Future farming:
Machine vision for in-season nitrogen assessment of grain crops

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Review – Nitrogen assessment in grain crops

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- Leaf or soil sampling -> time consuming and costly at spatial scale
- Traditional PA sensors NDVI and NDRE -> inconsistent linear relationships with N -> need new sensors and/or algorithms
- Alternatively machine vision could detect crop features linked with N algorithms

Sensors for nitrogen assessment:

Review – Machine vision for crop assessment

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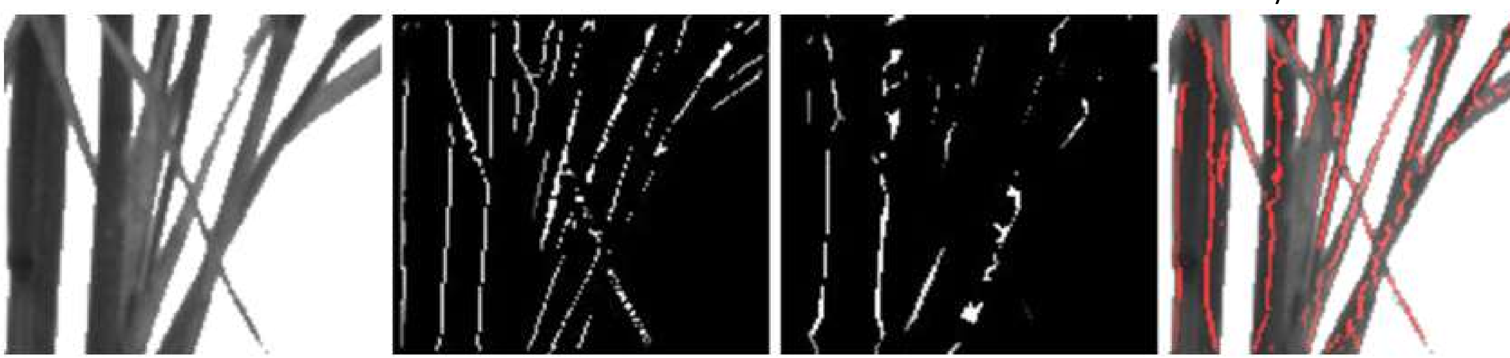
- Tillers, height, canopy cover and colour from on-the-go camera
- Image analysis algorithms include colour thresholding, shape and texture analysis
- Low-cost alternative to existing optical sensors

New sensor for nitrogen assessment?

Machine vision applications:

Source: Boyle et al. 2015



Source: McCarthy and Tscharke 2014

Nitrogen sensor – which crop features and inputs are needed?

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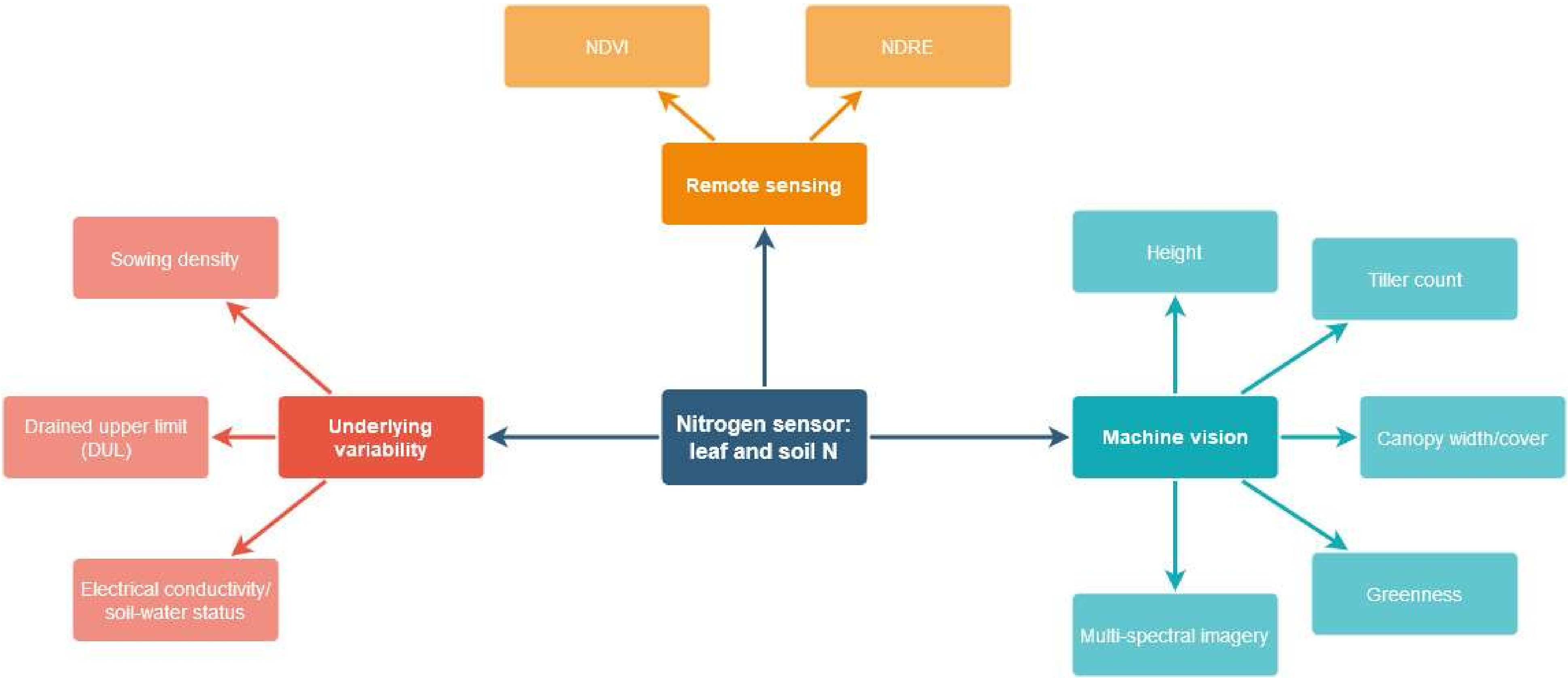

