Beyond Crop Production Estimates: Integrated climate, biophysical and remote sensing approaches

"If you can look into the seeds of time, and say which grain will grow and which will not, speak then unto me. "

William Shakespeare

A Potgieter et. al.

The University of Queensland Australia

QAAFI Queensland Alliance for Agriculture and Food Innovation

Queensland Government

DATA ≠ Application

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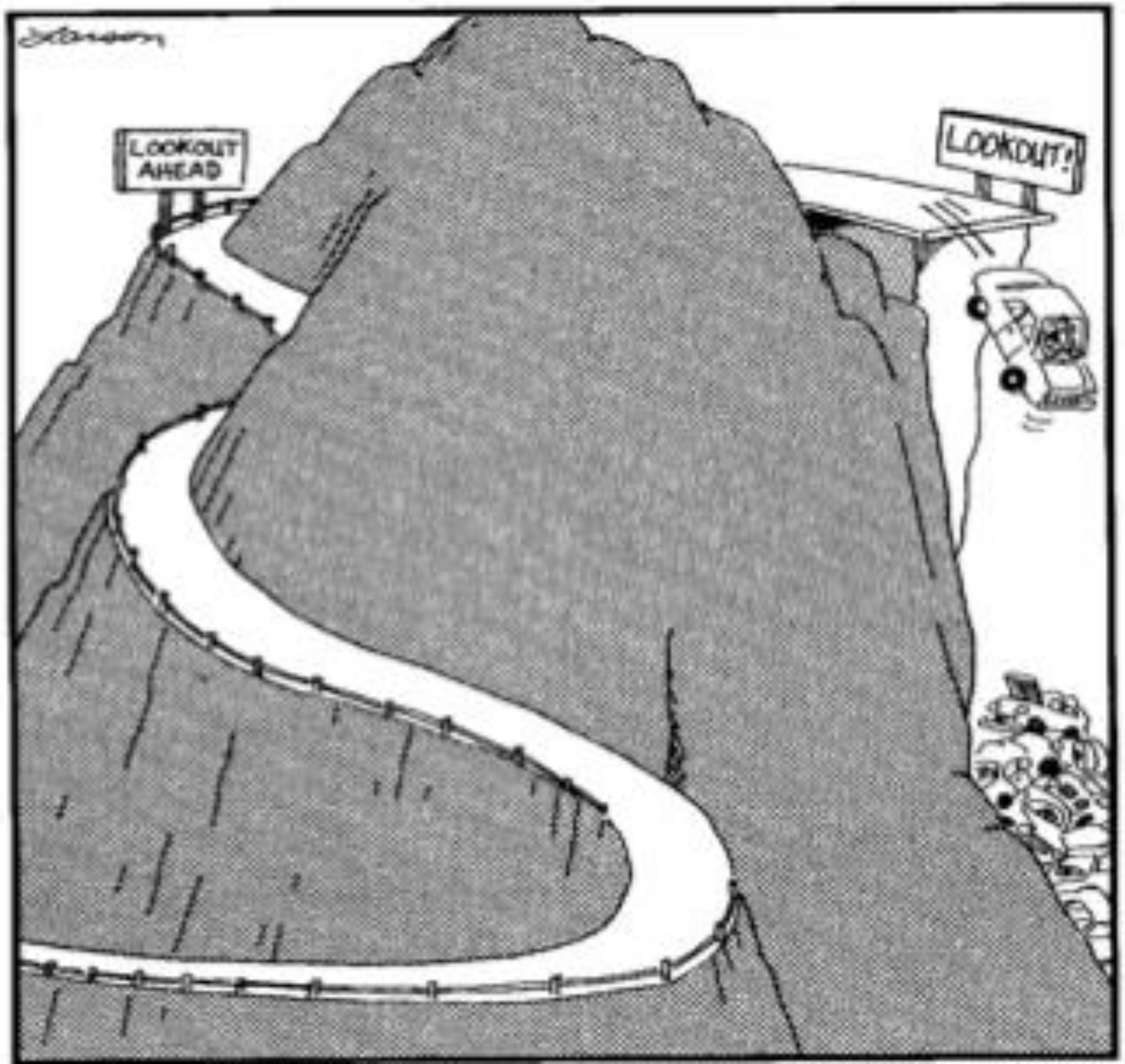


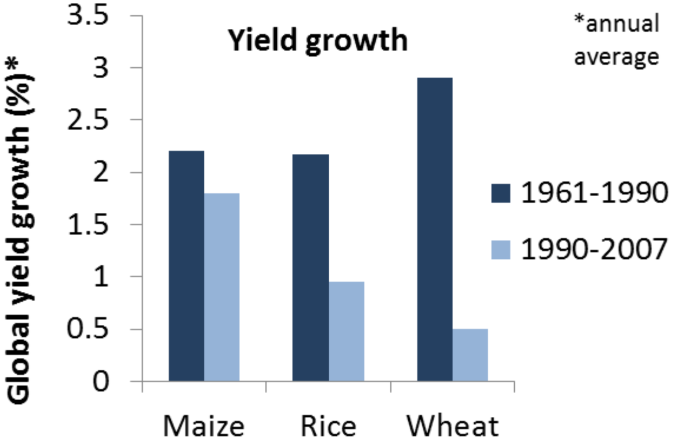
The right answer to the wrong question

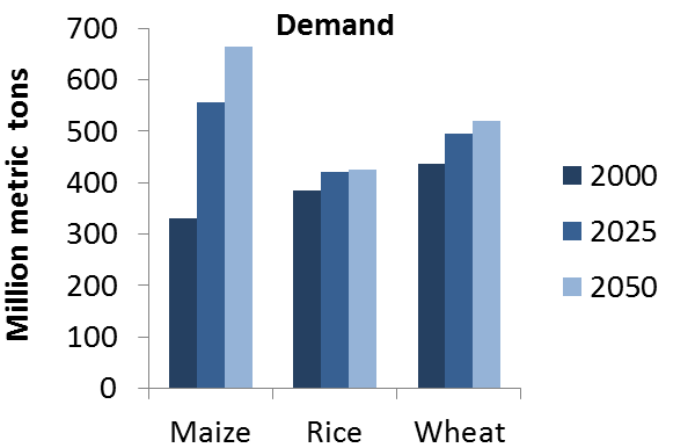
therefore…

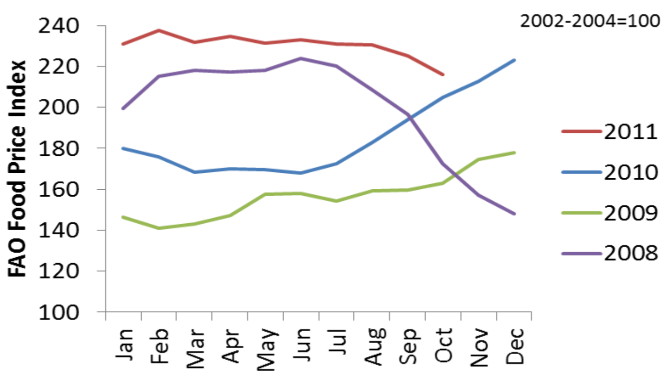
Asking the right questions before starting to collect DATA

