"Soil Big Data and Australian Agriculture"
– *looking back, looking forward.*
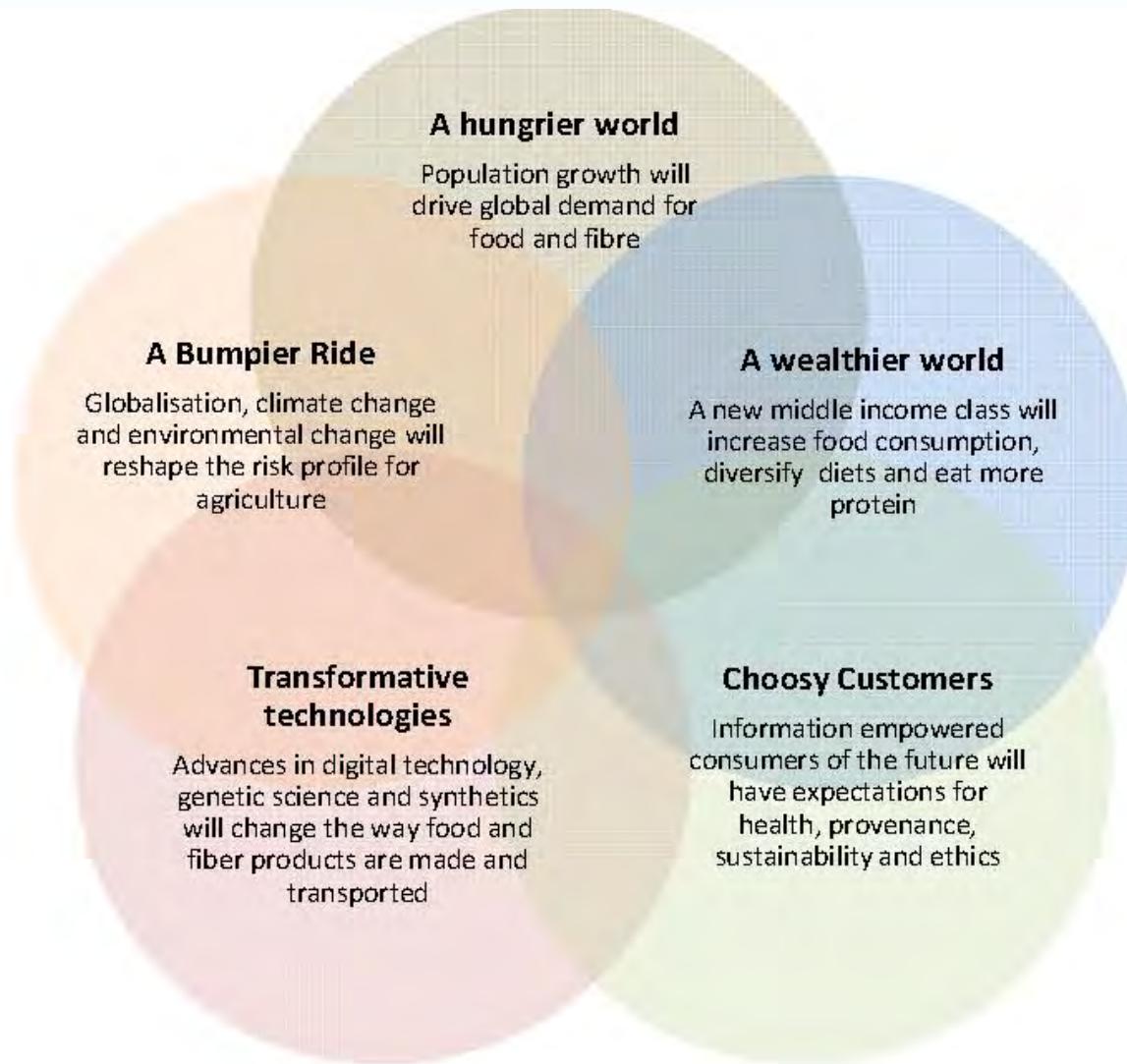
June 2015

Brian Keating Executive Director – Agriculture, Food and Health, CSIRO Australia
With input from CSIRO colleagues

We live in interesting times ....

A hungrier world

Population growth will drive global demand for food and fibre

A Bumpier Ride

Globalisation, climate change and environmental change will reshape the risk profile for agriculture

A wealthier world

A new middle income class will increase food consumption, diversify diets and eat more protein

Transformative technologies

Advances in digital technology, genetic science and synthetics will change the way food and fiber products are made and transported

Choosy Customers

Information empowered consumers of the future will have expectations for health, provenance, sustainability and ethics

Rural Industry Futures

Megatrends impacting Australian agriculture over the coming twenty years

Stefan Hajkowicz and Sandra Eady
A DRAFT report for comments and editing
CSIRO and the Rural Industries Research and Development Corporation – February 2015

RURAL INDUSTRIES
Research & Development Corporation

CSIRO

Looking back: Global agriculture's great success

1960 to 2000

- Population rose 98%

This required a sustained combination of:
- scientific and technological innovation,
- government policy and institutional intervention and
- business investment, innovation and delivery

