



Australian Government

Department of Agriculture
and Water Resources



UNIVERSITY
OF SOUTHERN
QUEENSLAND



Automated camera-based pasture monitoring for variable-rate irrigation

12th April, Mt Gambier, SE SA

Written by Dr Alison McCarthy; delivered by Dr Joseph Foley



Australian Government

Cotton Research and
Development Corpora^{tion}



tia
TASMANIAN
INSTITUTE OF
AGRICULTURE

12081



Sugar Research
AustraliaTM

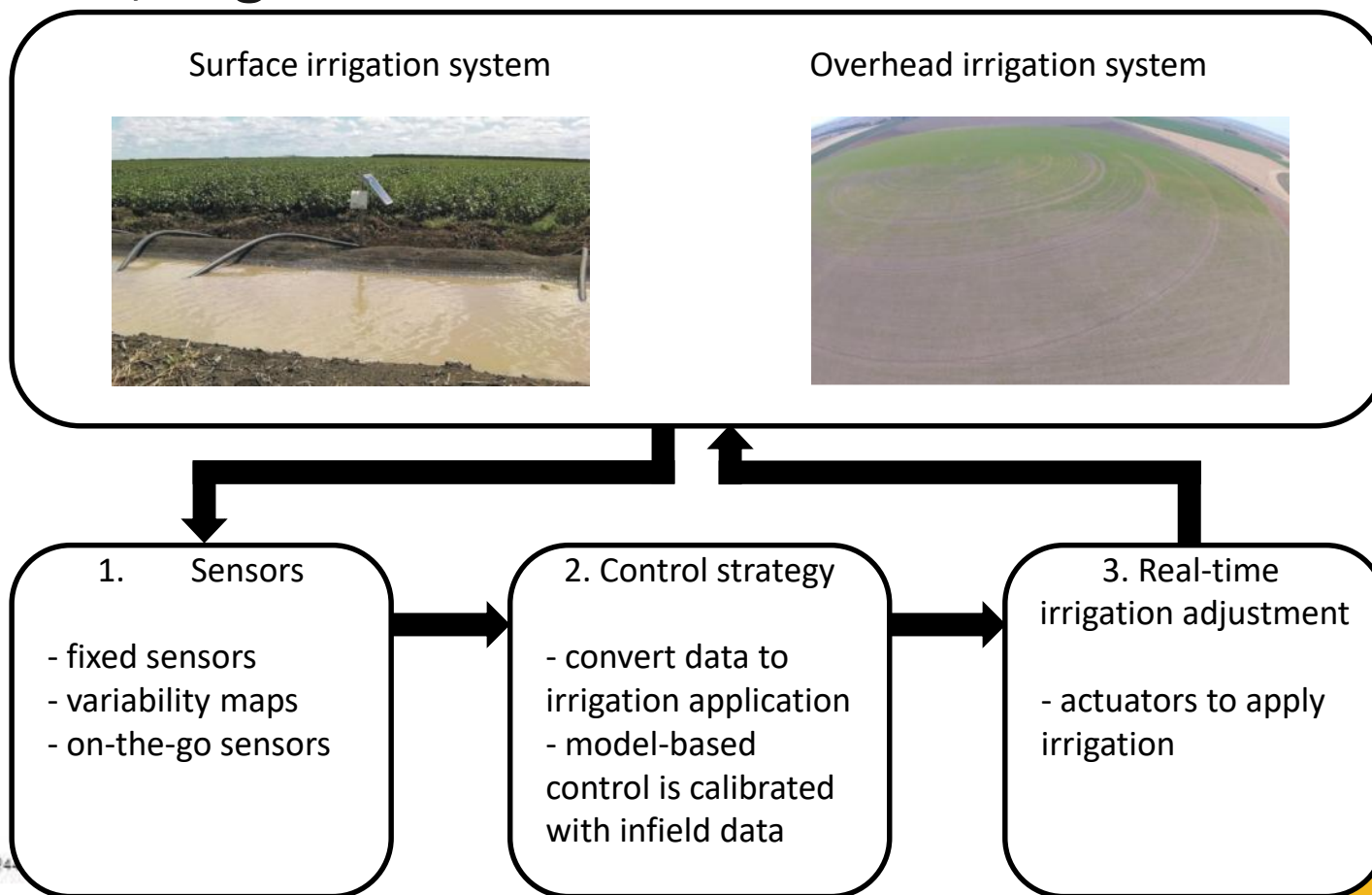


Dairy
Australia

NCEA VRI research



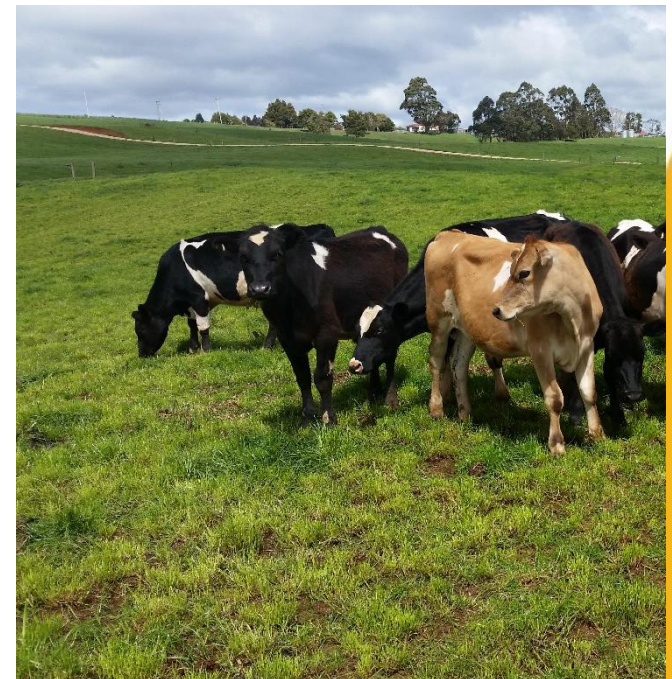
- Variable-rate irrigation is not adaptive
- Developing automated control strategies – dairy, cotton, sugarcane