Nitrogen algorithms – traditional and machine learning approaches

- Potential inputs: remote sensing (NDVI/NDRE), crop features (tillers/height/width), underlying variability (e.g. sowing density)
- Traditional algorithm: linear model fitted from response in low and high nitrogen plots with most similar sowing density
- Machine learning algorithm: learning from training data to make predictions

Trial to compare inputs – field data collection and processing

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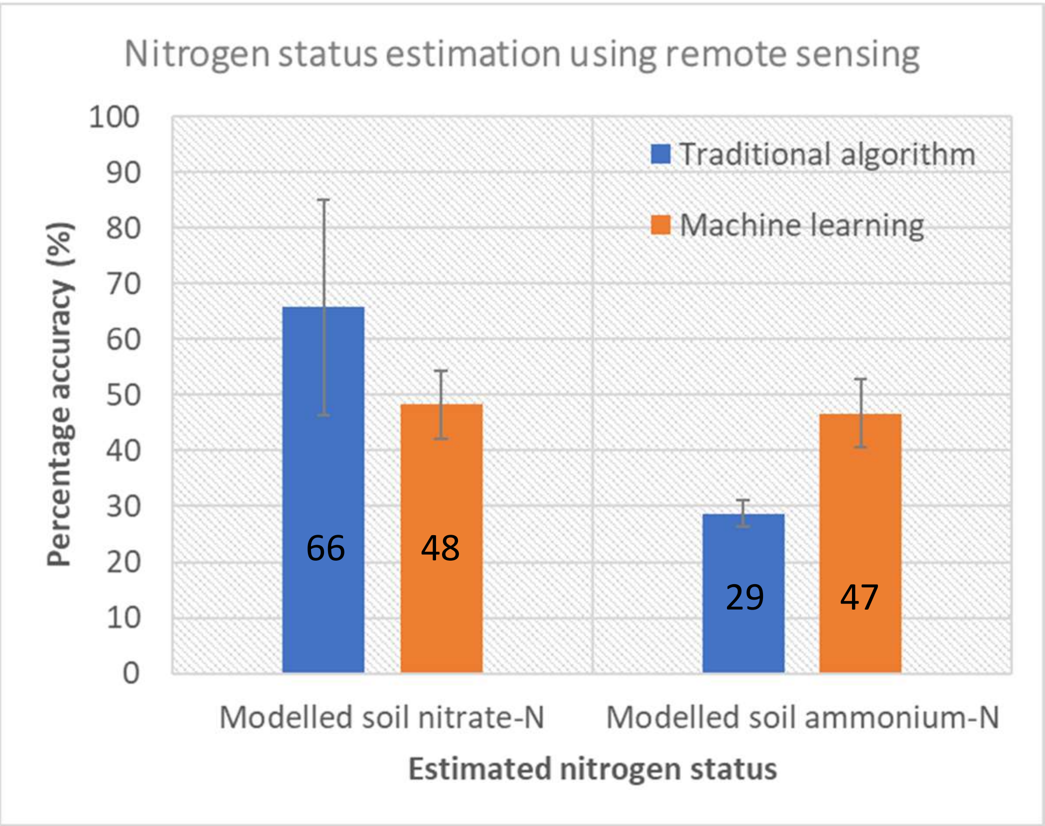
- Nine plots with N-minus and N-rich areas
- Measured weekly crop features (tillers/cover/height), remote sensing data (NDVI/NDRE), soil moisture content and density for underlying variability
- Estimated weekly soil nitrogen from APSIM and soil nitrogen at harvest
- Compared traditional and machine learning N algorithms