- Arable land in use rose only 8%
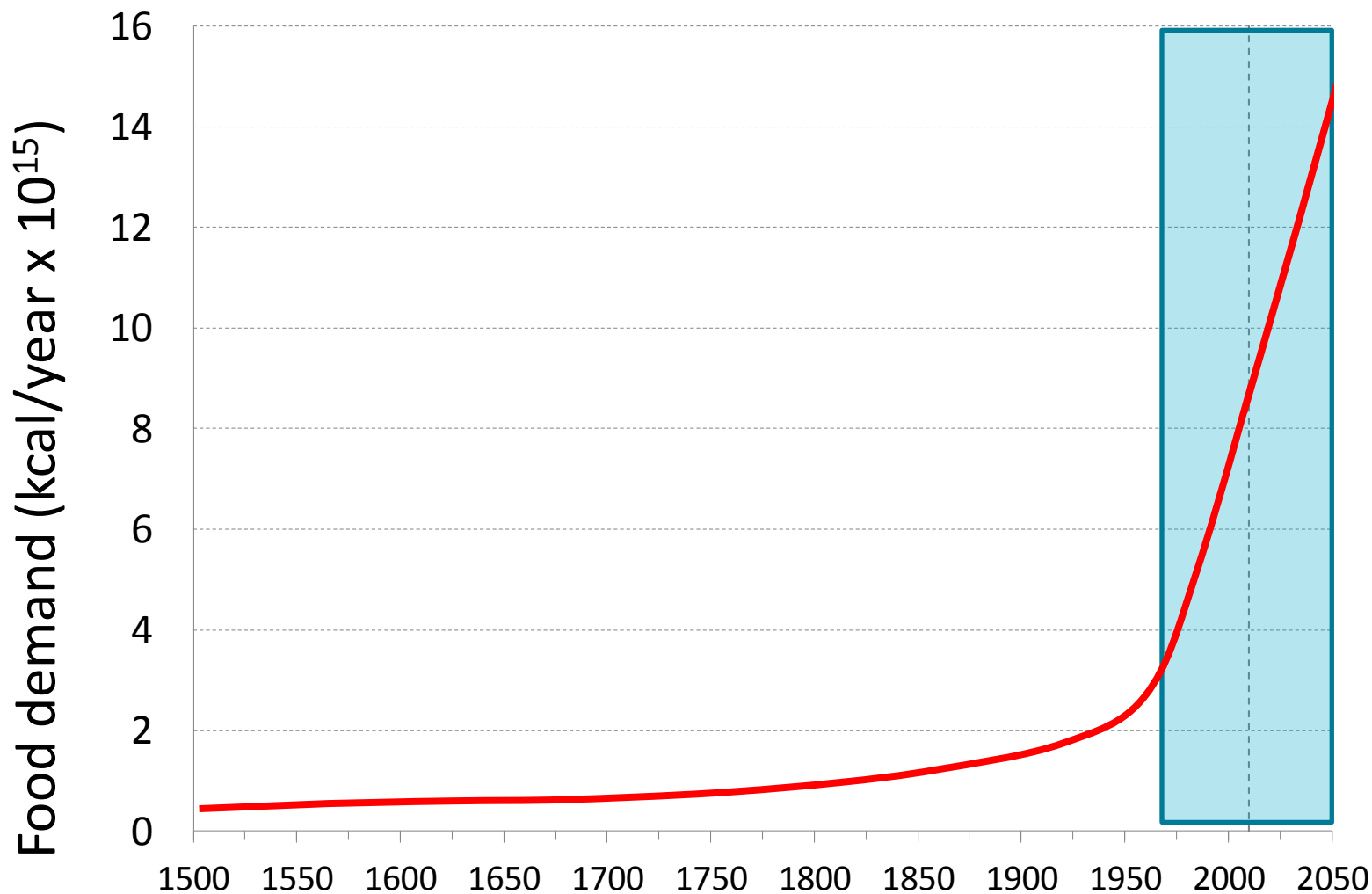- Arable land per person fell from 0.45
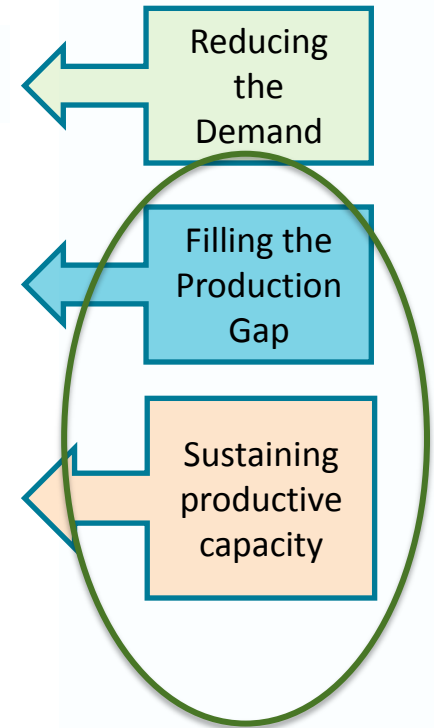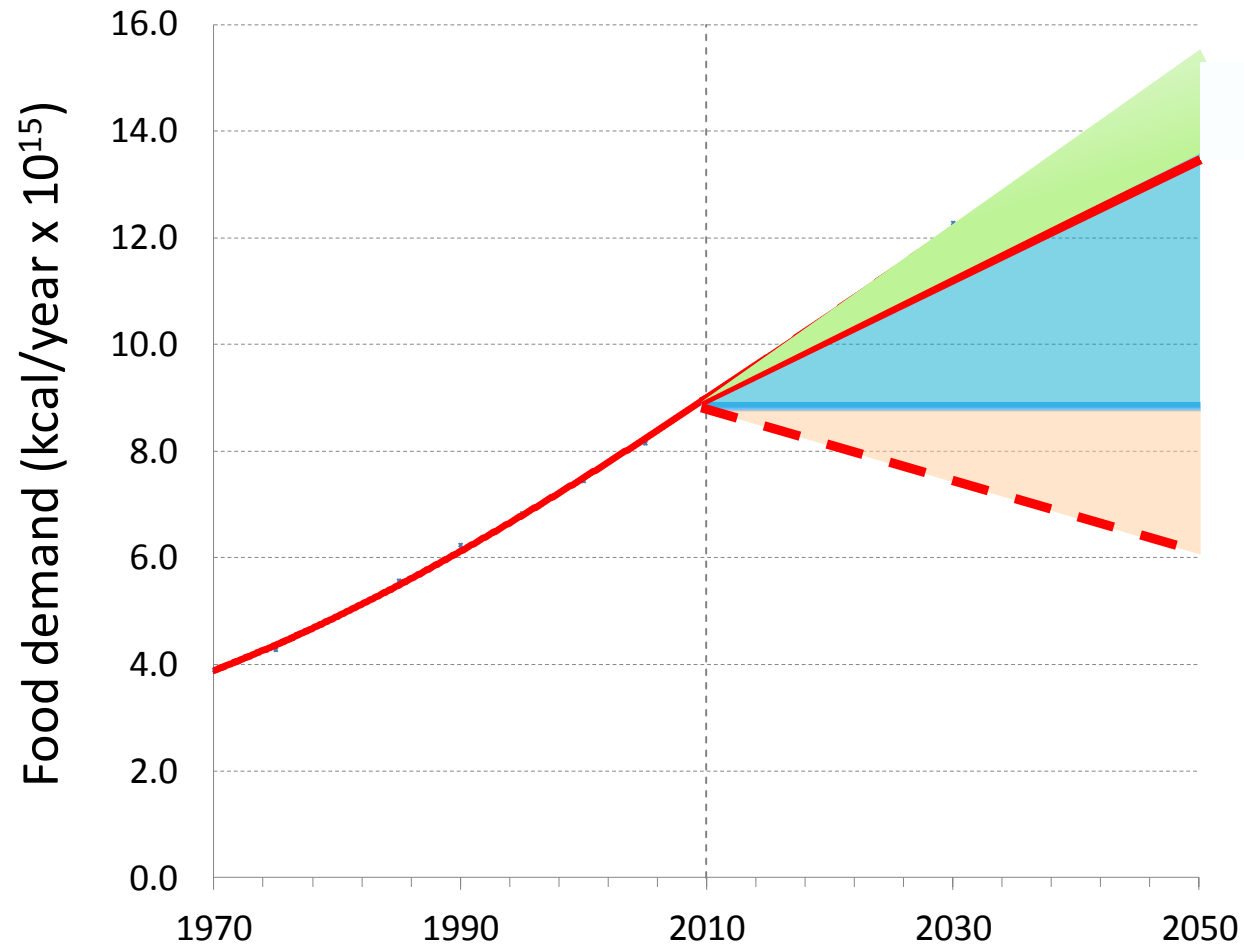
Became known as the "the green revolution"

- Inputs rose many fold
  – x 7 N fertiliser
  – x 3 P fertiliser
  – x 2 irrigation water

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The food demand challenge – looking forward to 2050

Food demand (kcal/year x 10^{15}) plotted against year from 1500 to 2050.

Balancing food supply and demand

Looking back – Australian agricultural success
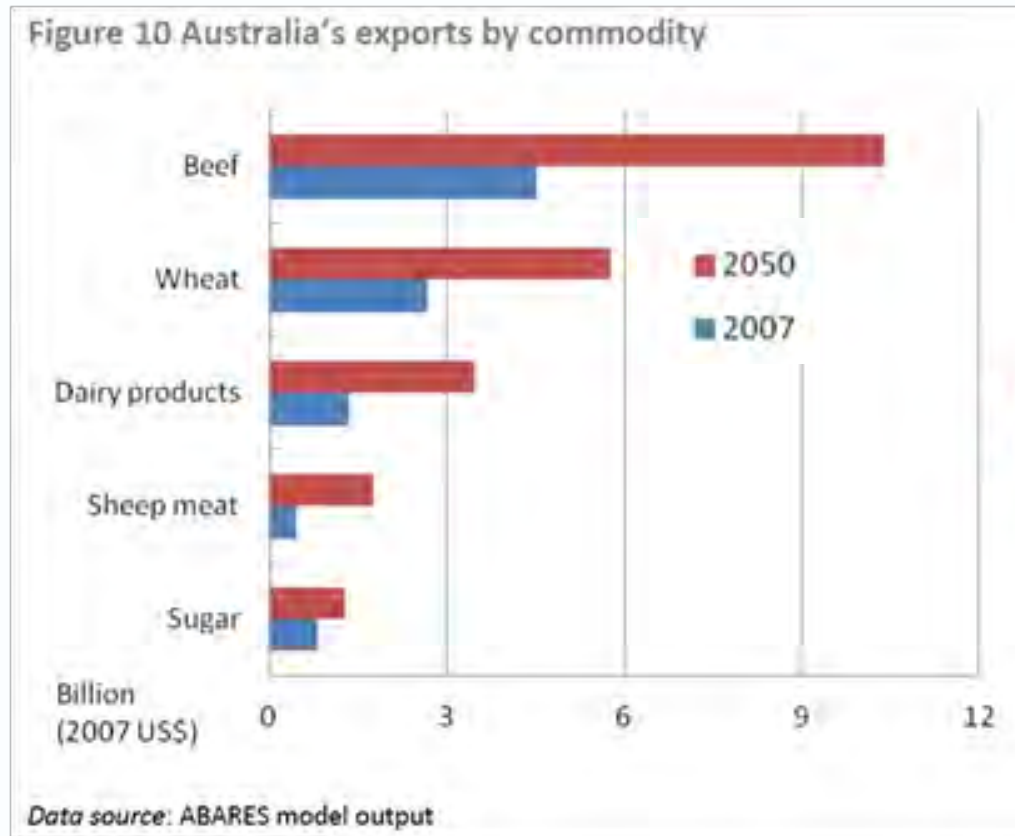
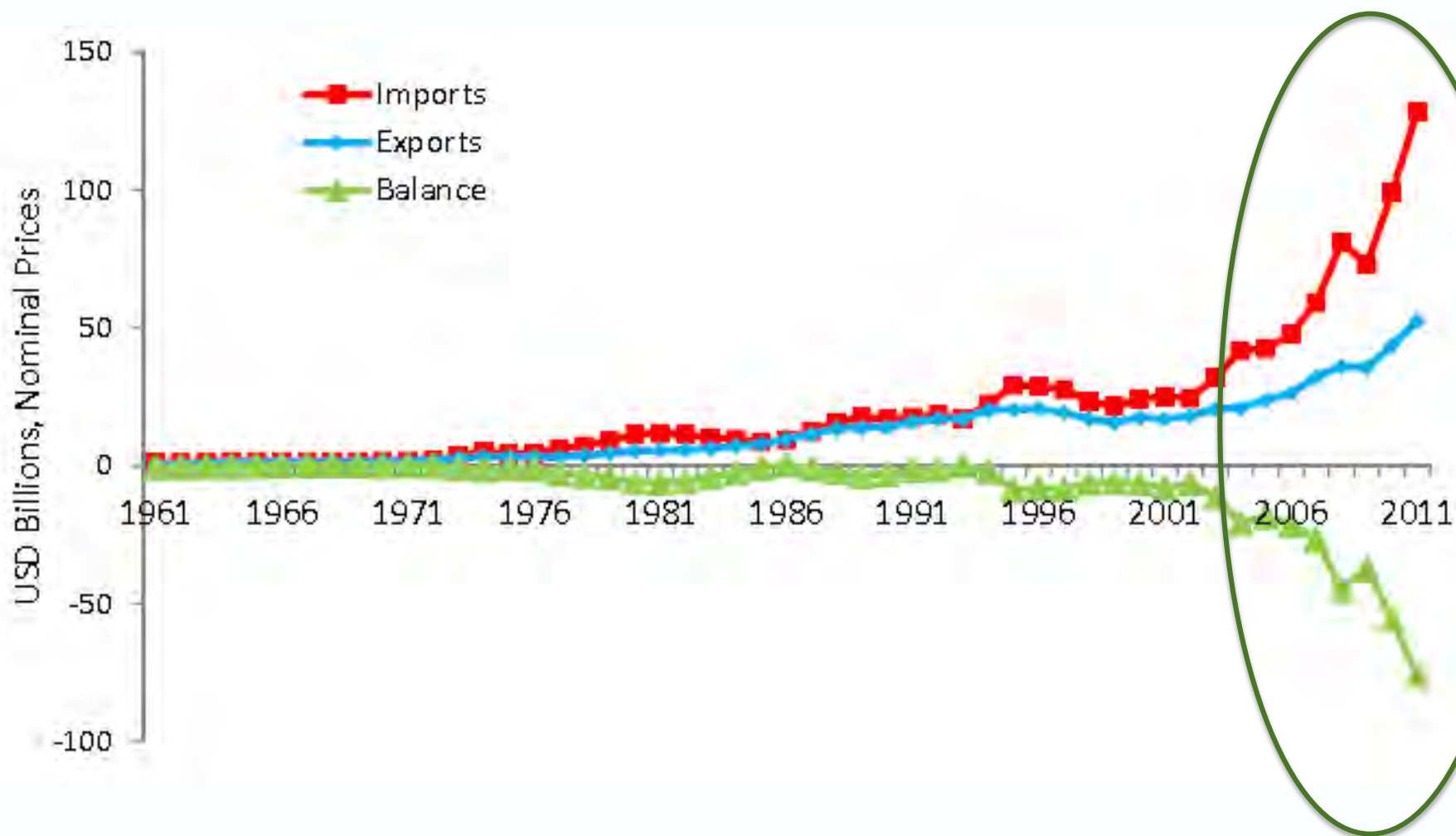**Australian agriculture**