Pasture growth rates – assess, optimise



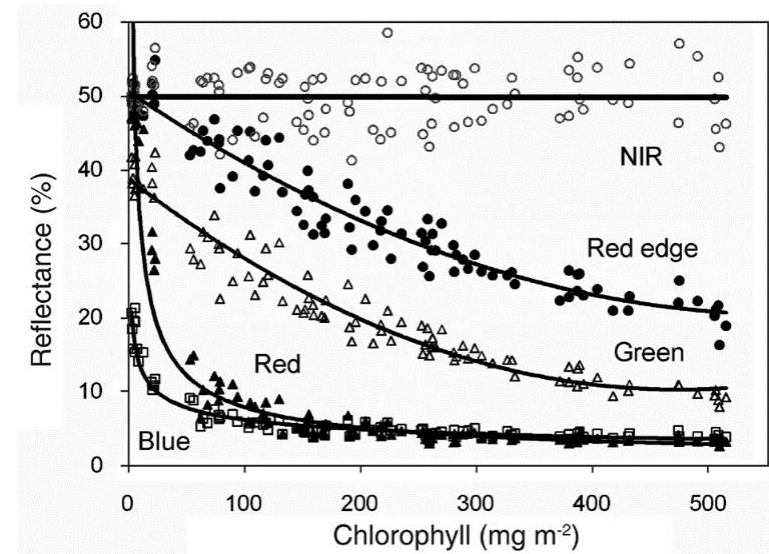
- Typically conducted manually
- Need automated pasture sensors to reduce labour and improve temporal and spatial resolution of pasture assessment
- Then can link with pasture prediction and site-specific irrigation optimisation



Pasture growth rates – imagery approaches



- Typical automated image analysis from cameras assesses canopy cover using green channel or NIR imaging
- NIR helps to increase contrast for distinguishing canopy from bare soil/stubble
- But NIR cannot detect chlorophyll or stress levels in plants


