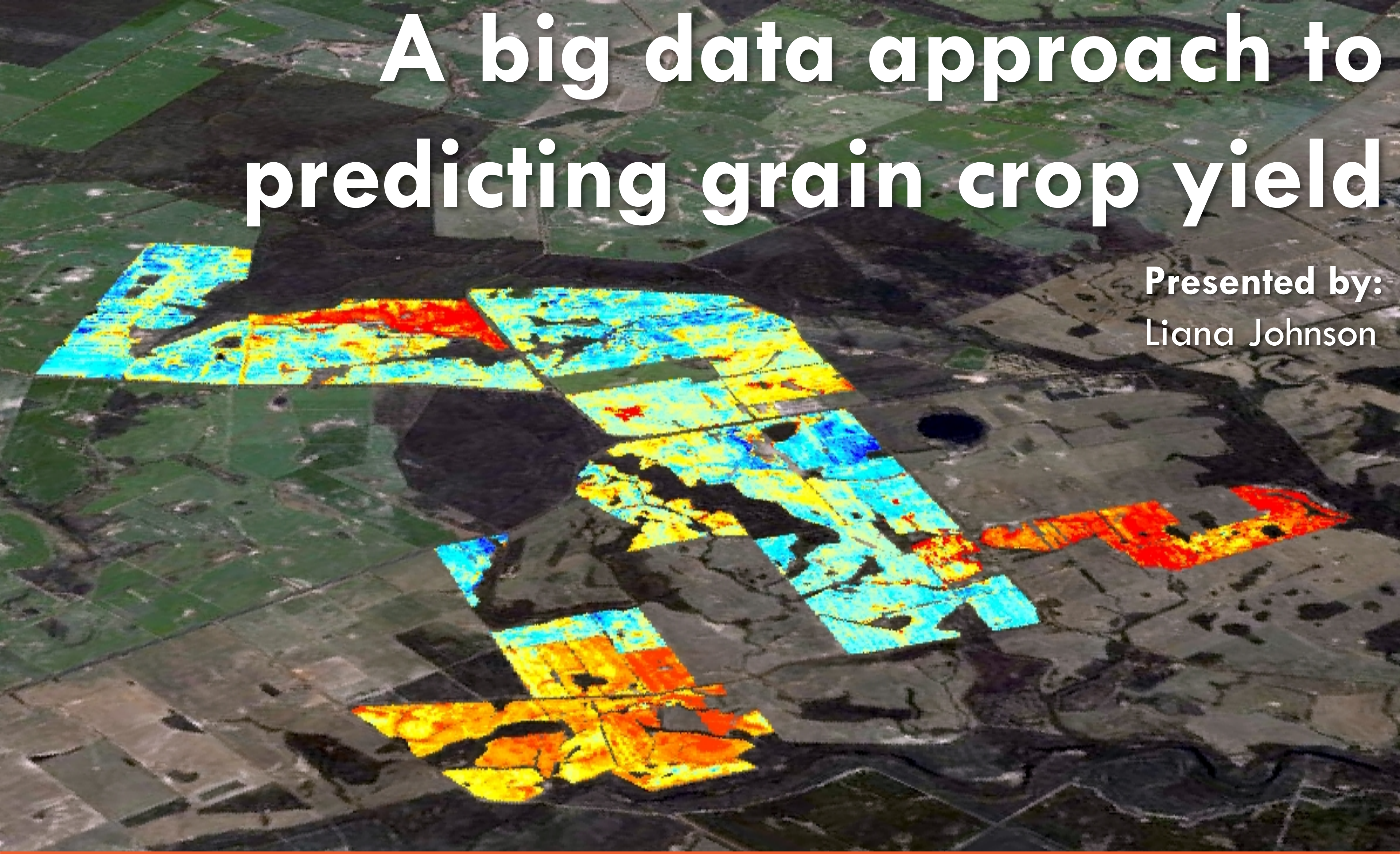
A big data approach to predicting grain crop yield