- wheat yields doubled since the 1950's
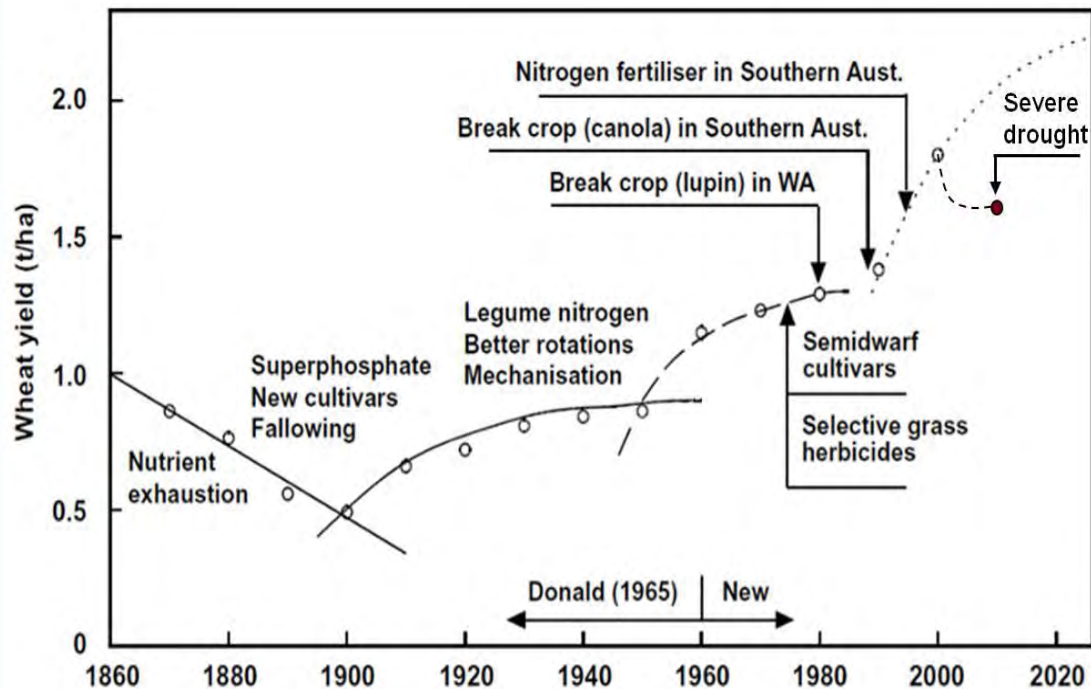
Sources: Angus 2001, ABARE 2010

.... and great market opportunity for Australia

- Prospects for a doubling of commodity exports by 2050

Figure 10 Australia's exports by commodity

Legend: ■ 2050 ■ 2007

Commodities (top to bottom): Beef, Wheat, Dairy products, Sheep meat, Sugar

X-axis: Billion (2007 US$): 0, 3, 6, 9, 12

Data source: ABARES model output

China's balance of agri-food trade

Brazil's explosive growth as a food exporter

FIGURE 32 Value of Brazil's food trade

Legend: Exports, Imports, Net trade

x 3
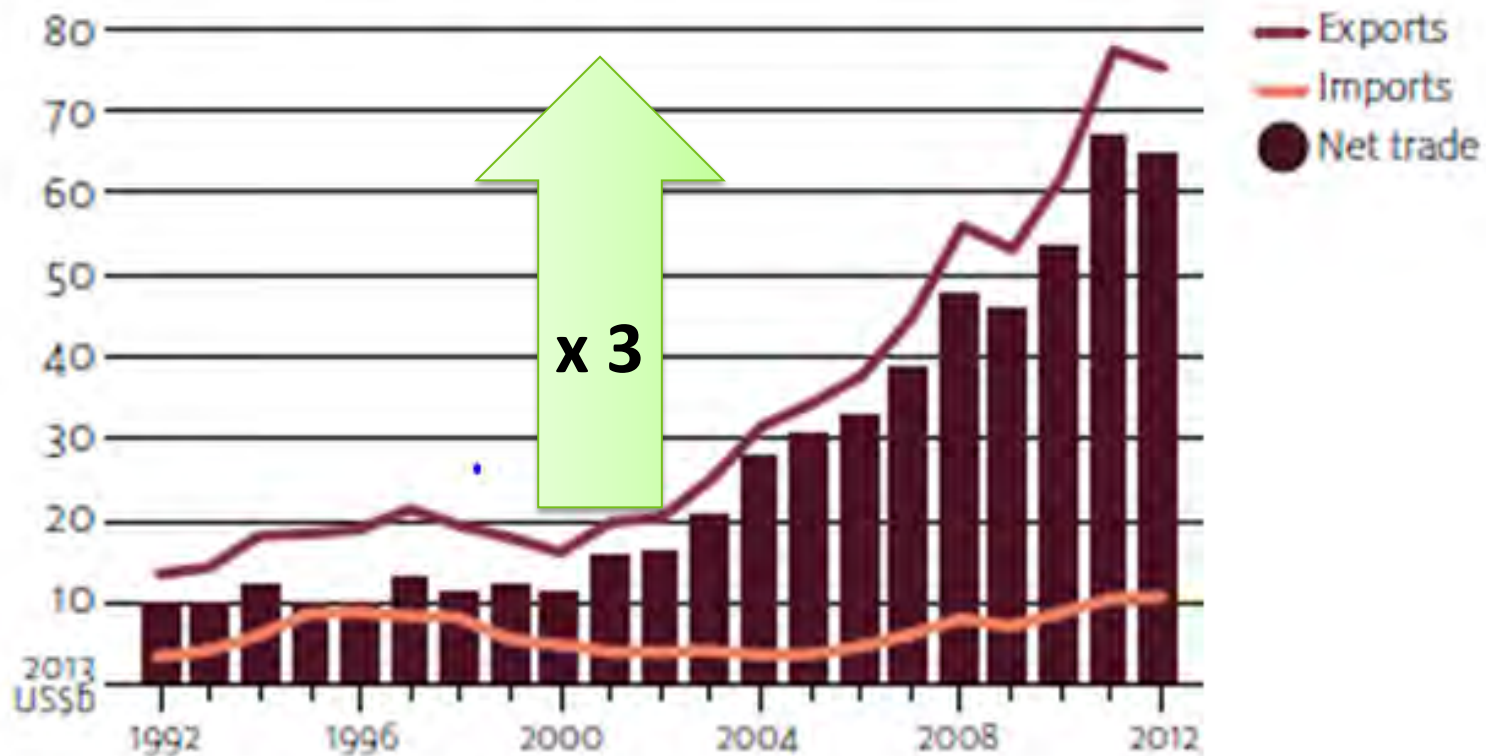
Source: United Nations Statistics Division (2014)

But, can we make the most of these opportunities ?