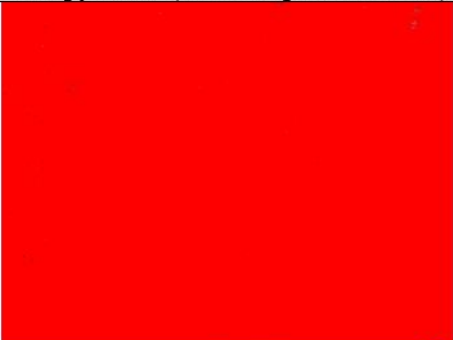



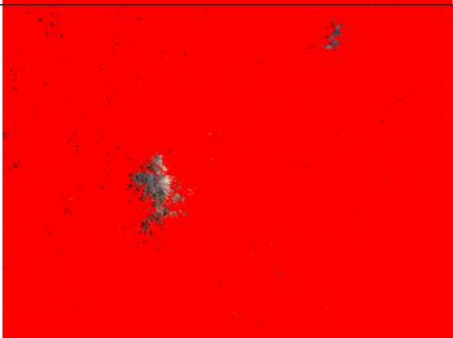


Source: Steele et al. 2008

Pasture growth rates – technique comparison



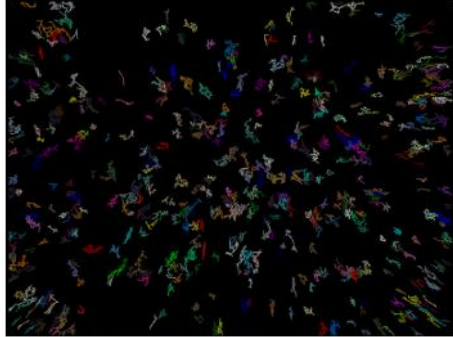


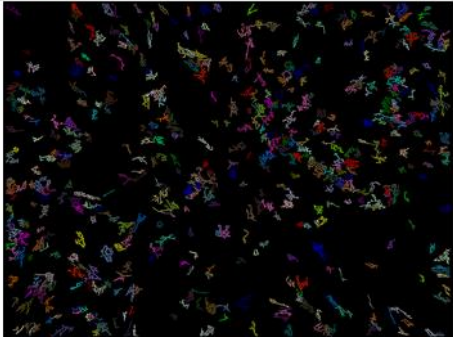

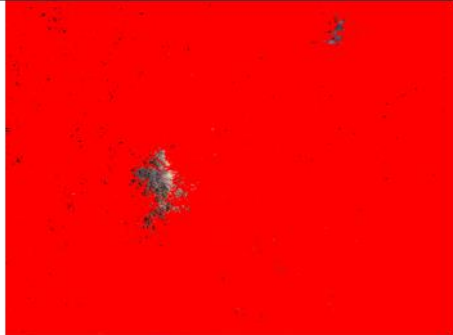
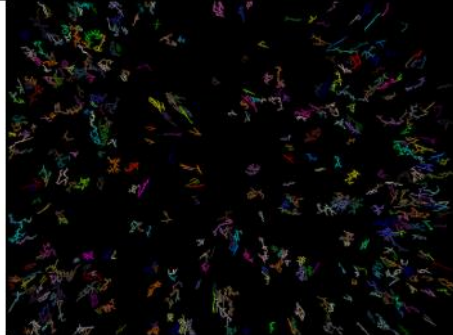


- Also canopy cover often does not indicate dry matter:

Original image	Canopy cover (detected pixels are red)	
		100%
		100%
		95%

Pasture growth rates – technique comparison

■ Instead we can apply texture analysis to same image:

Original image	Canopy cover (detected pixels are red)	Detected lines
		
		
		

46 mm

86 mm

100 mm

Pasture growth rates – fixed infield cameras



- Sensors installed on irrigation machine to collect imagery while passing over field
 - Reduces labour in data collection
 - Potential for fully automated collection and analysis
- Solar-powered smartphones on irrigation machine
 - 2 at Donovans pivot
 - 11 on two machines in Tasmania

Smartphone camera:



Pasture growth rates – texture analysis

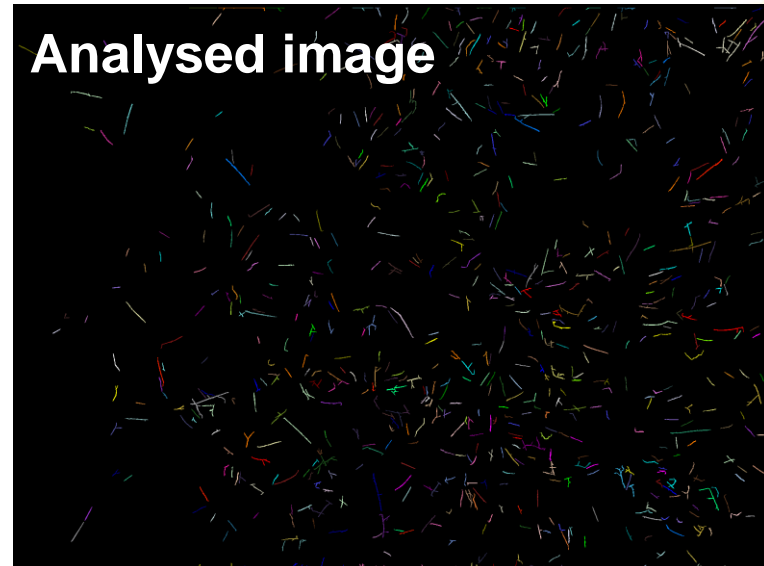


- Implemented texture analysis to extract:
 - number and length of ryegrass blades
 - greenness of canopy
- Identify correlation between pasture height and dry matter at sites in Tasmania

Original image



Analysed image



Pasture growth rates – algorithm evaluation



- Compared blade length and density with height from C-Dax
- Correlations between pasture height and blade length, density and greenness

Image analysis of blade length

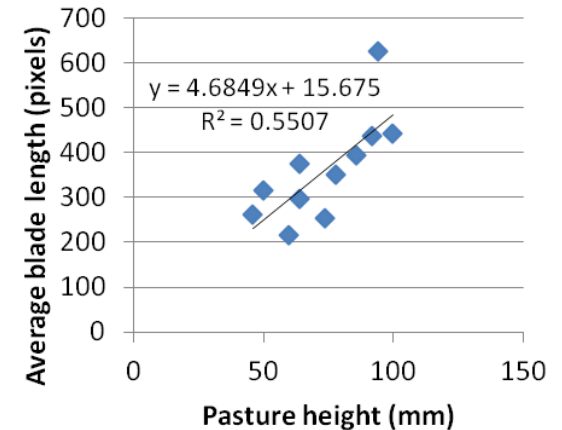


Image analysis of greenness

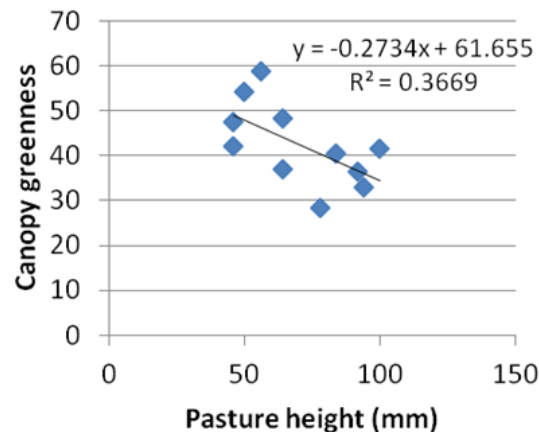
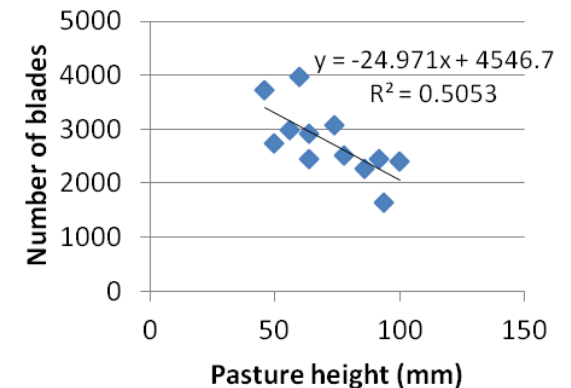