Centre for Plant Science

Global food supply and demand (food security)



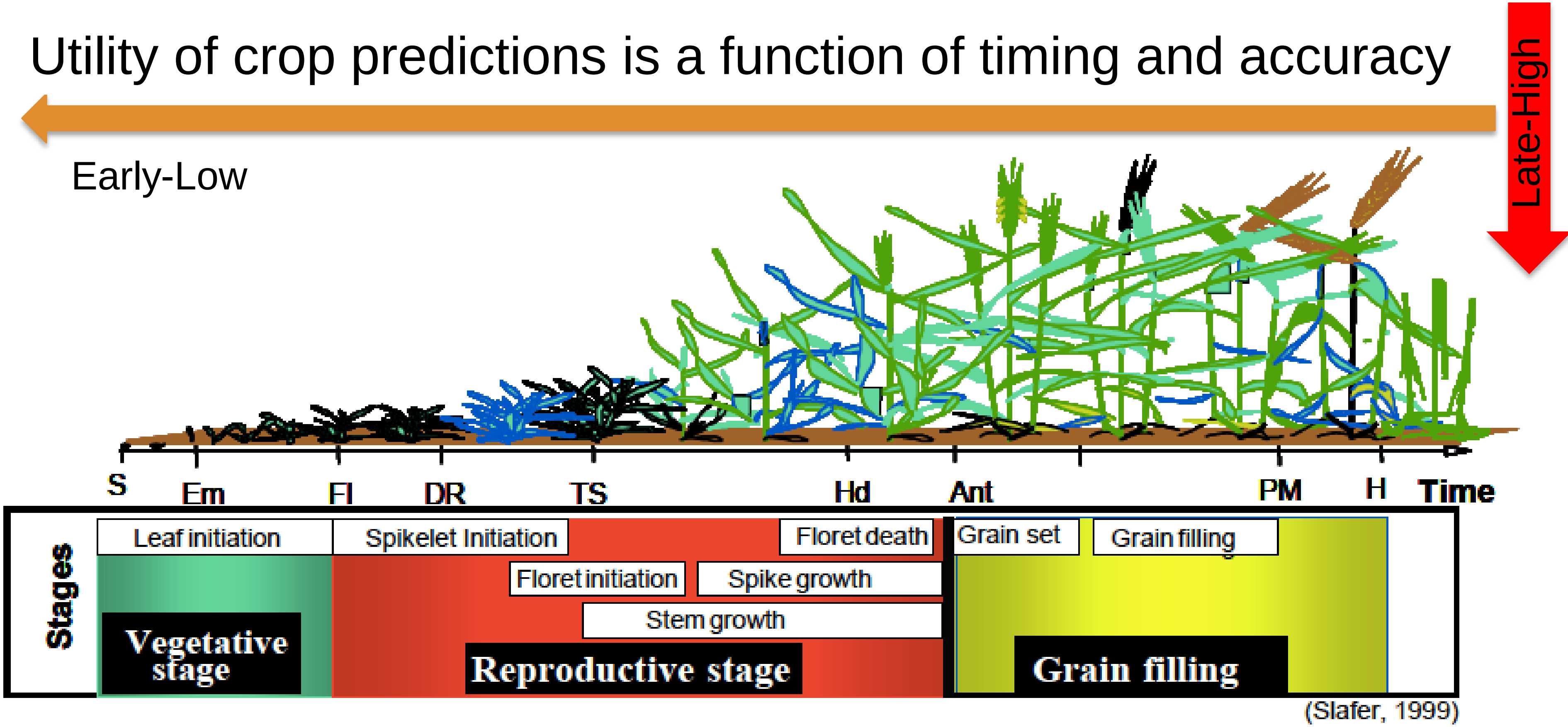




- Challenge – production nearly DOUBLE by 2050,
- Yield growth of most crops is declining,
- Demand for maize, rice and wheat is increasing and
- Population increased by 40% by 2050
- International markets fail the poor.
- Thus, knowledge of How Much, Where and When is produced will become

Predicting Plant Growth

Utility of crop predictions is a function of timing and accuracy



Crop life cycle duration is closely associated with temperature

Example 1: USA maize yields

David Lobell,

Stanford University, USA

A scalable crop yield mapper (SCYM)

ELSEVIER

Remote Sensing of Environment

journal homepage: www.elsevier.com/locate/rse

A scalable satellite-based crop yield mapper

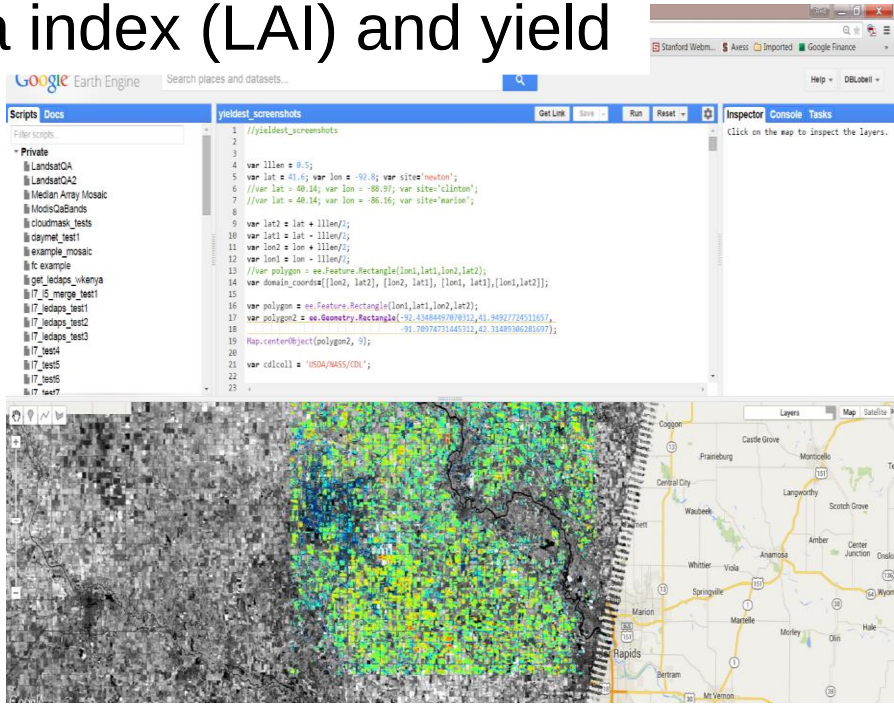
David B. Lobell [a,*], David Thau [b], Christopher Seifert [a], Eric Engle [b], Bertis Little [c]