Field site for data collection:

N-rich area

N-minus area

Results – remote sensing or crop features



Results – remote sensing or crop features

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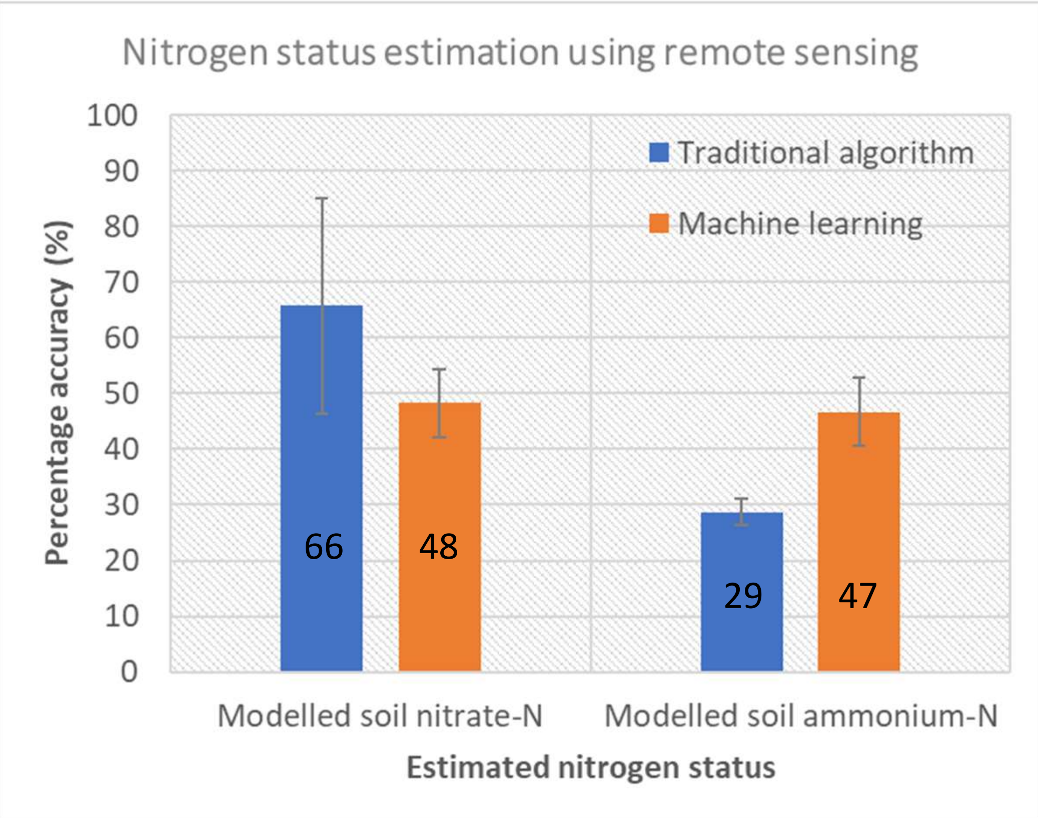
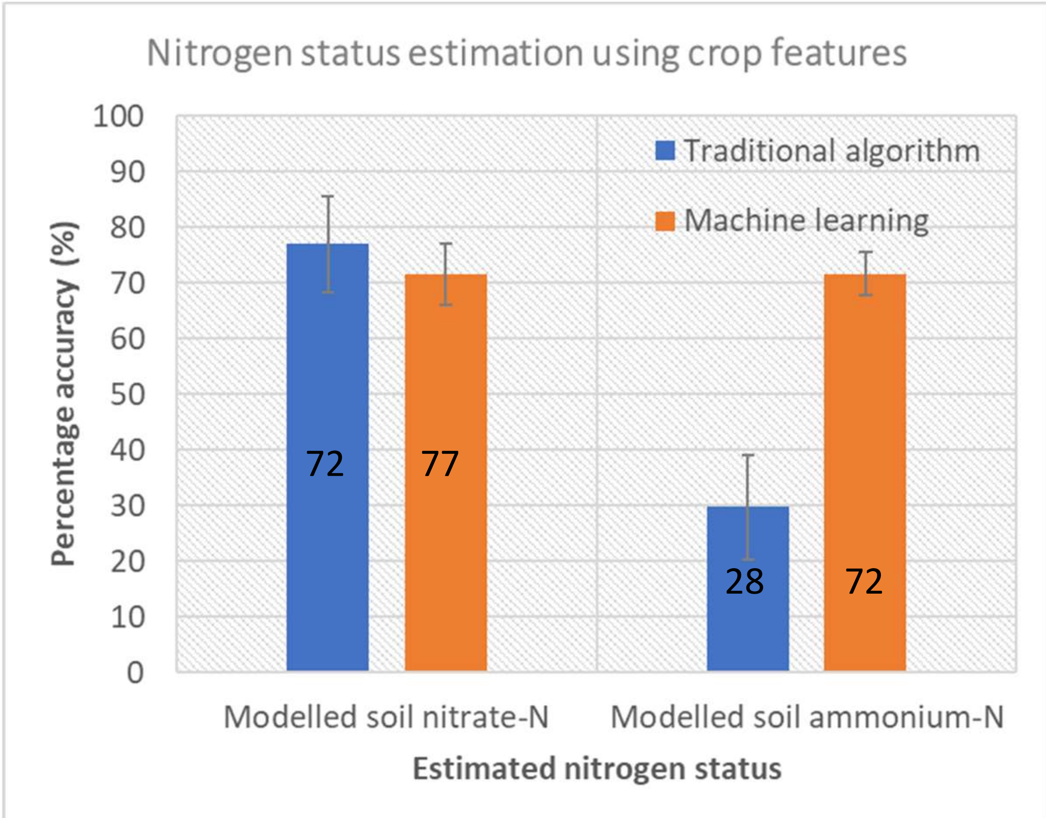