Image analysis of number of blades



Pasture growth rates – algorithm evaluation



- Compared blade length and density with height from C-Dax
- Correlations between pasture height and blade length, density and greenness
- Confirms no relationship between canopy cover and pasture height

Image analysis of blade length

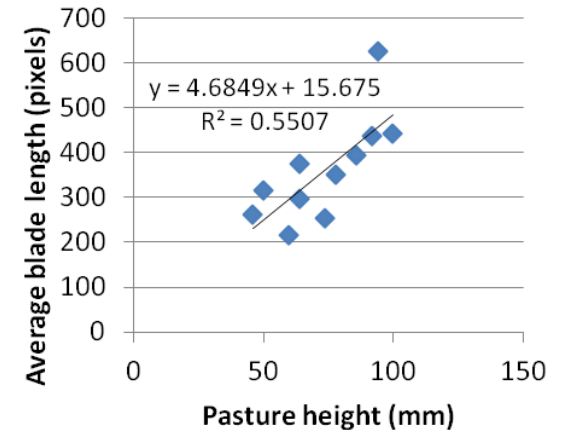


Image analysis of canopy cover

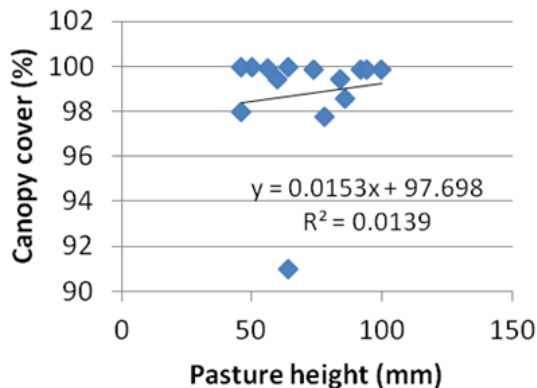


Image analysis of greenness

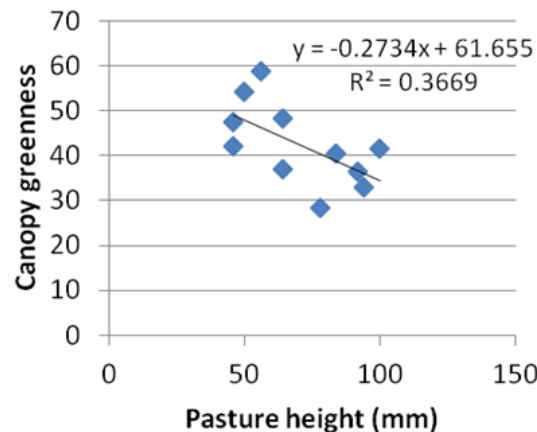
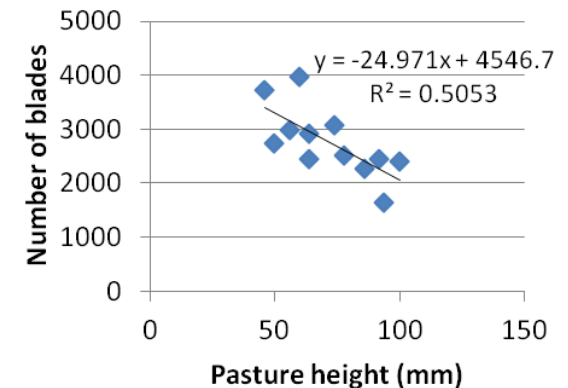


