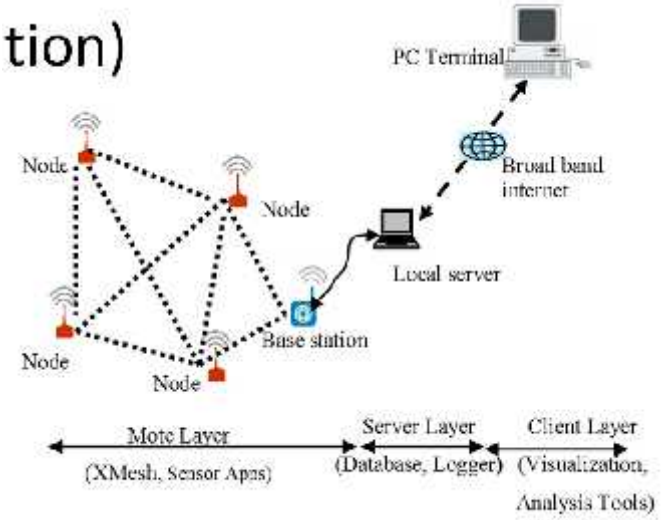


%N plant and 'NBI_G' fluorescence index at growth stage Zadoks 65 (heading) of wheat.

Future

Integration of sensors, platforms, wireless networks and modelling

- Thermal: Canopy temperature (water status)
- LiDAR: Canopy structure (biomass)
- UAV hyperspectral
- Microwave: (tree structure, soil water)
- Raman spectroscopy (chemical composition)



Devadas et al., 2011

Acknowledgements

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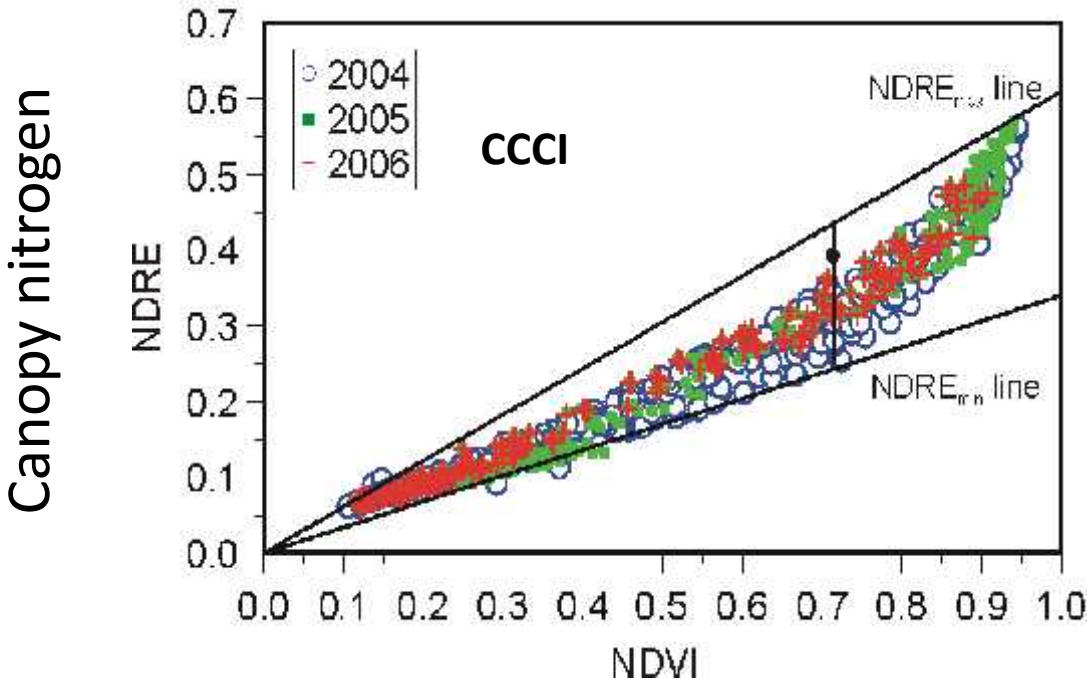
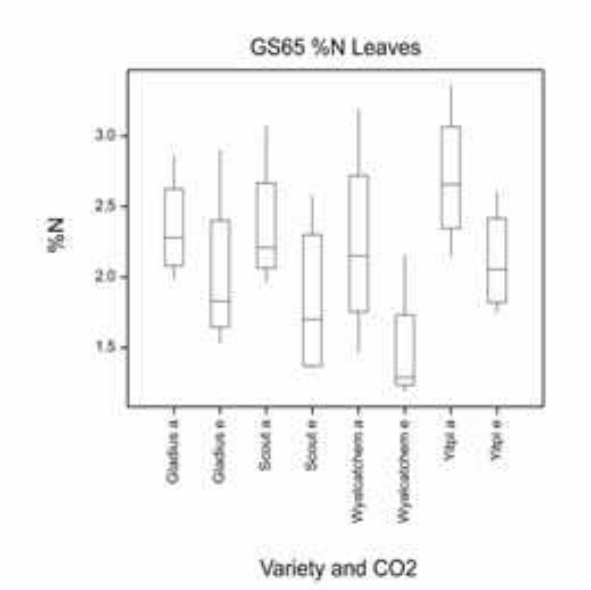
pips
Apples & Pears

Additional slides

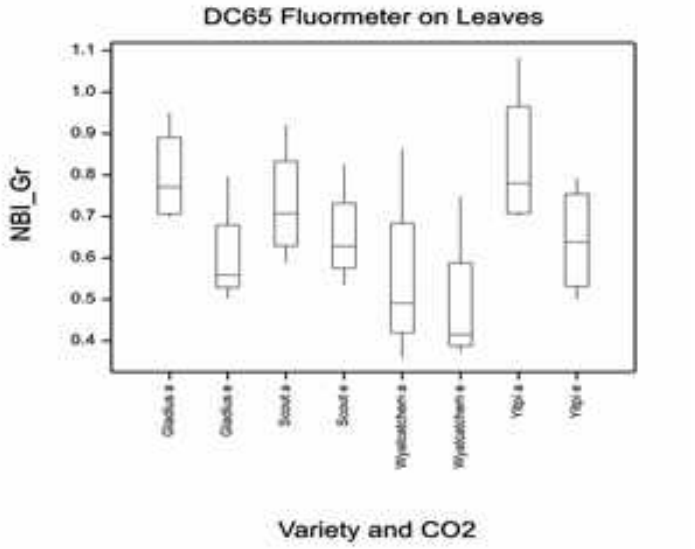
Derivation of CCCI



N and fluorometer



Reduction in %N due to elevated CO_2 across a range of wheat varieties at Z65 (heading), (p<005).



NBI_G index measurement of leaves across the same varieties in Fig. 3 (p<005).