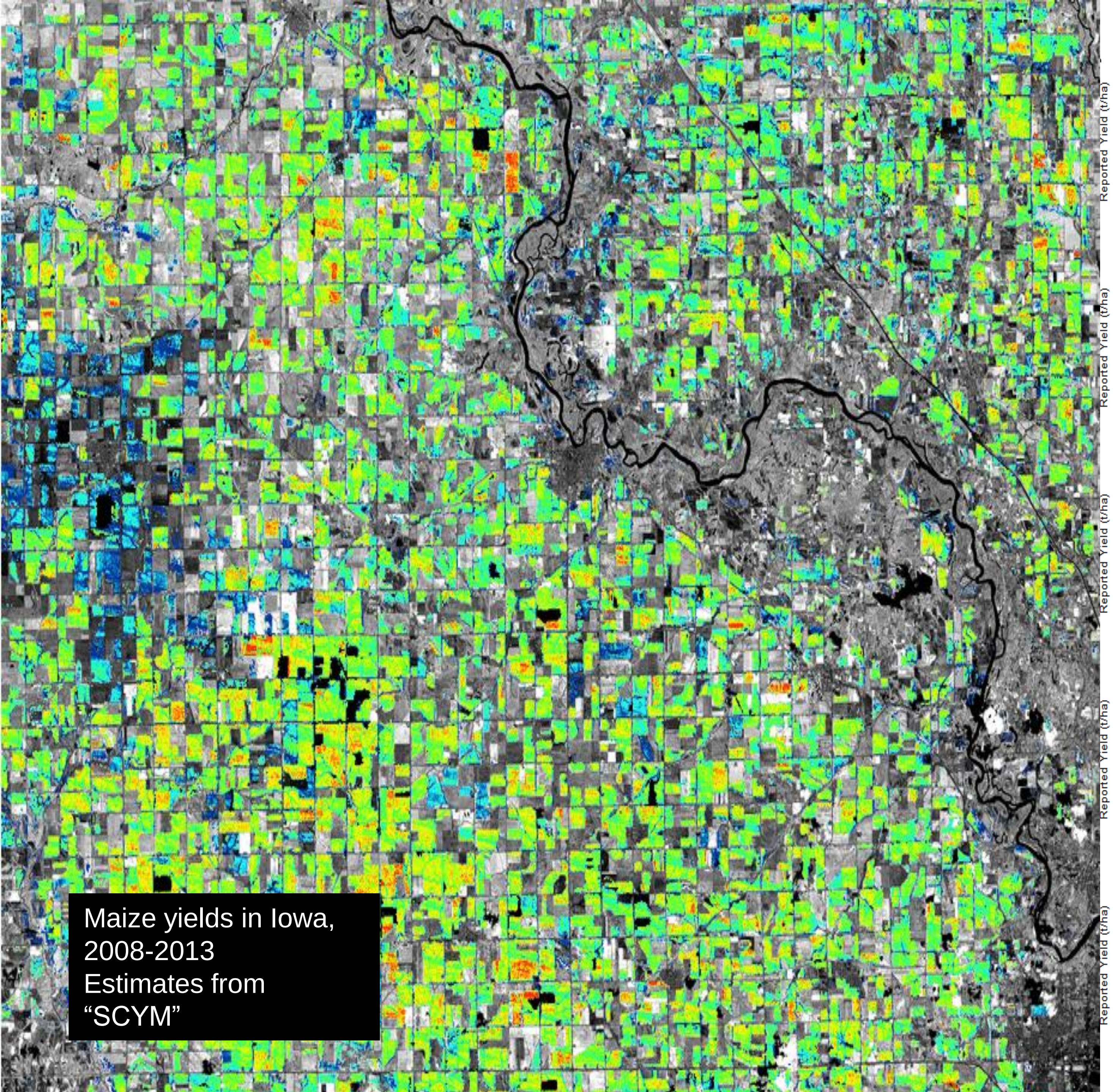
APSIM crop simulations of leaf area index (LAI) and yield

Convert LAI to satellite measure

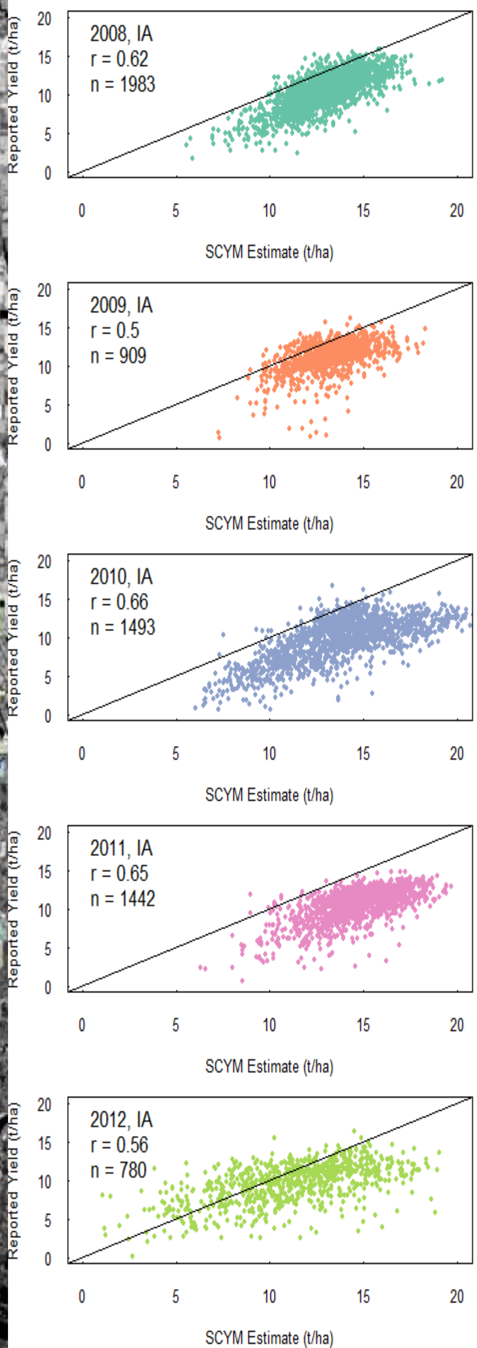
Train regressions, which relate yield to vegetation index and weather, for various image timings