"Productivity isn't everything, but in the long run it is almost everything"
- *Paul Krugman, Nobel Prize winning economist*

Agricultural productivity

Legend:
- Broadacre
- Cropping
- Mixed cropping-livestock
- Beef
- Sheep
- Dairy

y-axis: index, 1977-78=100
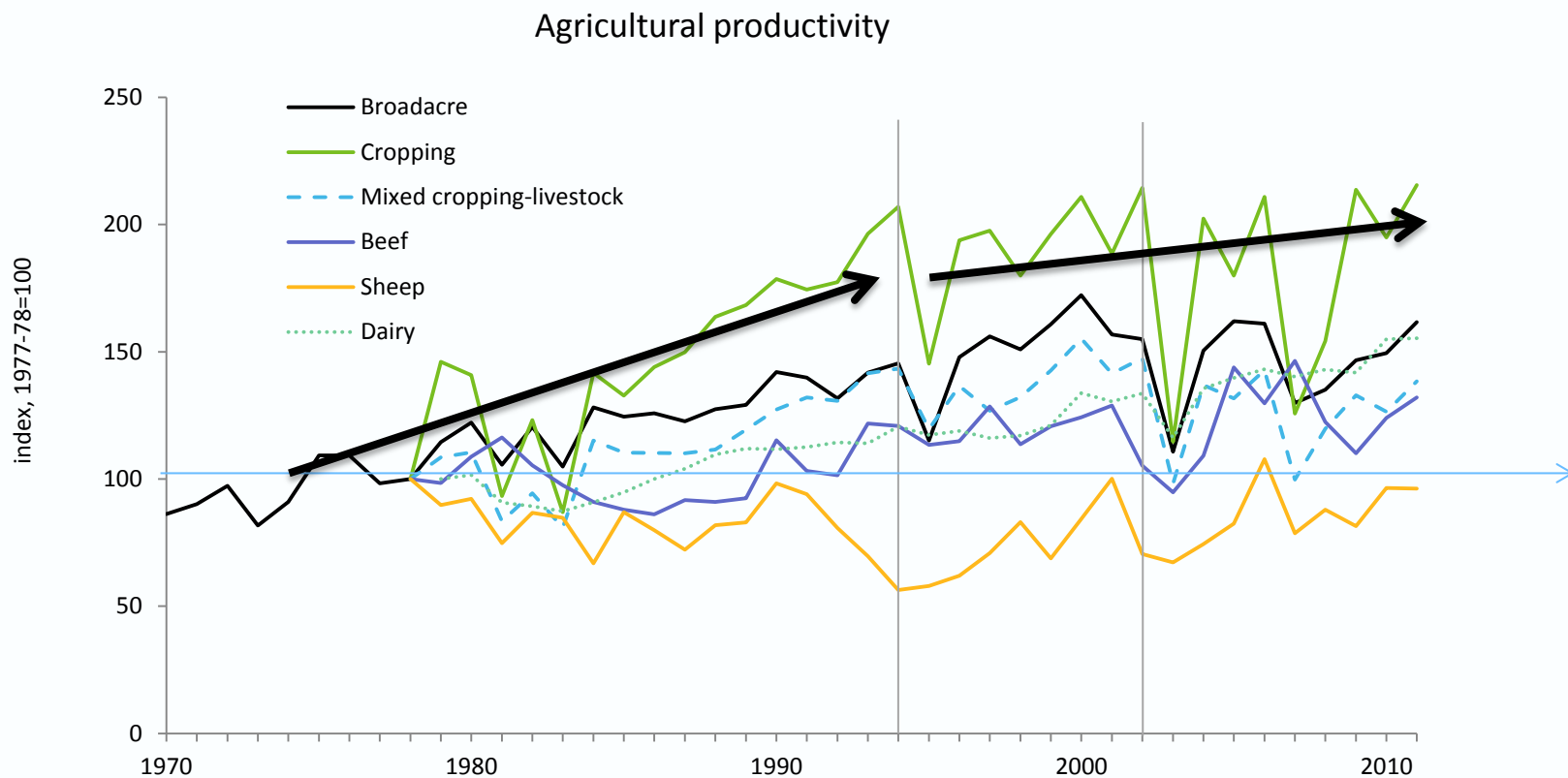
Soils (data) have always been central to Australian agricultural development

".... It seems to me we should make a start with a problem which will take many, many years, perhaps centuries, to complete, namely the making of a soil survey of the Continent"

- R.D. Watt, Professor of Agriculture, University of Sydney, 1917
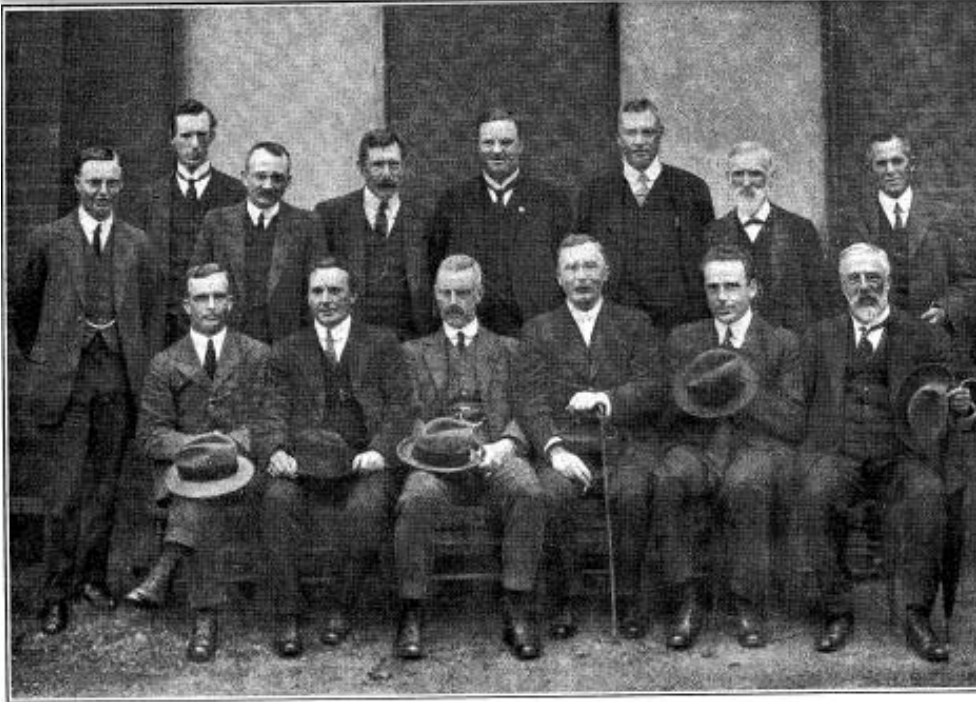
GROUP OF MEMBERS OF THE CONFERENCE. Photo, by "?

Back row (left to right): W. B. Alexander (Sec.), Prof. T. T. Flynn (Tas.), G. L. Sutton (W.A.), Dr. W. H. Green (Vic.), (Vic.), H. T. Easterby (Q'lnd.), D. McAlpine (Vic.), H. C. Quodling (Q'lnd.), J. T. Pridham (N.S.W.). *Front row (left to right)*: H. Wenholz (N.S.W.), E. Breakwell (N.S.W.), Prof. J. W. Paterson (W.A.), Prof. A. J. Perkins Prof. R. D. Watt (N.S.W.), H. Pye (Vic.).

MONWEALTH OF AUSTRALIA

Advisory Council of Science and Industry

BULLETIN No. 7

AGRICULTURAL RESEARCH IN AUSTRALIA

— Being a —
Report of the Proceedings at a Conference of Agricultural Scientists held in Melbourne, 9th to 16th November, 1917

Published under the authority of
THE EXECUTIVE COMMITTEE
of the Advisory Council.

MELBOURNE, 1918

CSIRO

Diversity and evolving perspectives in Australian soils

1930s-1990s featured the battle of the soil classification schemes

(Presscott, Stephens, Northcote, Stace, Isbell)

to …..

Post 1990s challenge of creating unified national soil resource information sets across States
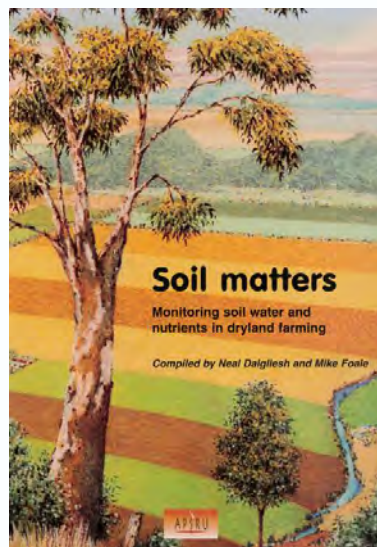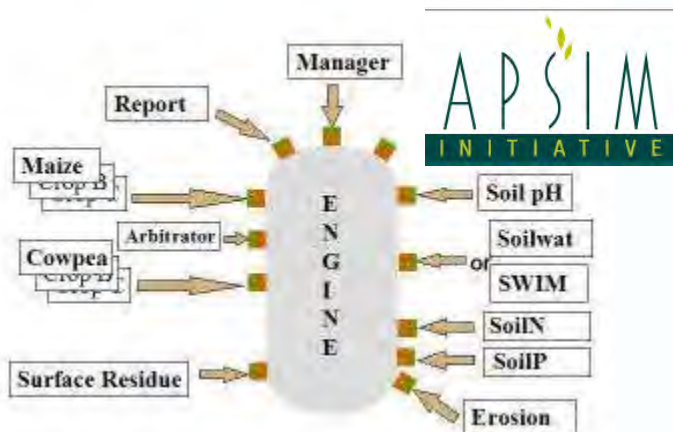
-and with enhanced functional value for agricultural applications