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A problem

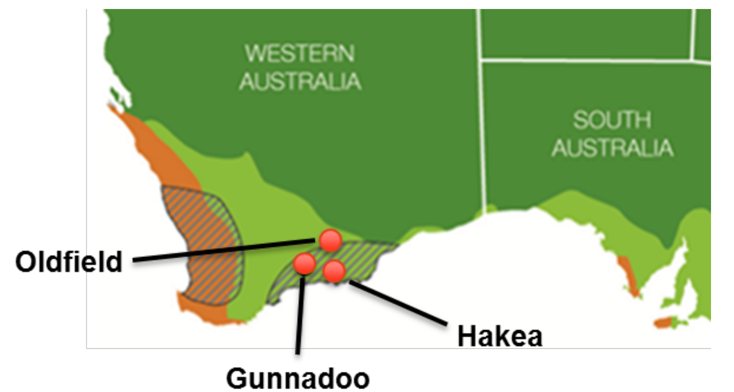
- Farms across Australia have large amounts of unused data
- This data may be difficult to utilise to make management decisions
  - → Different formats and located in a variety of repositories
  - → Different spatial and temporal resolutions

http://resources2.news.com.au/images/2013/12/05/1226776/186626-.jpg

How can we transform all of these disparate data streams into something useful, and then inform management decisions?

An opportunity

- Hackathon run by CSIRO and Lawson Grains
- Provided us with an abundance of spatial agricultural data (~15, 000 ha)
  - Yield
  - EM and gamma surveys
  - Management data
  - Soil tests



- There is a also a lot of publicly available spatio-temporal environmental data
  - Rainfall, soil map of Australia, remote sensing etc.

Available spatial and temporal data

Provided farmer data:

- Yield – 10 m (space & time)
- Radiometrics – 10 m (space)
- EM surveys – 10 m (space)
- Soil test results (space & time)

High spatial resolution data

Project-created data

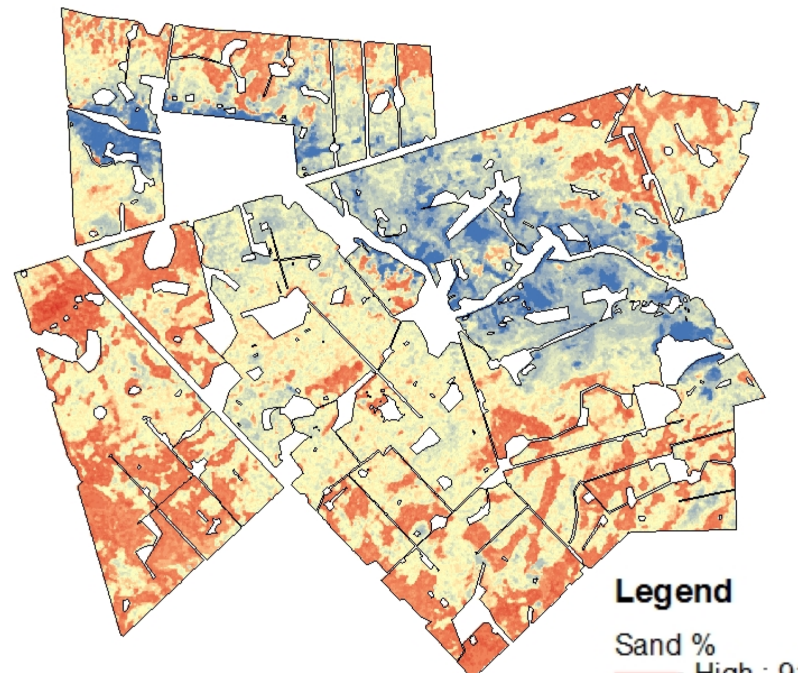
- Clay and sand soil maps – 10 m (space)

Publicly-available data:

- TERN – soil maps ~ 90m (space)
- NDVI – 250 m & 16 day (space & time)
- Rainfall forecasts – monthly (time)
- Rainfall received – 5km & daily (space & time)

Within-season measurements

Hakea Sand % 0-50 cm



Approach: Our predictive model

- Using this farmer data and publicly-available datasets, we created a model to predict the yield for these three crops in the production rotation:
    - **Wheat**
    - **Barley**
    - **Canola**

- Modelling method: Machine learning (Random Forest)

  → Data-driven rather than mechanistic

- The idea is to use the data from <u>all</u> fields and years to predict yield within each individual field for a farm

Modelling for decision support

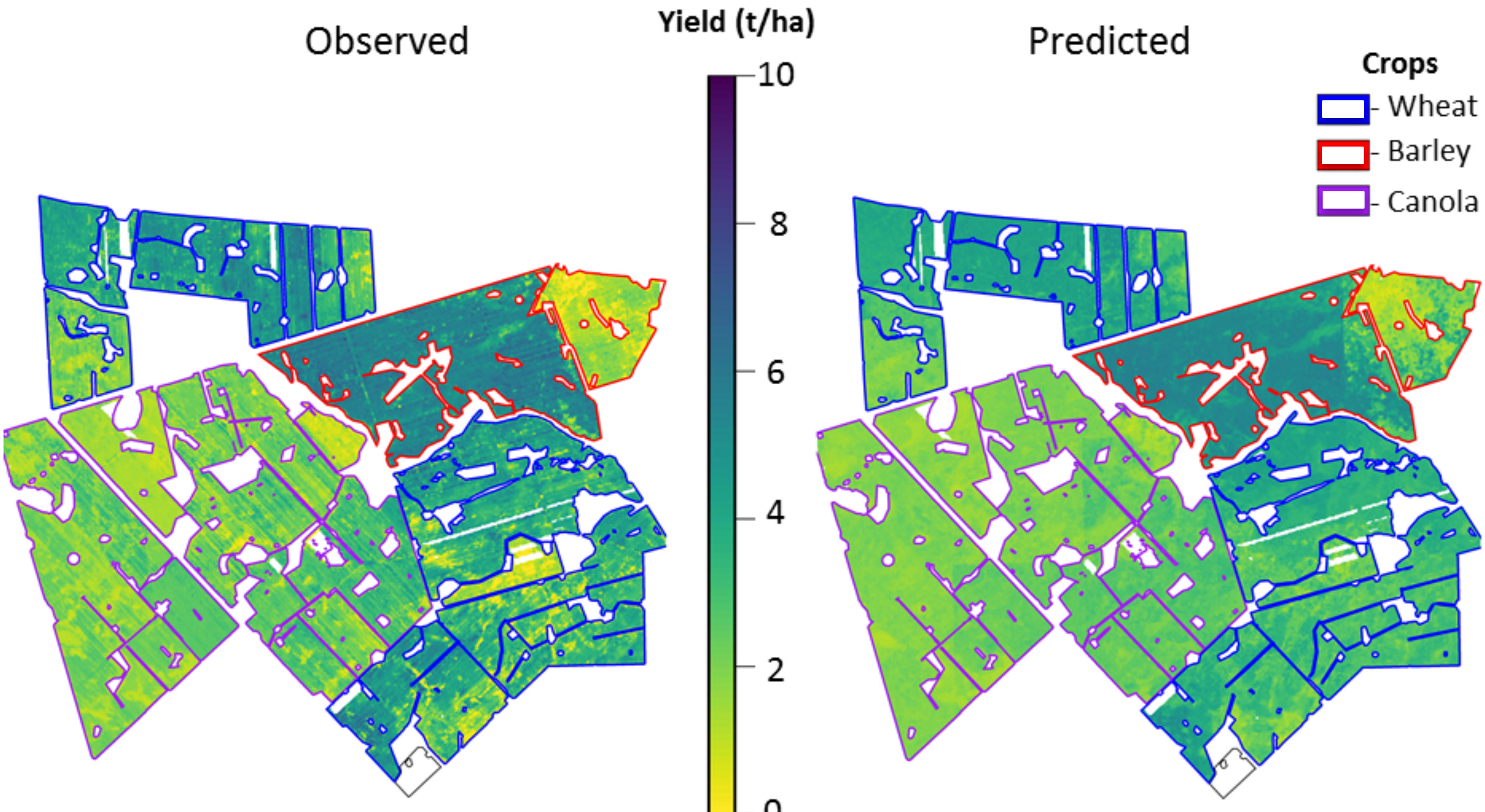
– 3 different predictive yield models for 3 important time points to inform key management decisions:

1. **APRIL MODEL**
   » To provide suggestions for **variable sowing N rates**
2. **JULY MODEL**
   » To provide suggestions for **variable top-dress N rates**
3. **SEPTEMBER MODEL**
   » To determine **final yield prediction**

– More data becomes available as the season progresses

Results – Map example

10 m resolution   Hakea - July 2015



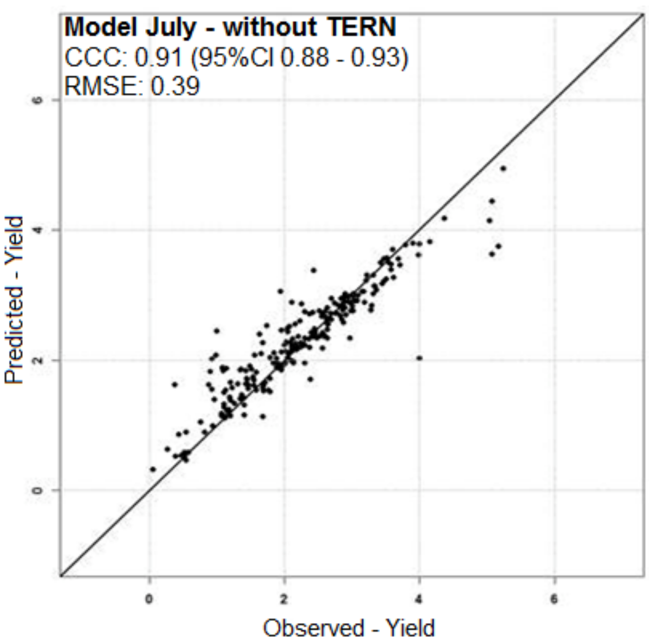
5,500 Ha

Results – paddock resolution model assessment

1. Predict yield within a paddock, all years of previous yield data <u>excluded</u>
2. Predict yield within a paddock, previous yield data <u>included</u>

TIME	APRIL		JULY		SEPTEMBER	
CV PADDOCK PREDICTIONS	RMSE (t/ha)	LCCC	RMSE (t/ha)	LCCC	RMSE (t/ha)	LCCC
1) Without previous yield	0.64	0.19	0.63	0.20	0.62	0.27
2) With previous yield	0.42	**0.89**	0.39	**0.91**	0.36	**0.92**

BEST MODELS



- LCCC of 1 characterises a perfect fit
- Including previous data from the prediction paddock results in a better prediction
- Models are very good