Apply regressions to Landsat in Google Earth Engine





Observed vs Predicted



Example 2: GEOGLAM

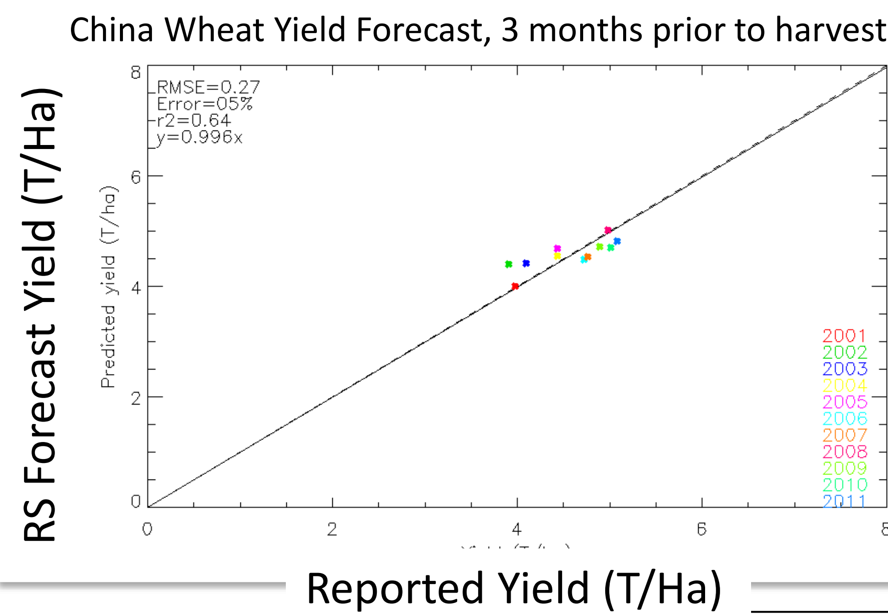
Inbal Rashef Becker,

Maryland University, USA

Group on Earth Observations Global Agricultural Monitoring (GEOGLAM) & Agricultural Market Information System (AMIS)

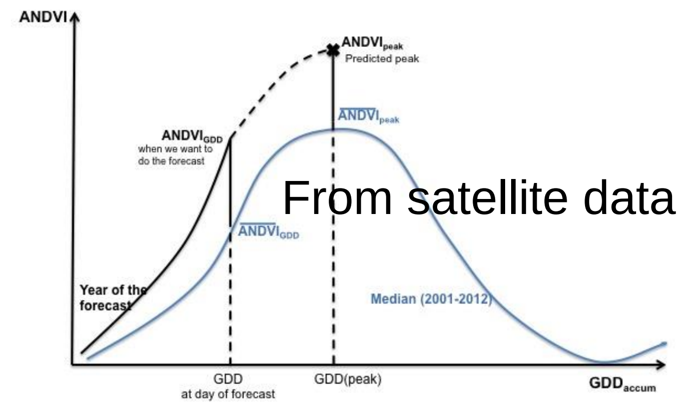
Model enhanced using Growing Degree Days (GDD) to improve timeliness Extended to China and all of US

China Example: Forecast within 6% of final yields 2-3 months prior to harvest

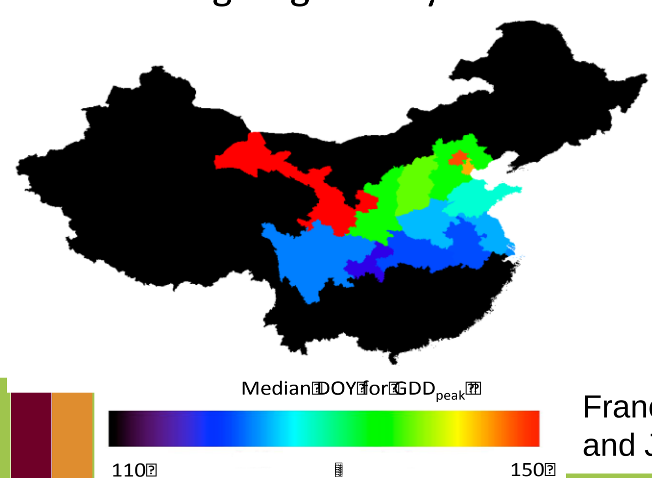


$$GDD = \frac{T_{max} + T_{min}}{2} - T_{base} \qquad GDD_{accum}(day) = \sum_{i=biofix\ date}^{day} GDD_i$$

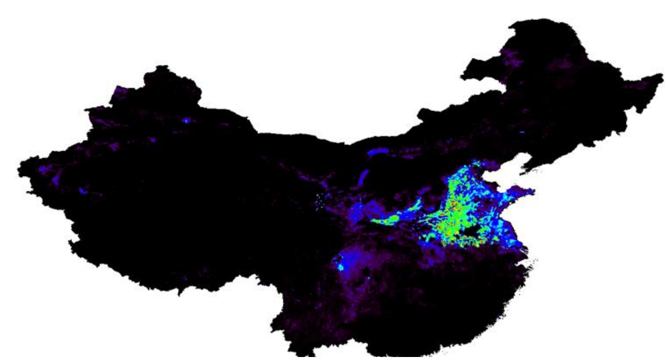
$$T_{base} = 0\ °C$$



Growing Degree Day at Peak



Percent Wheat



Franch, B., E. F. Vermote, I. Becker-Reshef, M. Claverie, J. Huang, J. Zhang, C. Justice and J. A. Sobrino (2015). RSE

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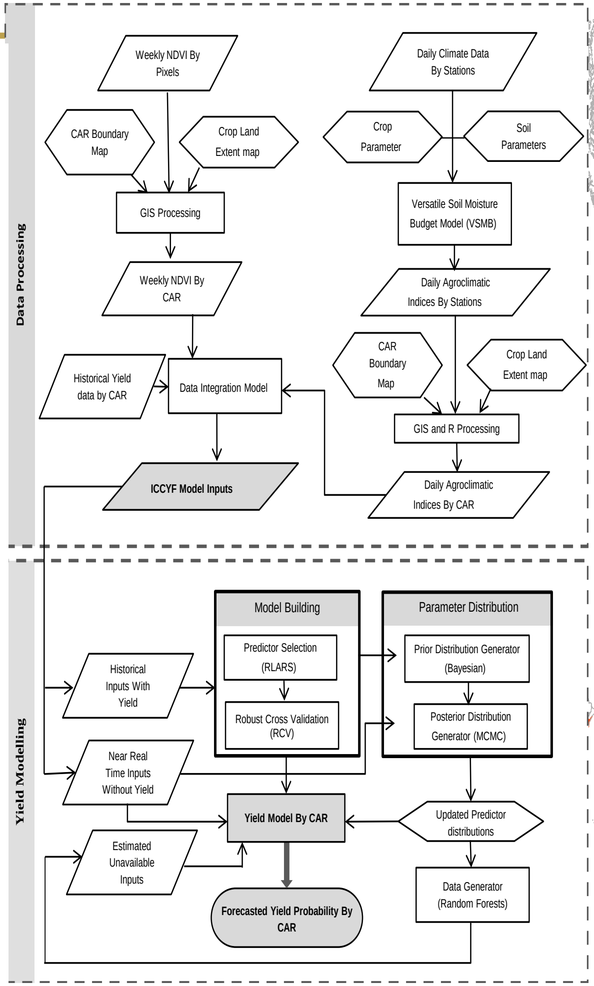
Example 3: Canada