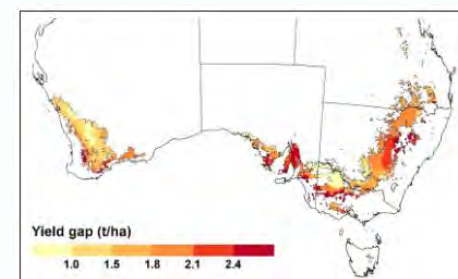*-Australian Collaborative Land Evaluation Program (ACLEP success*
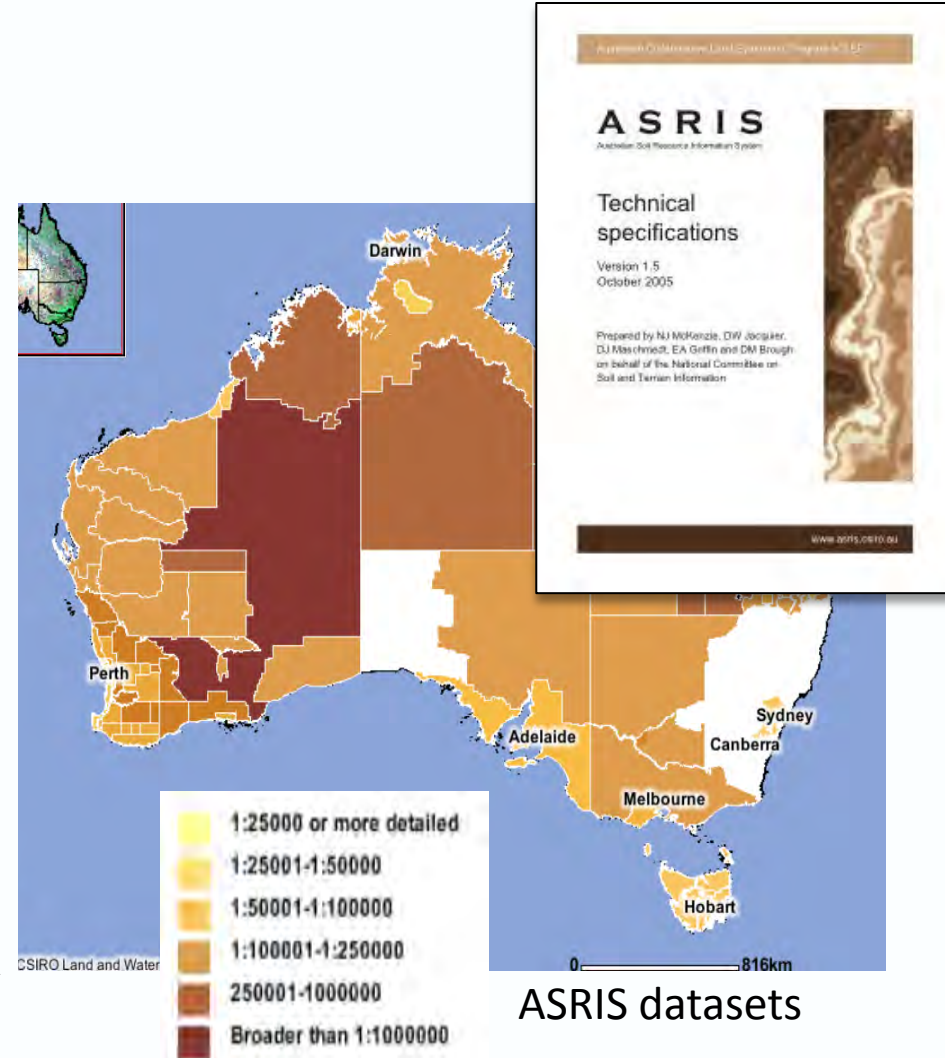
ASRIS datasets

The modern era – post 1990 -making soils data more useful in agricultural decision making

Apsoil
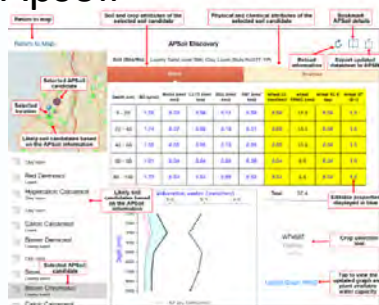
SoilMapp
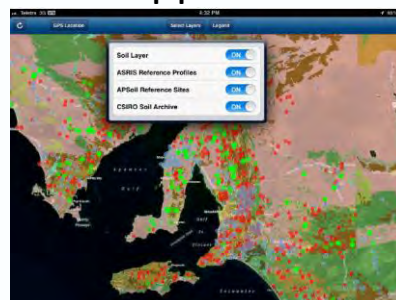
Crop and soil data and models ➜ Prospects to lift wheat yields
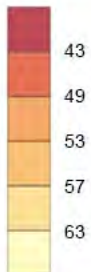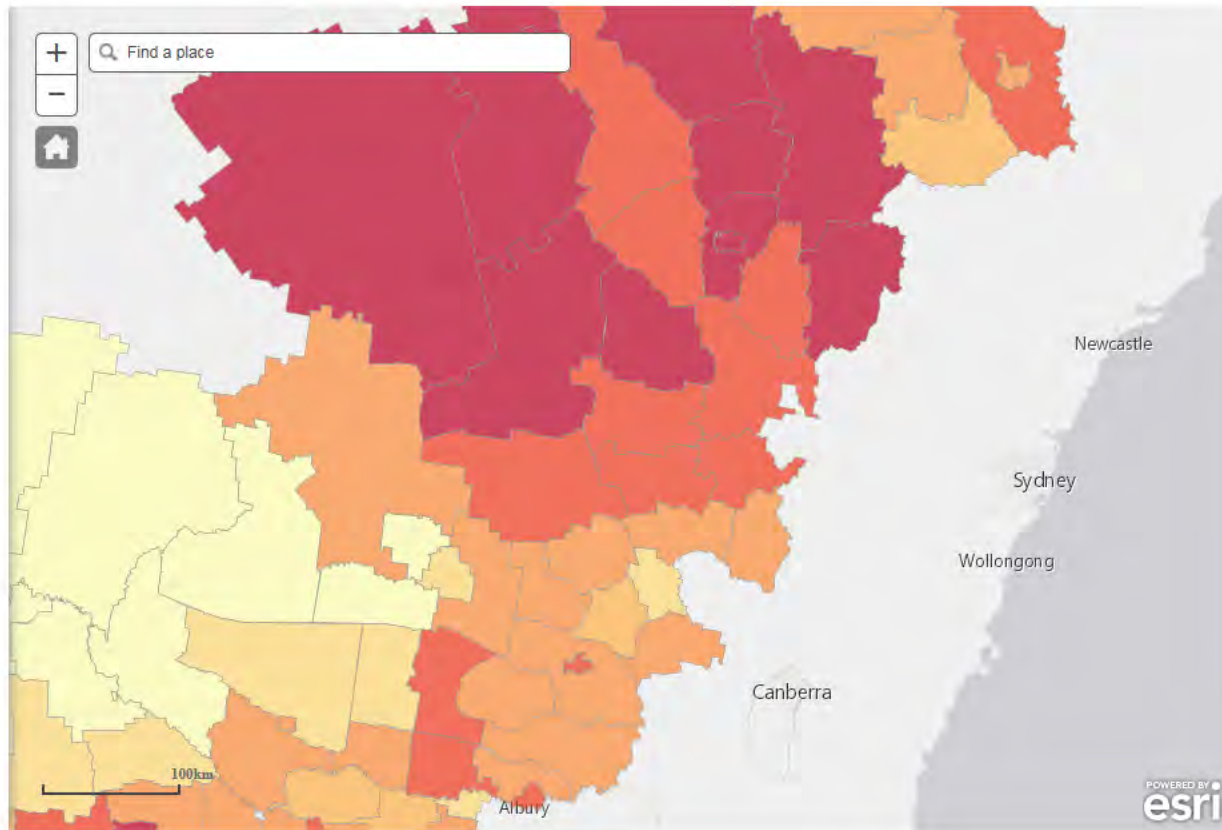
Prospects for agricultural expansion in northern Australia
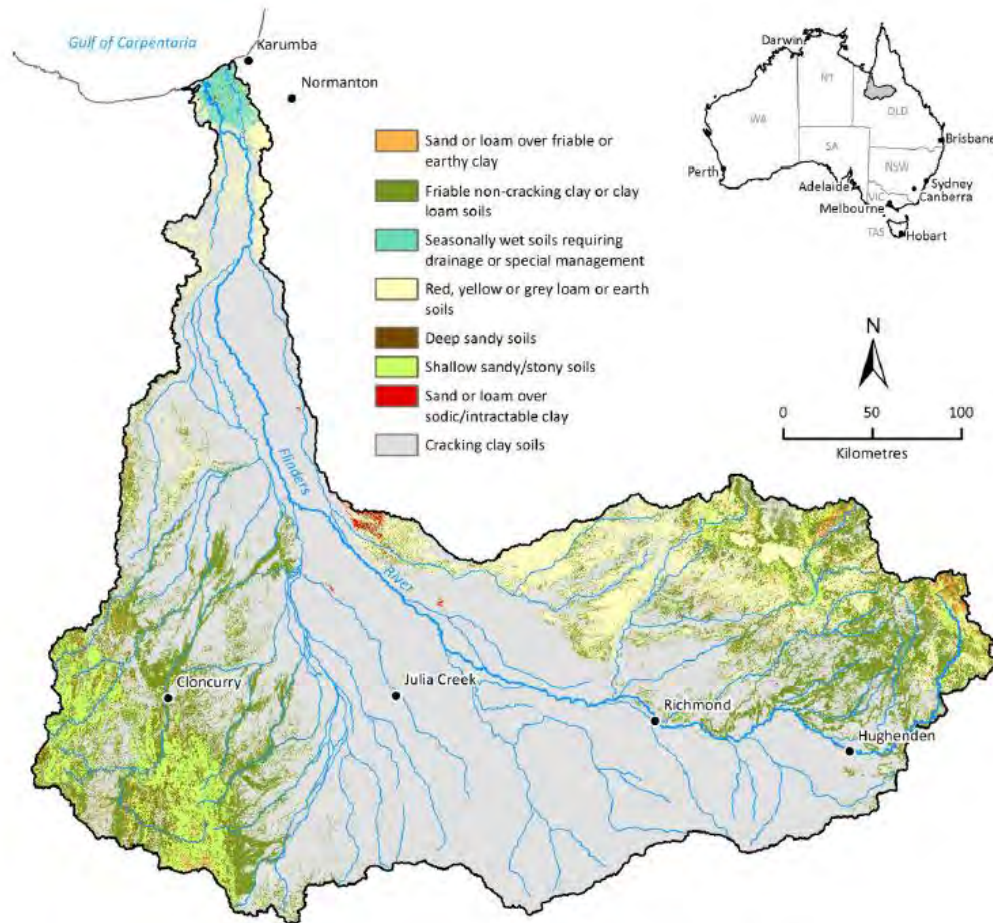
Soil and Landscape Grid of Australia