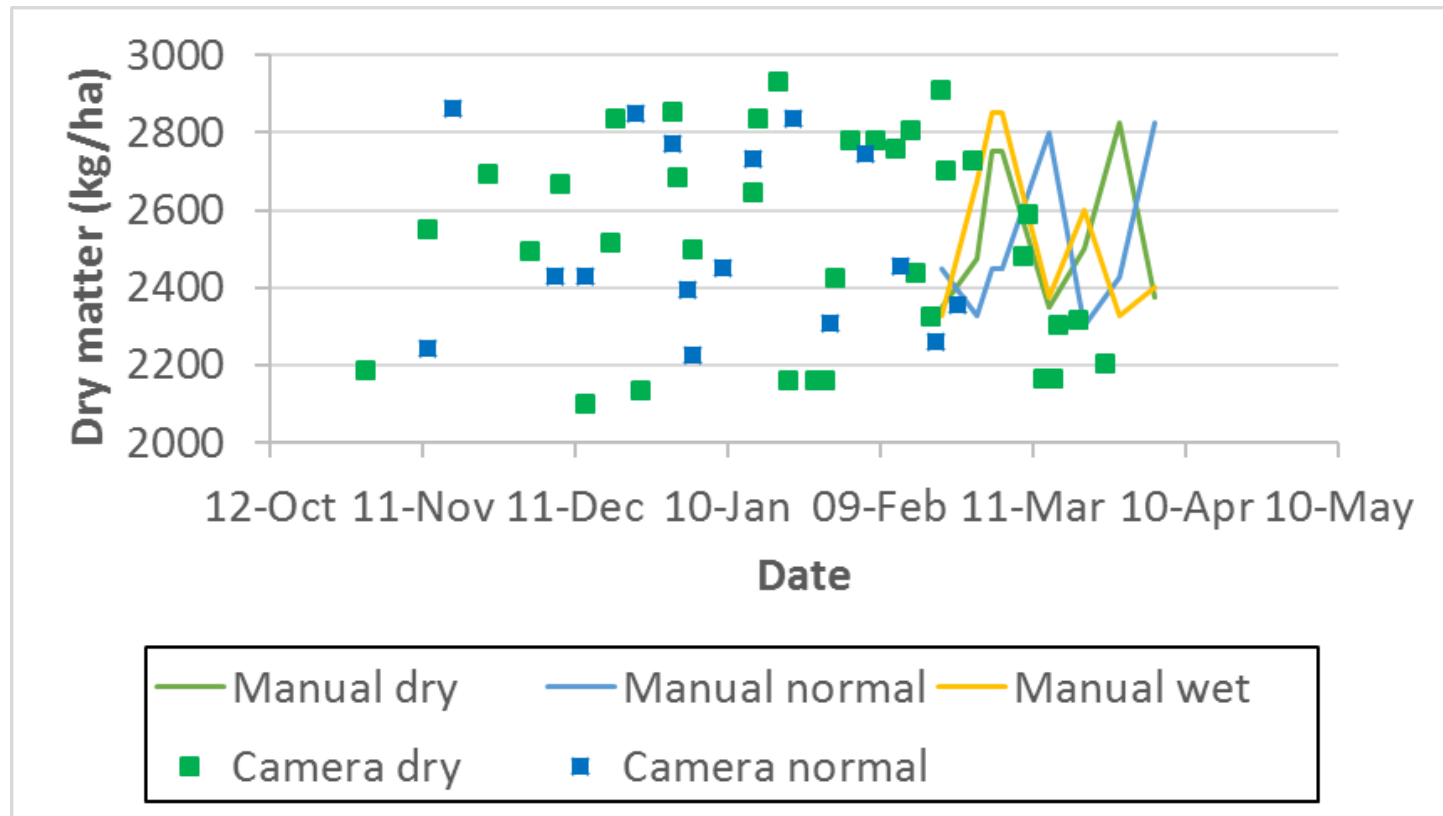
Image analysis of number of blades



Pasture growth rates – SA