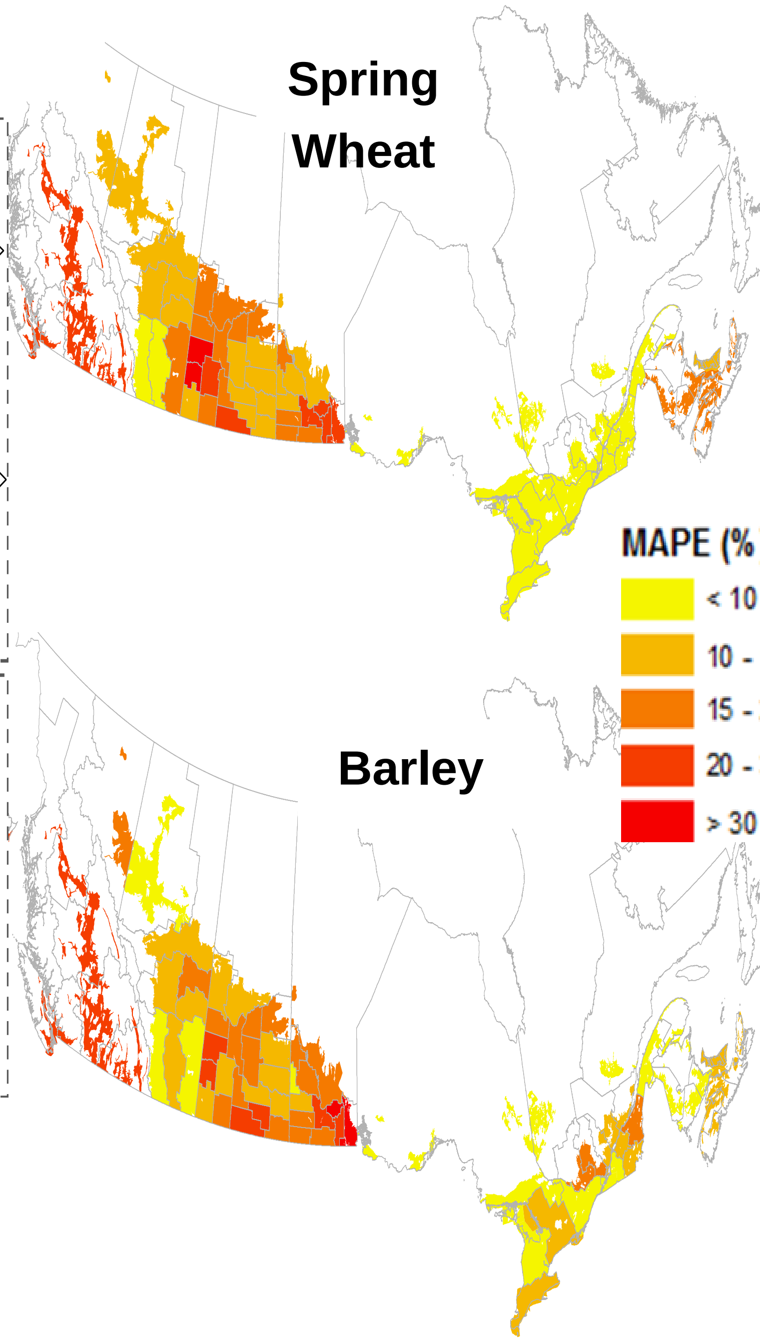
Nathaniel Newlands,

Agriculture and Agri-Food Canada (AAFC)

The Integrated Canadian Crop Yield Forecaster (ICCYF) tool

The ICCYF integrates climate, satellite remote sensing derived vegetation indices, soil and crop information through a physical process-based soil water budget model and statistical algorithms





References:

- *Newlands et al., 2014. Front. Environ. Sci. 2,17. doi : 10.3389/fen*
- *Kouadio el al., 2014. Remote Sens. 6:10193-10214*
- *Chipanshi et al., 2015. Agri. For. Meteor. 206:137-150*