Soil and Landscape Grid of Australia

- Soil information that is consistent, reliable, functional and comprehensive

- Designed for national and global challenges

  - ecosystem function and change

  - food productivity & security
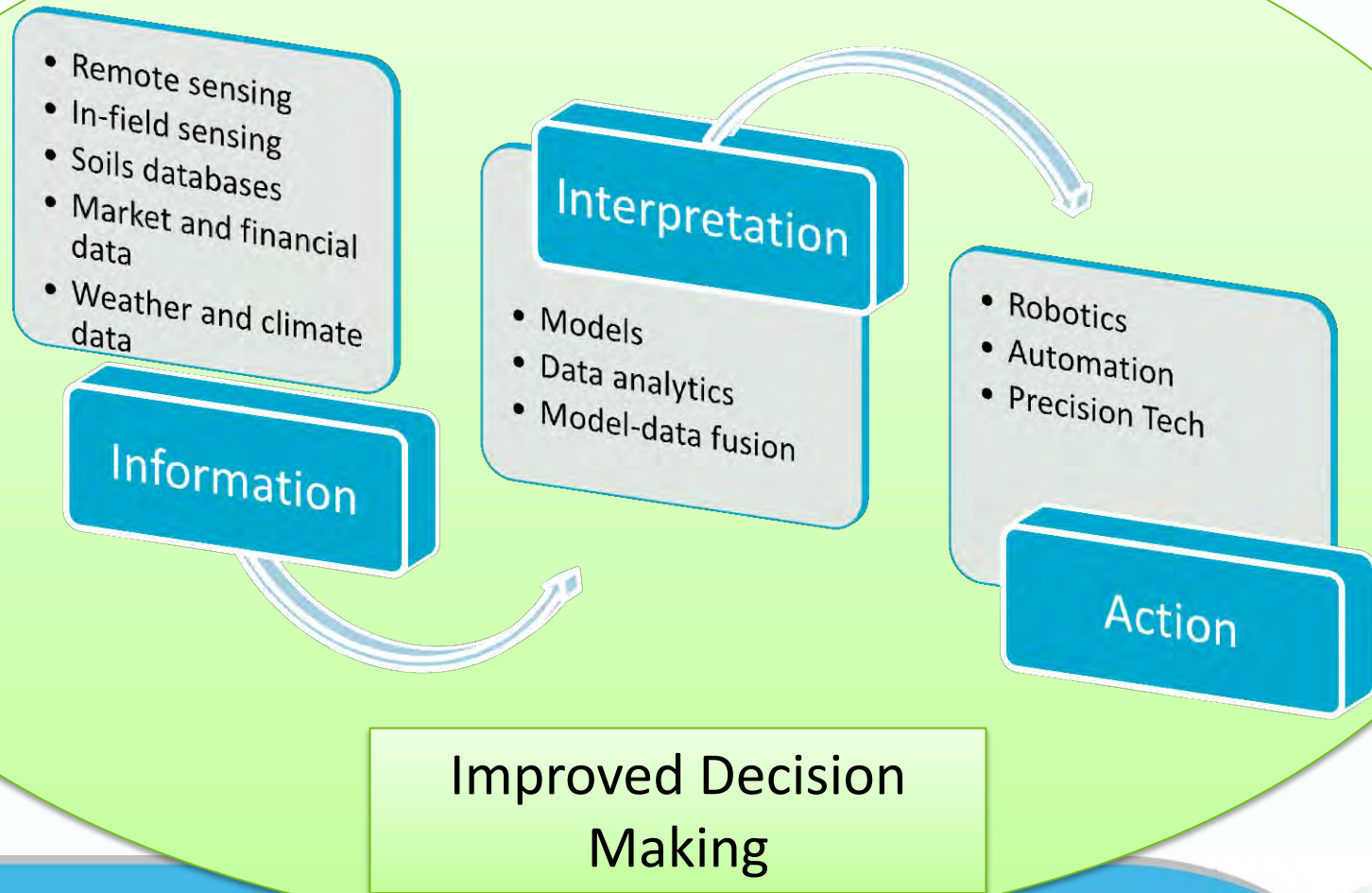
  - resource constraints & scarcity

Joining the dots - how far away is "digital agriculture" ?

- Remote sensing
- In-field sensing
- Soils databases
- Market and financial data
- Weather and climate data

Information

Interpretation

- Models
- Data analytics
- Model-data fusion

- Robotics
- Automation
- Precision Tech

Action

Improved Decision Making

CSIRO

A note of caution ....

data confidentiality

*data ownership and control*

System complexity and incompatibility

human dimensions of farming

Social and institutional challenges are likely to be more significant than the technical challenges

Collaboration and cooperation will remain central going forward

National Soil RD&E Plan – can we make use of it to advance the national cooperation and coordination ?
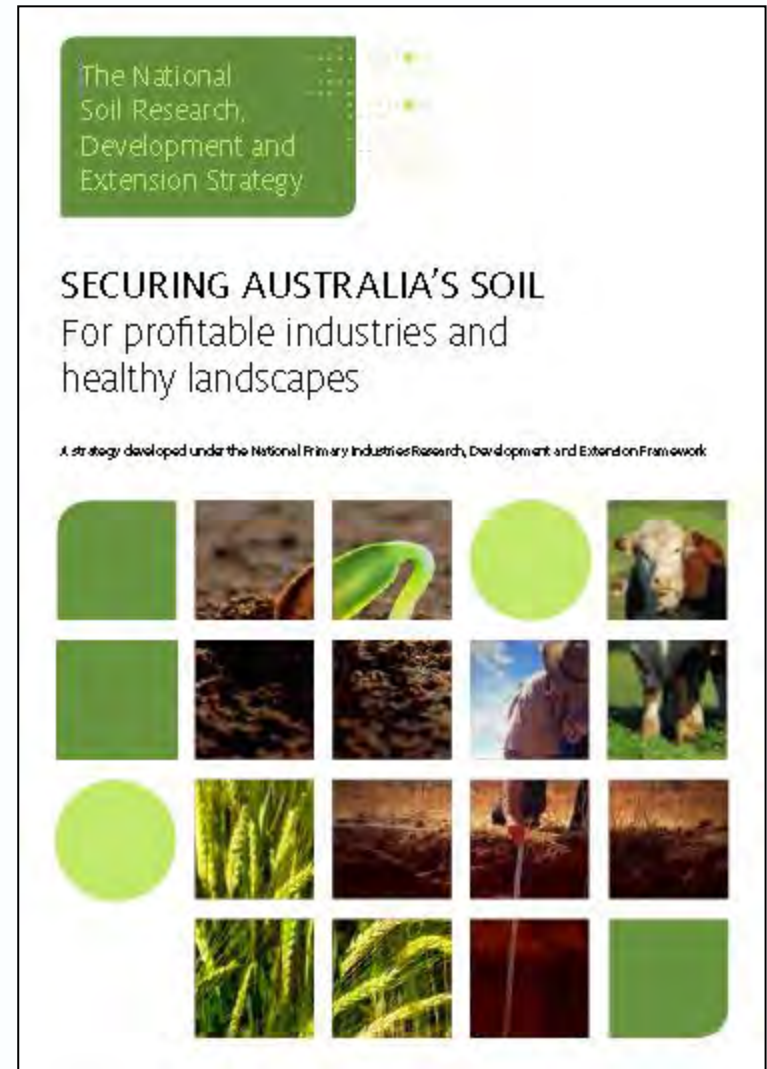
Brian Keating
Executive Director