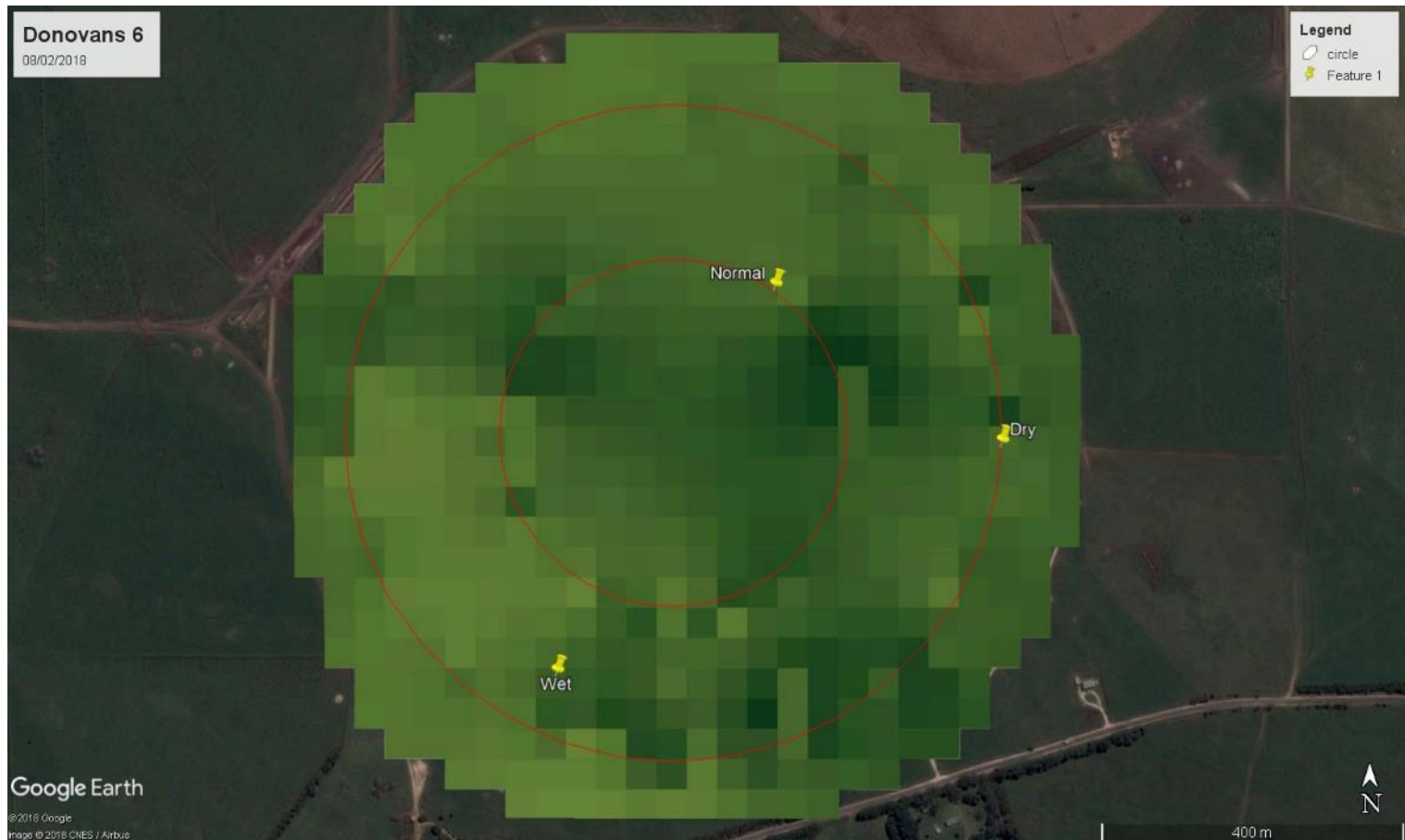
- Compared dry matter estimated from cameras and infield observations