Example 4: Production estimates for major crops in Australia

A Potgieter,
University of Queensland Australia

Regional scale commodity forecasting framework

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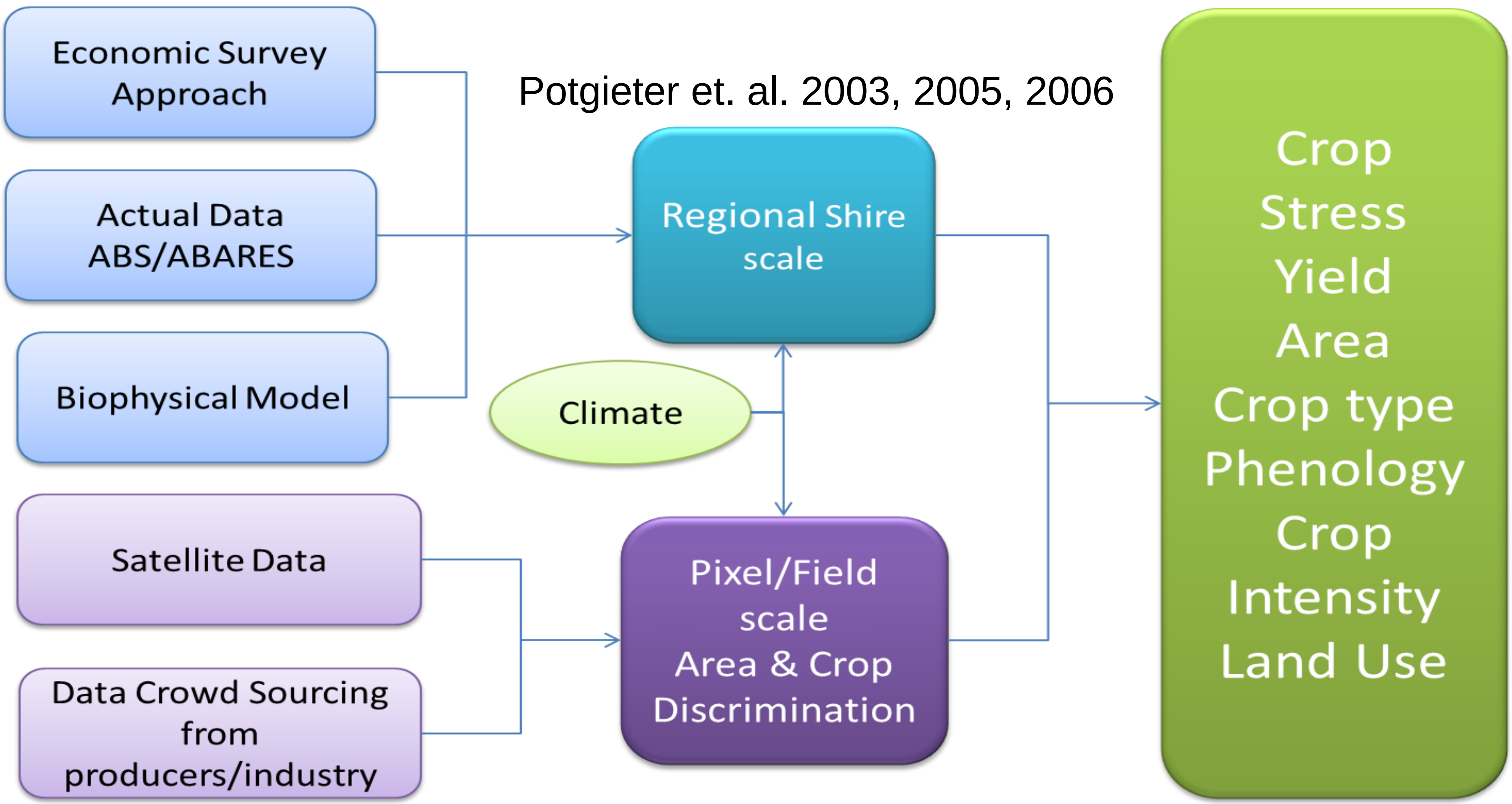
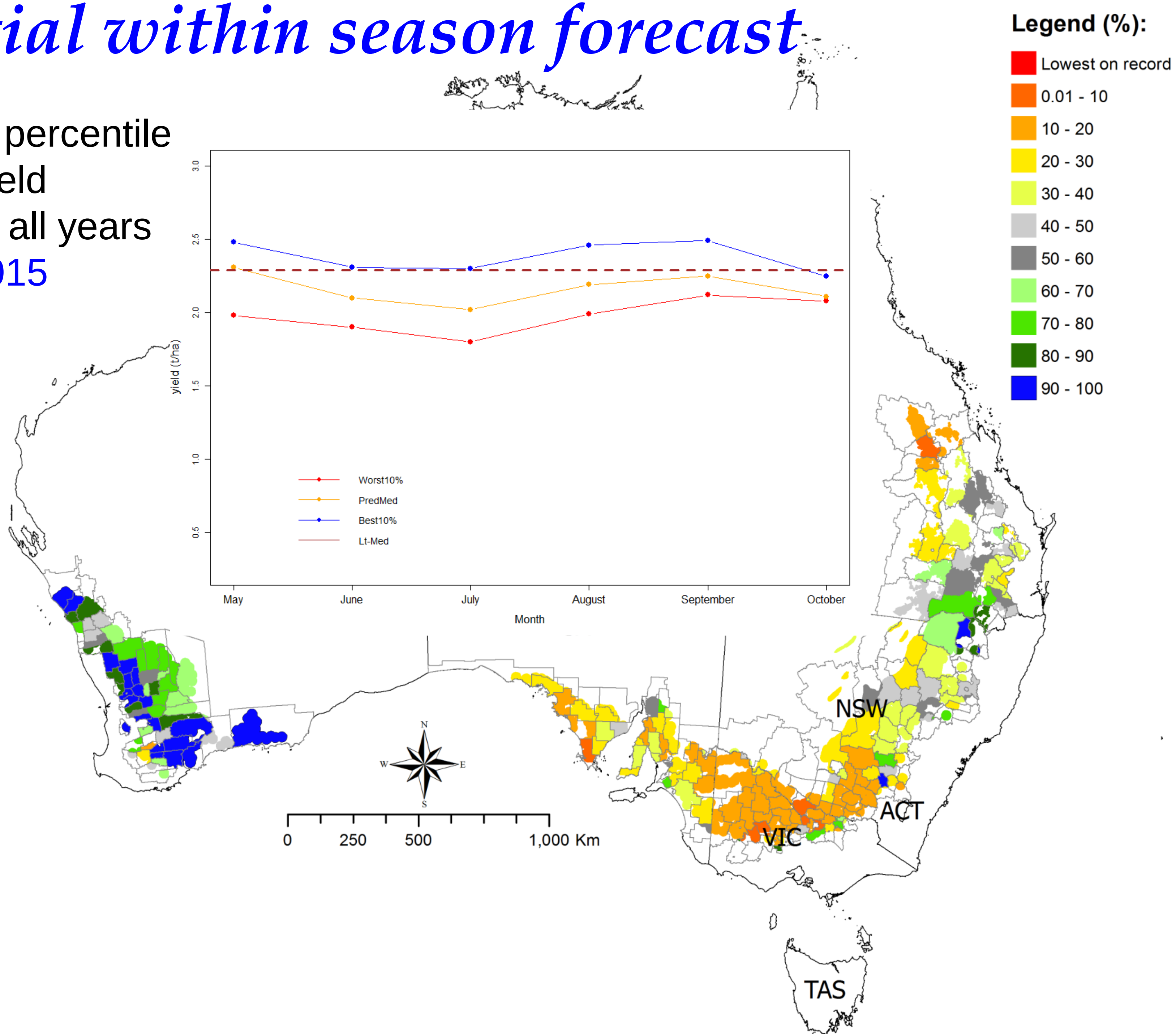
Near-real time Integrated Crop & Agricultural Monitoring System (iCAMS)