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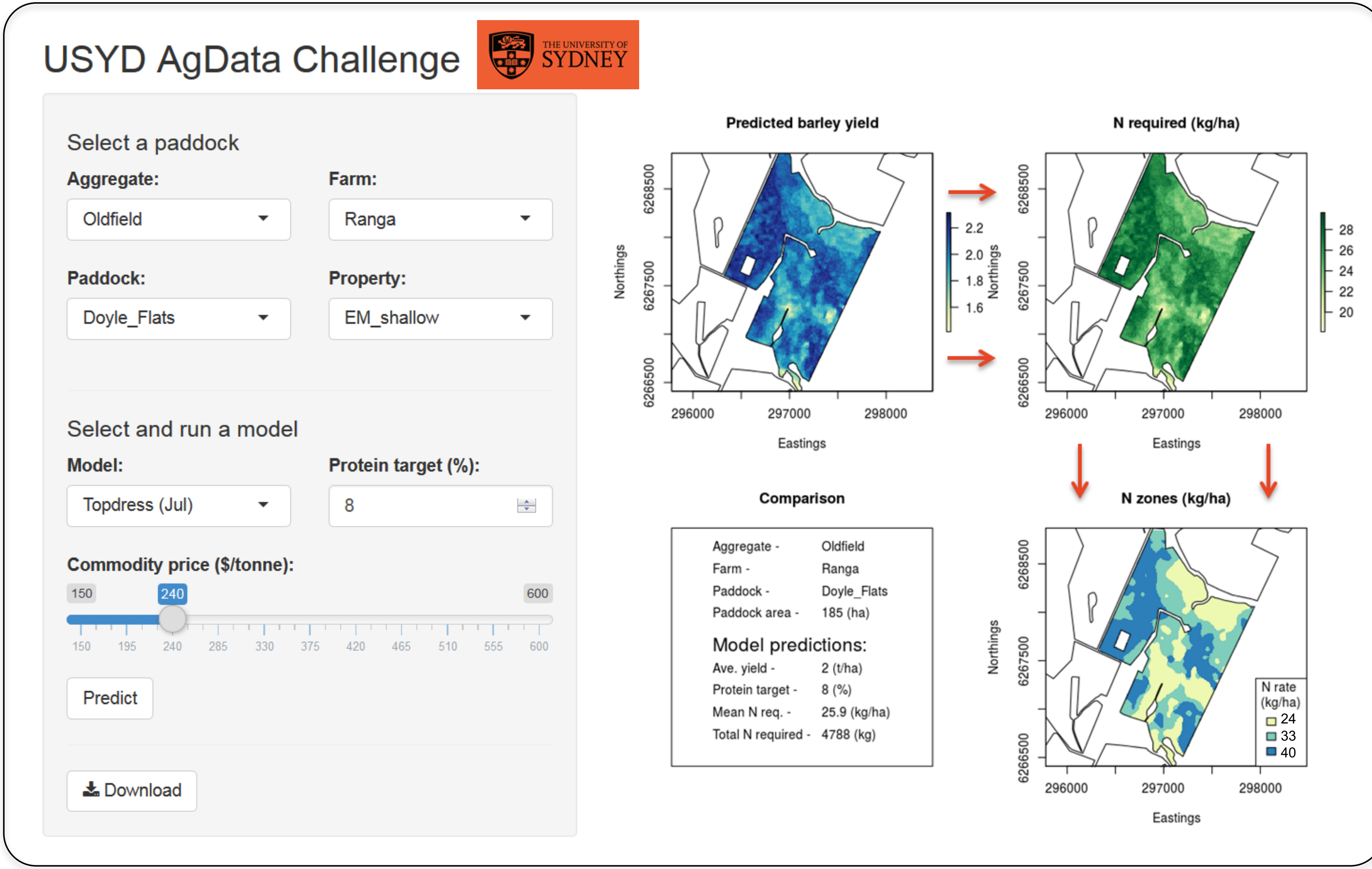
We have a model that predicts yield, but how can we make this <u>useful</u> and <u>user-friendly</u> for growers and consultants to inform management decisions?

Answer: Our user interface



Conclusions

- We used large amounts of agricultural and environmental data to:
  - accurately predict wheat, barley and canola yield across a collection of farms
  - developed a user-friendly application for farmers to aid key management decisions

What next?

- More data, more accurate predictions- model will improve over time

  → potential to integrate fine spatial resolution remote sensing (drones, Landsat, Sentinel etc.)

- With more consistent data collection it will be useful for:
  - Identifying yield gaps
  - Sowing seeding rate
  - Variable rate application – Lime, P, K & S
  - Futures contracts and market speculation

For any cropping system