CSIRO - Agriculture Food and Health

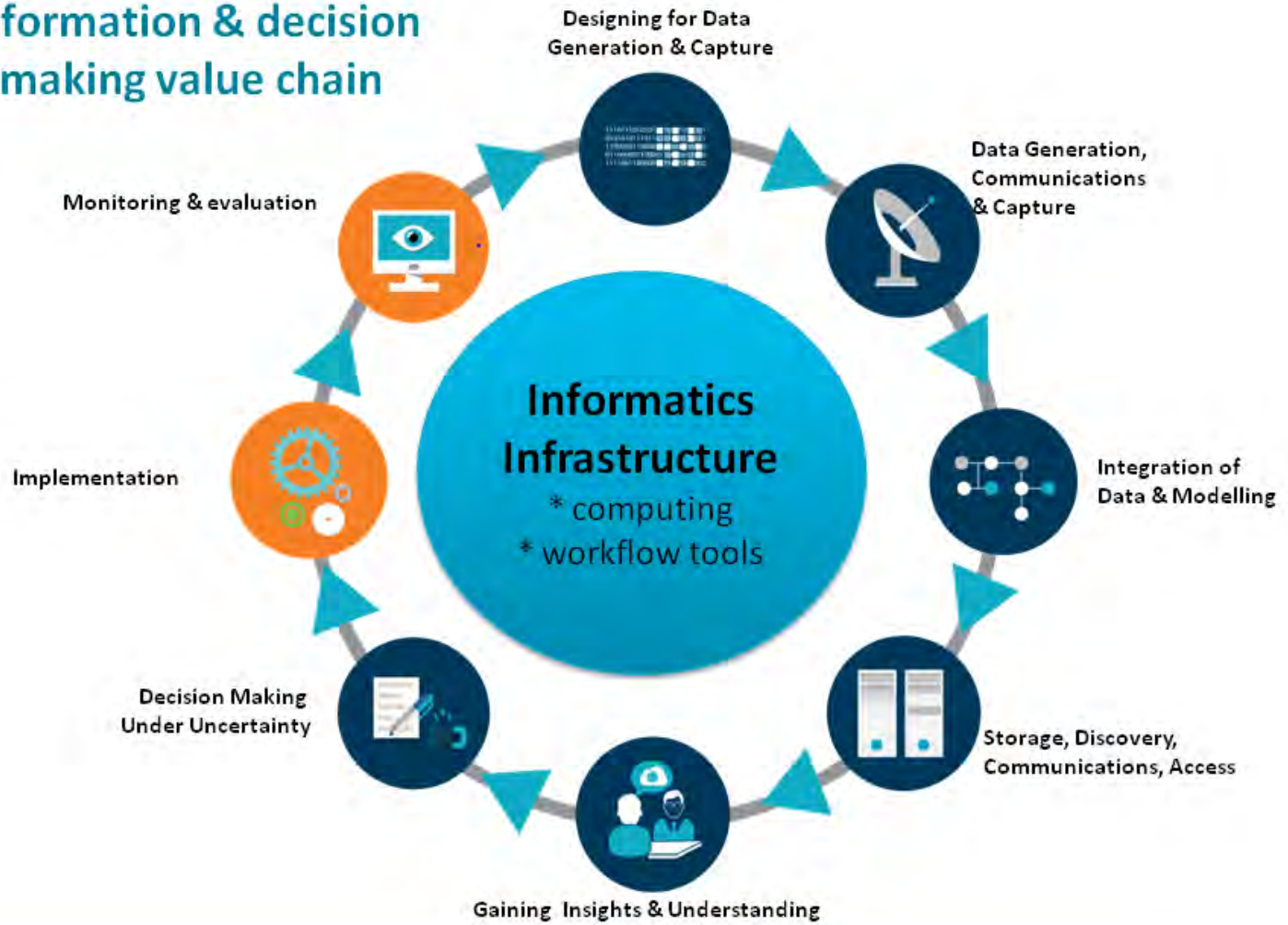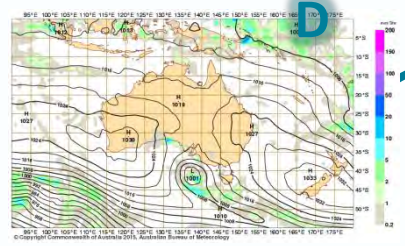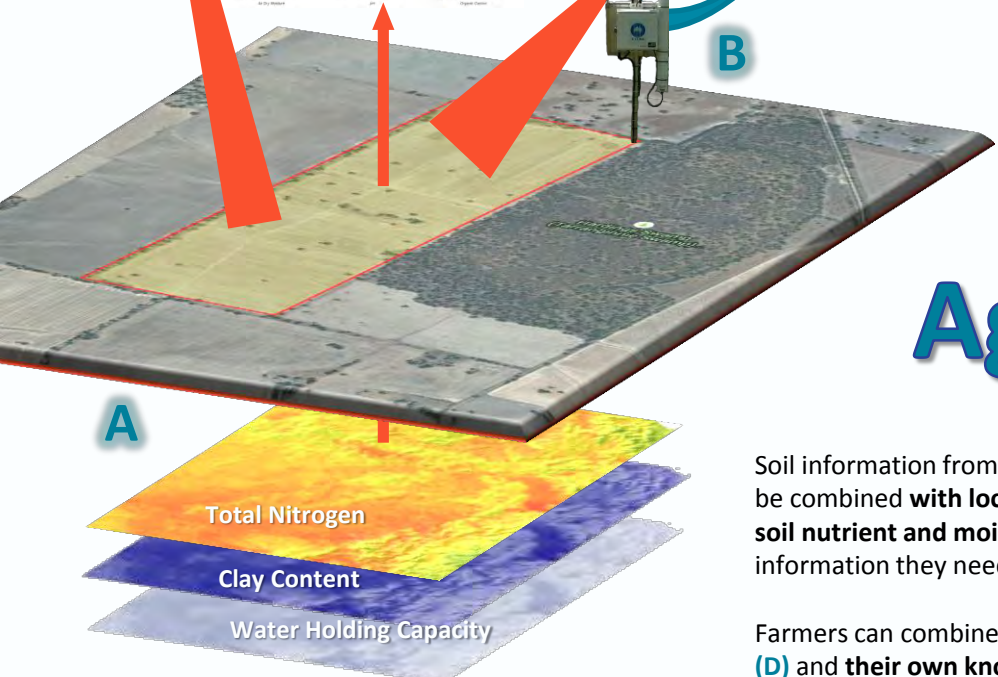**t** +61 7 3833 5632
e brian.keating@csiro.au

Thank you

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A bigger picture – soil big data is one link in the value chain

Digital Agriculture

Soil information from the new **National Soil Grid (A)** can be combined **with locally (B) and remotely sensed (C) soil nutrient and moisture data** to give farmers the information they need to analyse **cropping options**.

Farmers can combine this information with **climate** data **(D)** and **their own knowledge (E)** to **run model scenarios** in the **Cloud (F)**. This **interactive** system provides easy to understand **farming options analysis (G)**.

Total Nitrogen

Clay Content

Water Holding Capacity

Nhill – Harold's Paddock (182.2 Ha)

Cropping Inputs

Wheat Variety	Scout
Fertilizer (kg/Ha):	100
Fixed Costs ($/Ha):	400
PAW (0-1):	0.5352
Urea ($/kg):	2.97
Wheat Price ($/T):	310
AUD-USD ($/$):	0.7715

Q (soil moisture)
Q (urea)
Q (wheat)
Q (currency)

My Predicted Rainfall   My Soil Properties

Options Analysis

My year ahead...

Soil Loss (mm/yr):	0.001
Drain (mm/yr):	0.000
Rainfall (mm/yr):	367.00
Runoff (mm/yr):	2.59
Wheat Yield (T/Ha):	3,045.80
Wheat Value ($):	172,047
Fertilizer Cost ($):	41,752
Returns ($):	**57,409**

ASRIS – a moderated collation of the nation's mapping

Digital disruption – why now ?