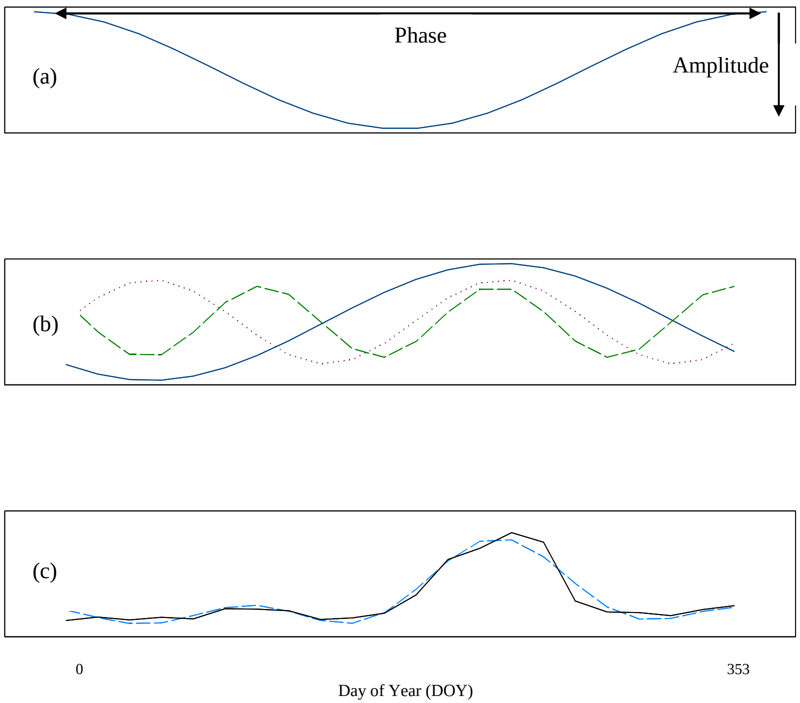
Spatial within season forecast

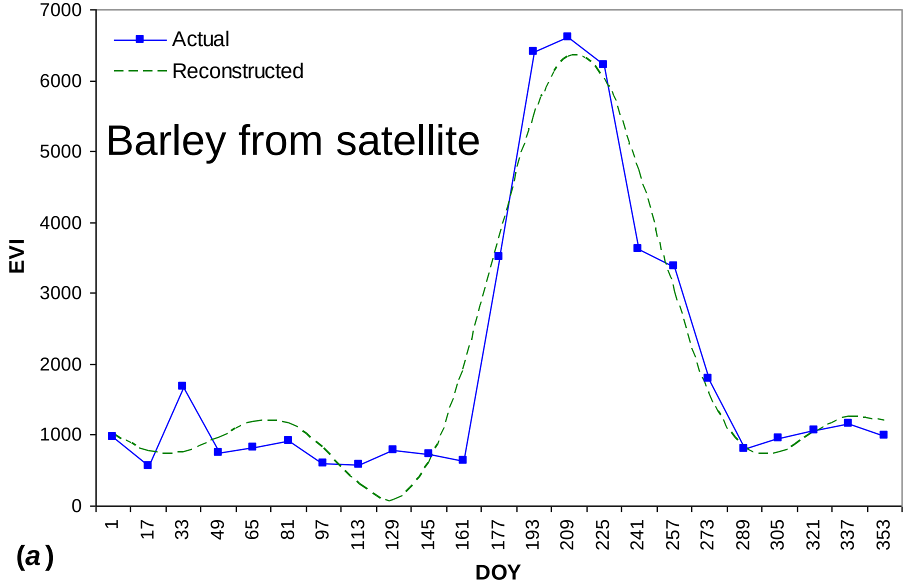
Predicted percentile median yield relative to all years
1st July 2015

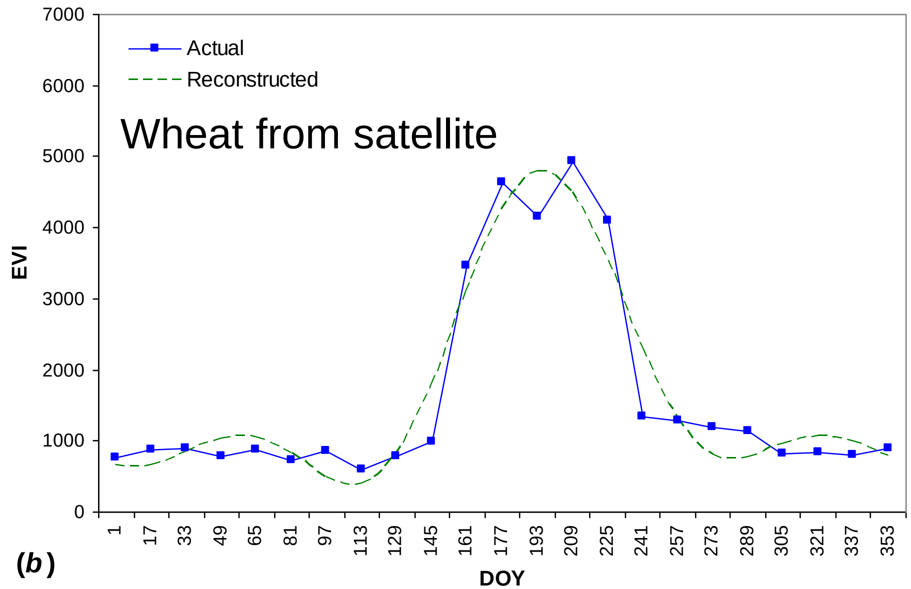


Area Estimates: Reconstructing of time series

Harmonic analysis of time series





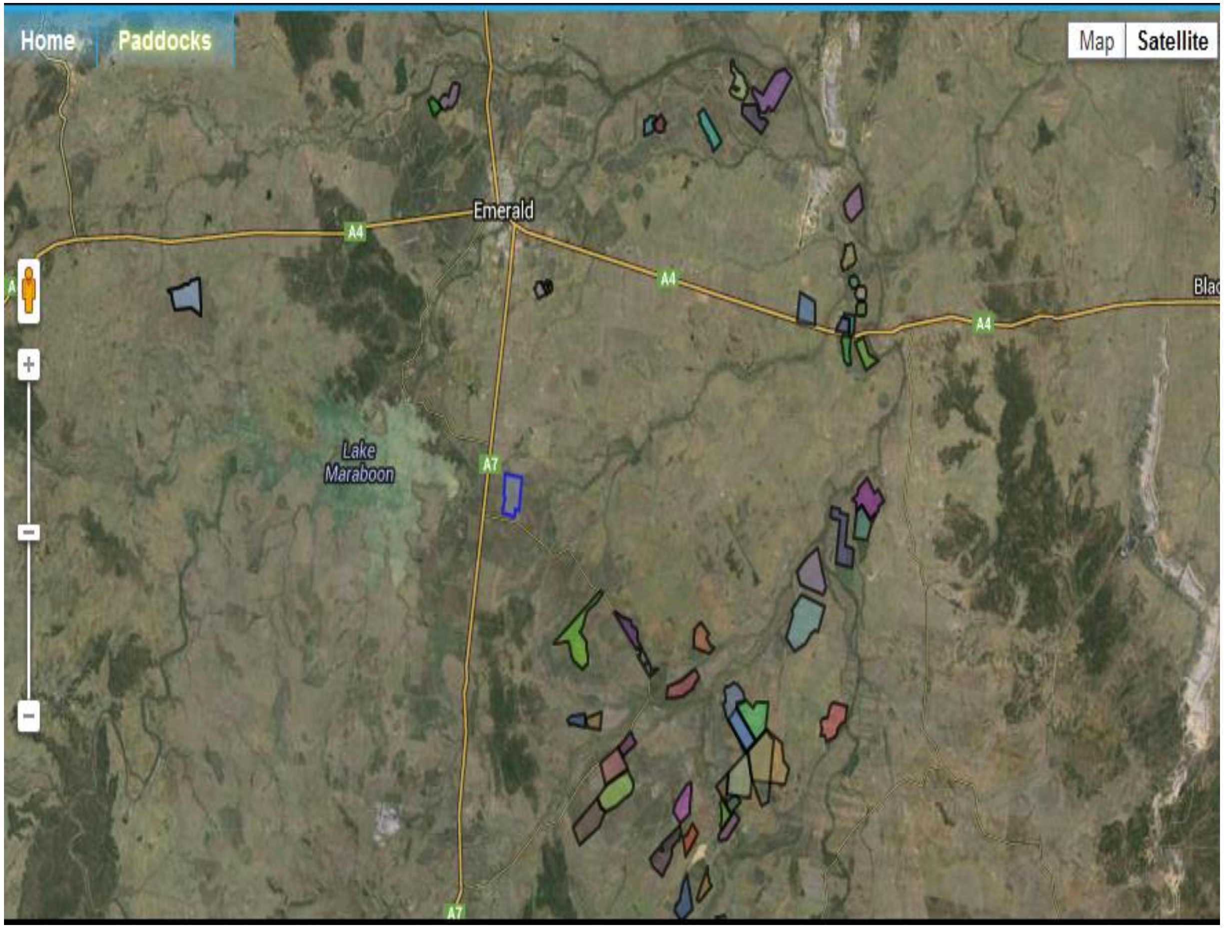


(Verhoef et al 1996; Potgieter et al. 2007, 2010, 2011)