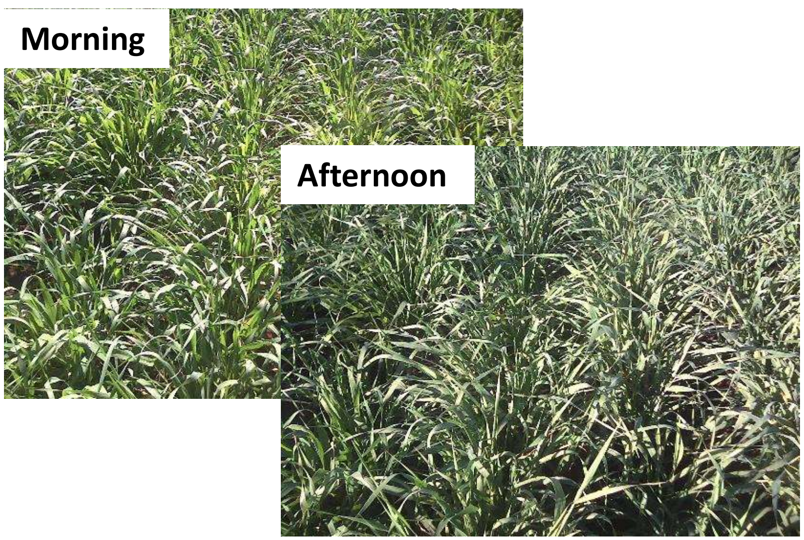


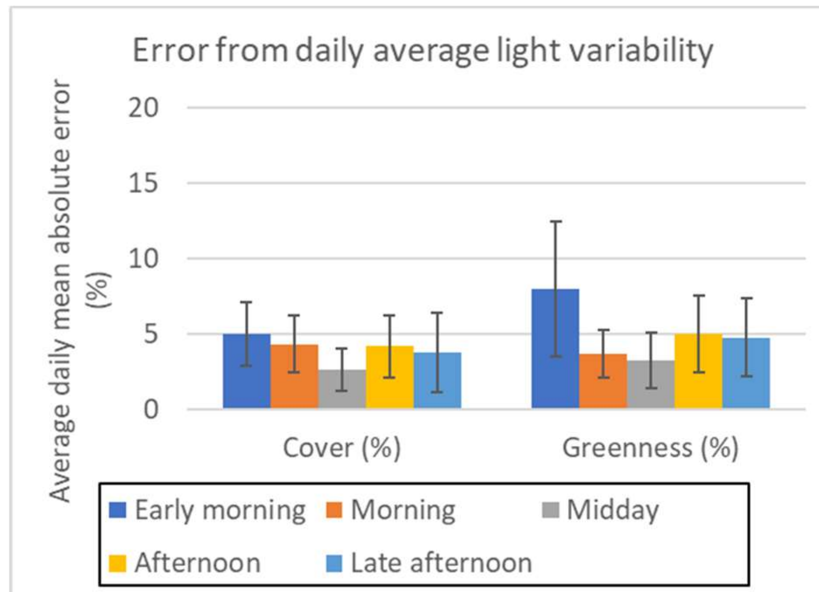
Machine vision robustness – camera image collection with lighting variations

- Collected images every 3 hours from infield cameras
- Compared robustness of canopy cover and greenness algorithms
- Errors <5%: lowest at midday, highest in early morning (consistent with NDVI)

Infield camera:

QSA:PRF12081





Conclusions

- Pilot study demonstrated potential for machine vision for in-season nitrogen status estimation
- Modelled soil nitrogen estimated with up to 77% accuracy with crop features and underlying variability (vs up to 66% with remote sensing)
- Further trials are refining and evaluating machine vision system at the Future Farm core sites

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