Pasture growth rates – SA



- Spatially interpolated camera measurements over season



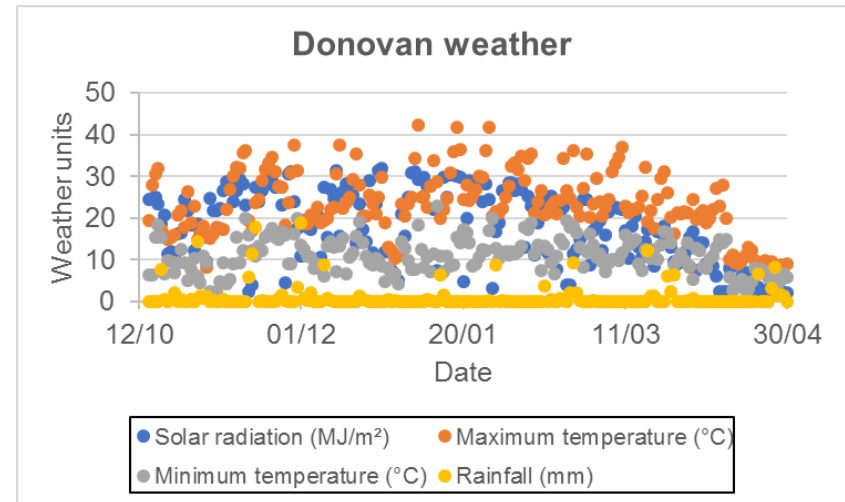
Pasture growth prediction, optimisation



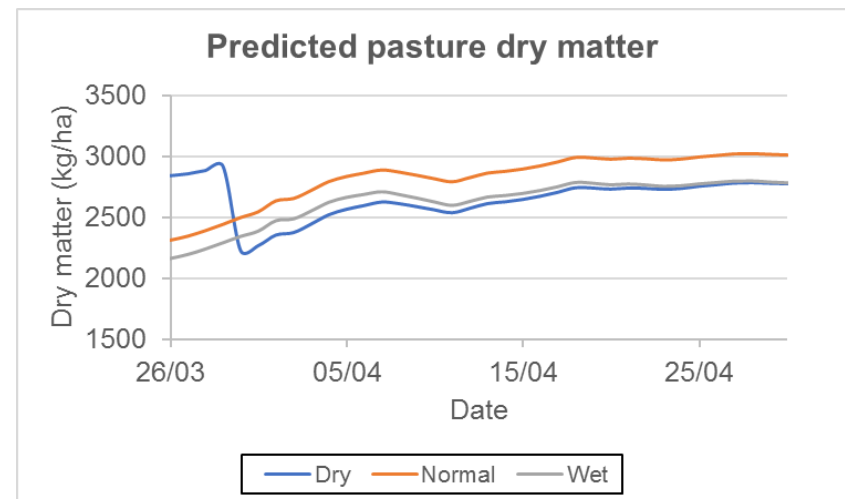
- Linked infield measurements with APSIM's AgPasture model for pasture growth optimisation:

- Local weather
- Grazing dates
- Dry matter from cameras
- Soil types in field

Input weather data:



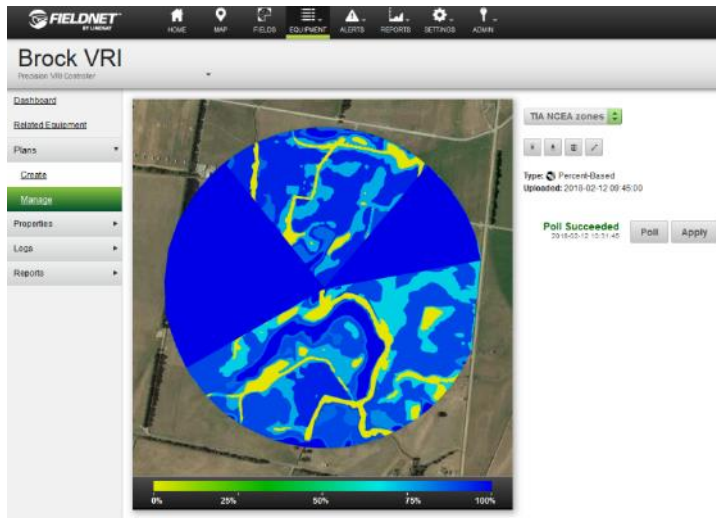
Predicted dry matter:



Prescription map development



- Irrigation optimisation linked with variable-rate hardware for Valley and Lindsay Zimmatic machines for cotton and dairy:



Research
National Centre for
Engineering in Agriculture

Conclusions



- Camera-based growth rate monitoring for dairy pasture increases spatial and temporal resolution of measurement
- Cotton variable-rate irrigation led to 9% water use efficiency improvements consistent with prior trials
- Automated variable-rate irrigation maps for both Valley and Lindsay Zimmatic reduces labour and potential for increased adaptability and repeatability



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