Ground truthing - Crowd sourcing

Google Earth environment

Paddock Watch

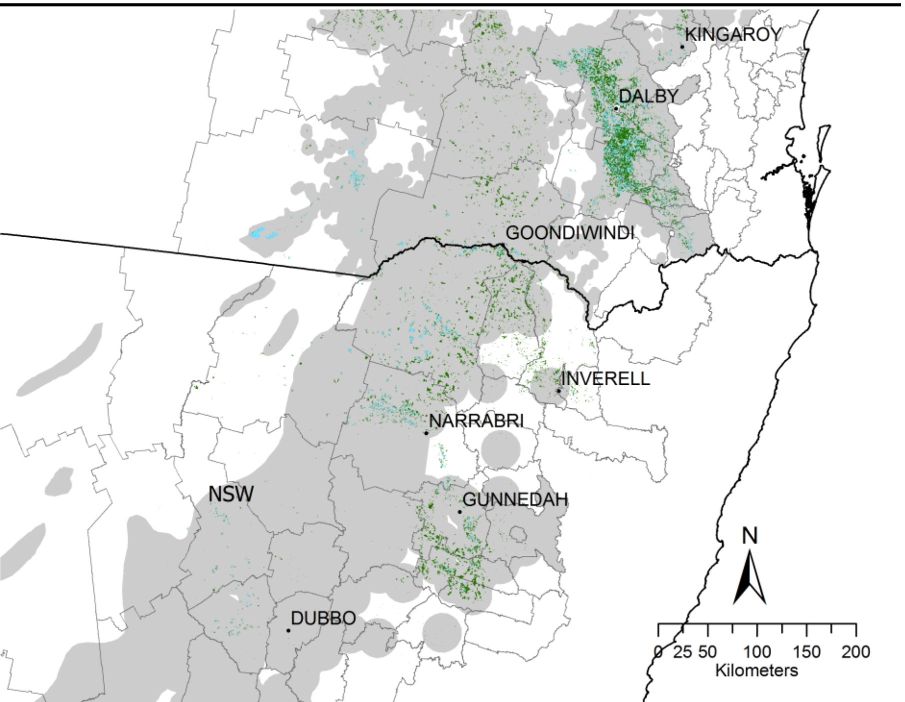


http://www.paddockwatch.com.au

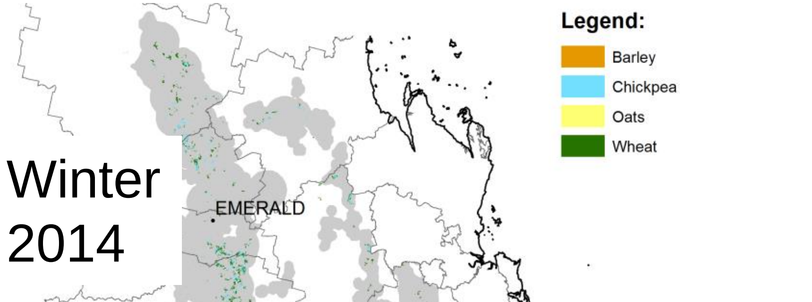
Specific & Total Crop Area & Production

Summer
2014/15

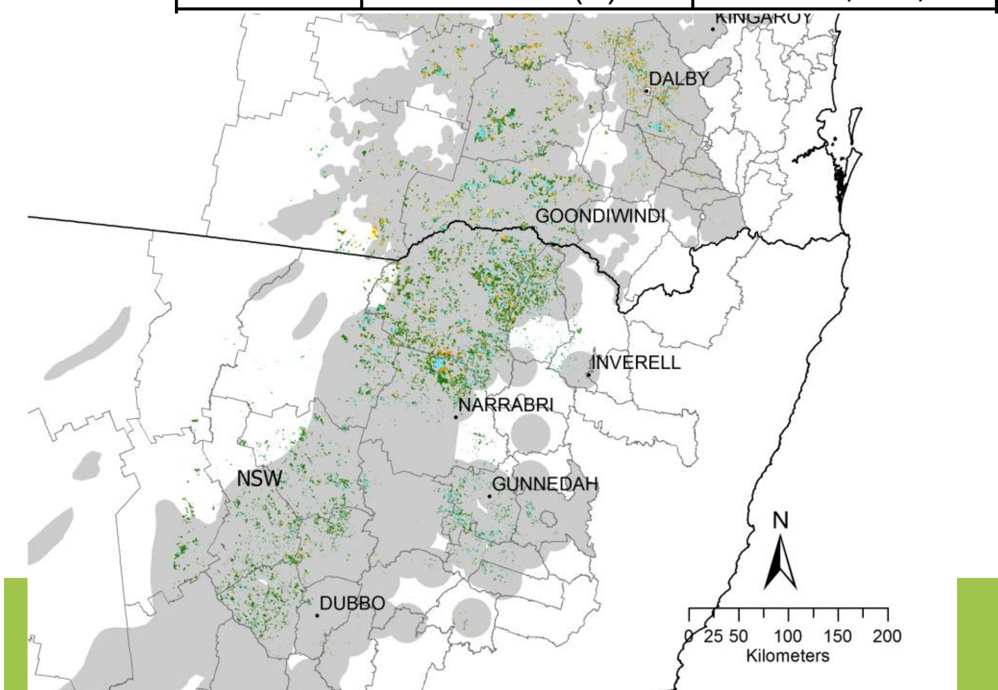
Region	Cotton (Ha)	Sorghum (Ha)	Sorghum Tonnes
CQ	215,862	16,675	460,135
NNSW	249,366	58,753	675,554
SEQ	265,695	148,986	728,080
SWQ	117,883	28,392	113,177
Total	848,806	252,806	1,976,946



Winter
2014



Region	Totals	Total
NEAUS	Barley (Ha)	247,222
	Chickpea (Ha)	413,591
	Oats (Ha)	61,685
	Wheat (Ha)	937,845
	Wheat Prod (T)	1,324,758



Where to from here

- Framework high efficacy in predicting point and regional crop yield, through integration of satellite imagery and crop simulation models
- Aligns with UN SDG 2 (food security) & SDG 13 (climate change & impacts)
- Issues for further discussion:
  - Scalability (State, Nation Continental, Global)?
  - Automation to enable implementation?
- Increase Lead time further (linking with Global General circulation models)