- Business drivers shaping markets for knowledge services
- Model – data fusion possibilities
- Capacity in the systems models
- Computing power and communications infrastructure
- Remote and proximal sensing generating new data streams
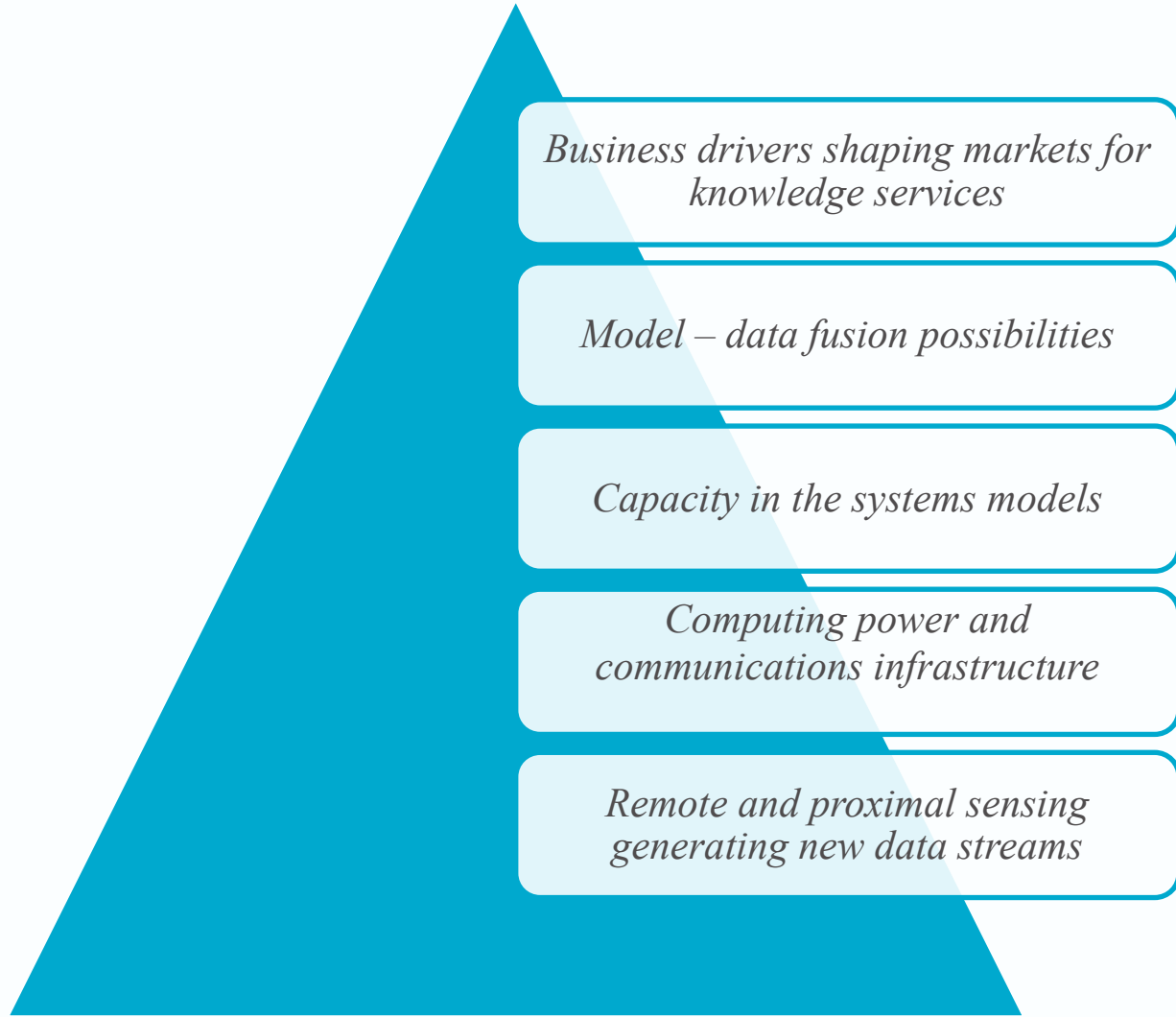
Australian agriculture 1972 - 2013
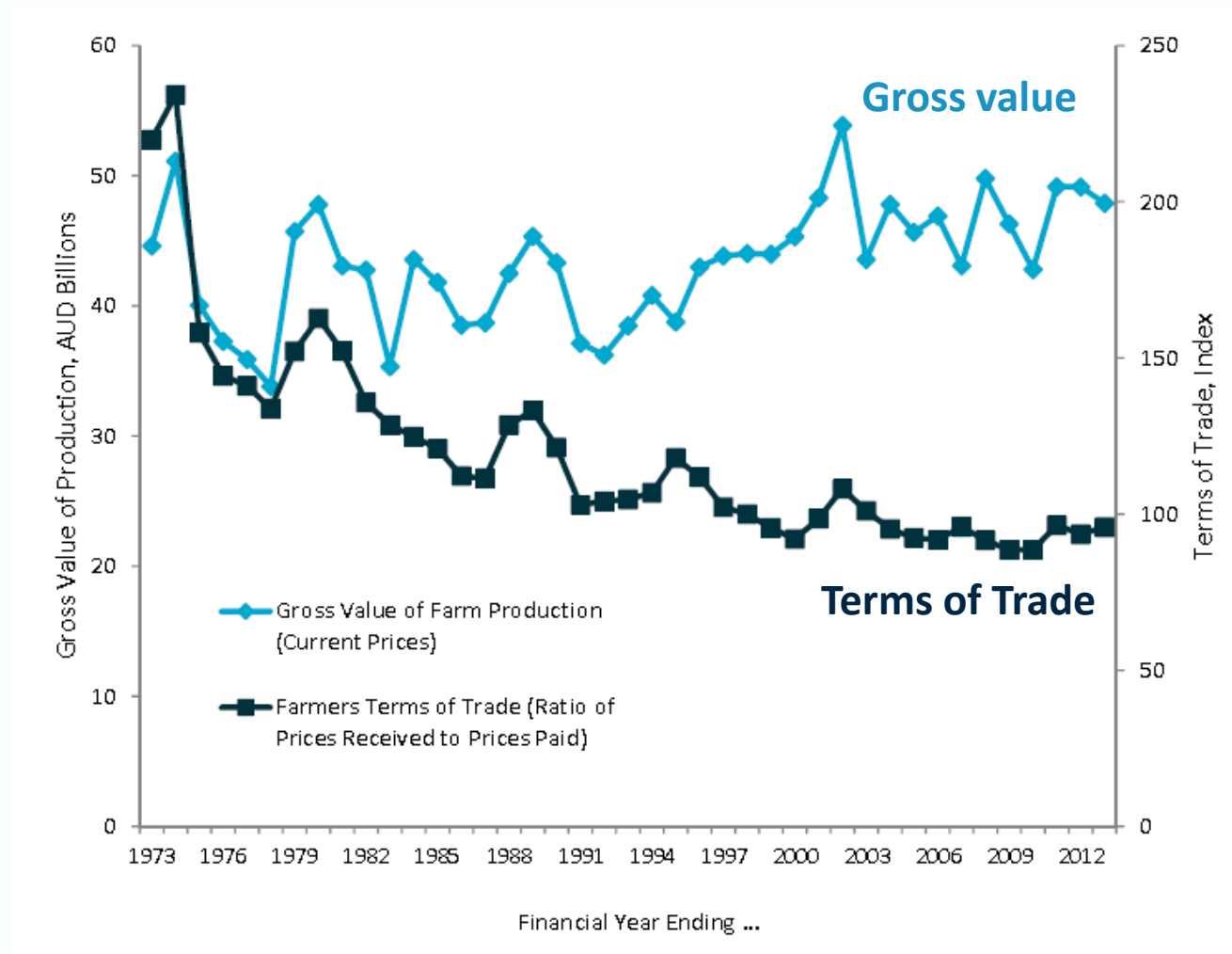
Linking soils information to agricultural systems models in a 'big data' way

1. Model ready soil attributes from the Soils Grid

2. Web services link information stores and models together into workflows

3. Prospects for near real time modelling of our farm production systems – to support farmer decision making

4. Elaborated by farmer data and local knowledge

Legend
Water Limited Potential Wheat Yield T/Ha/Yr
- 0
- 1.9
- 3.9
- 5.9
- 7.9
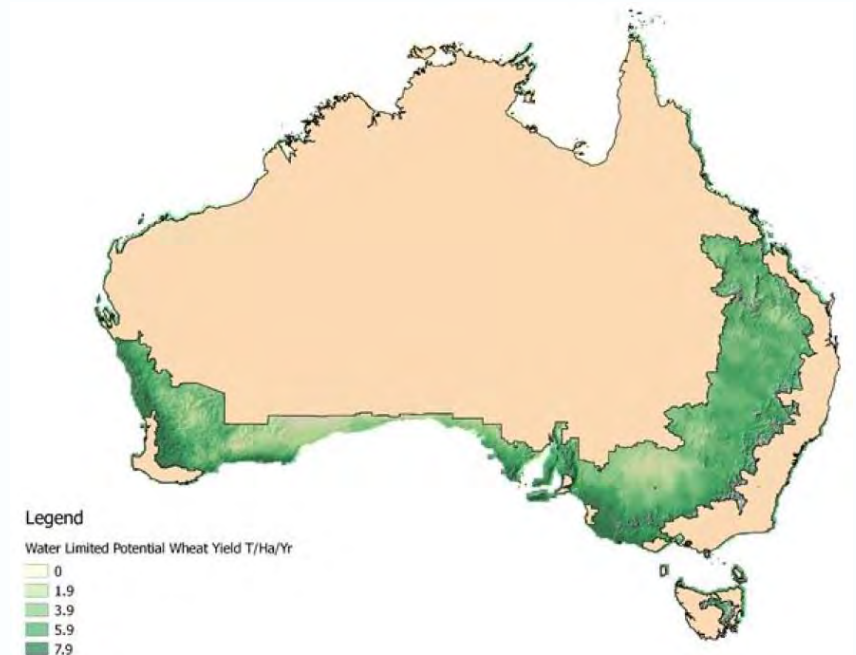
APSIM based Wheat yield estimates using soil attributes derived from the Soil Grid