

# APSIM - Agricultural Production Systems Simulator

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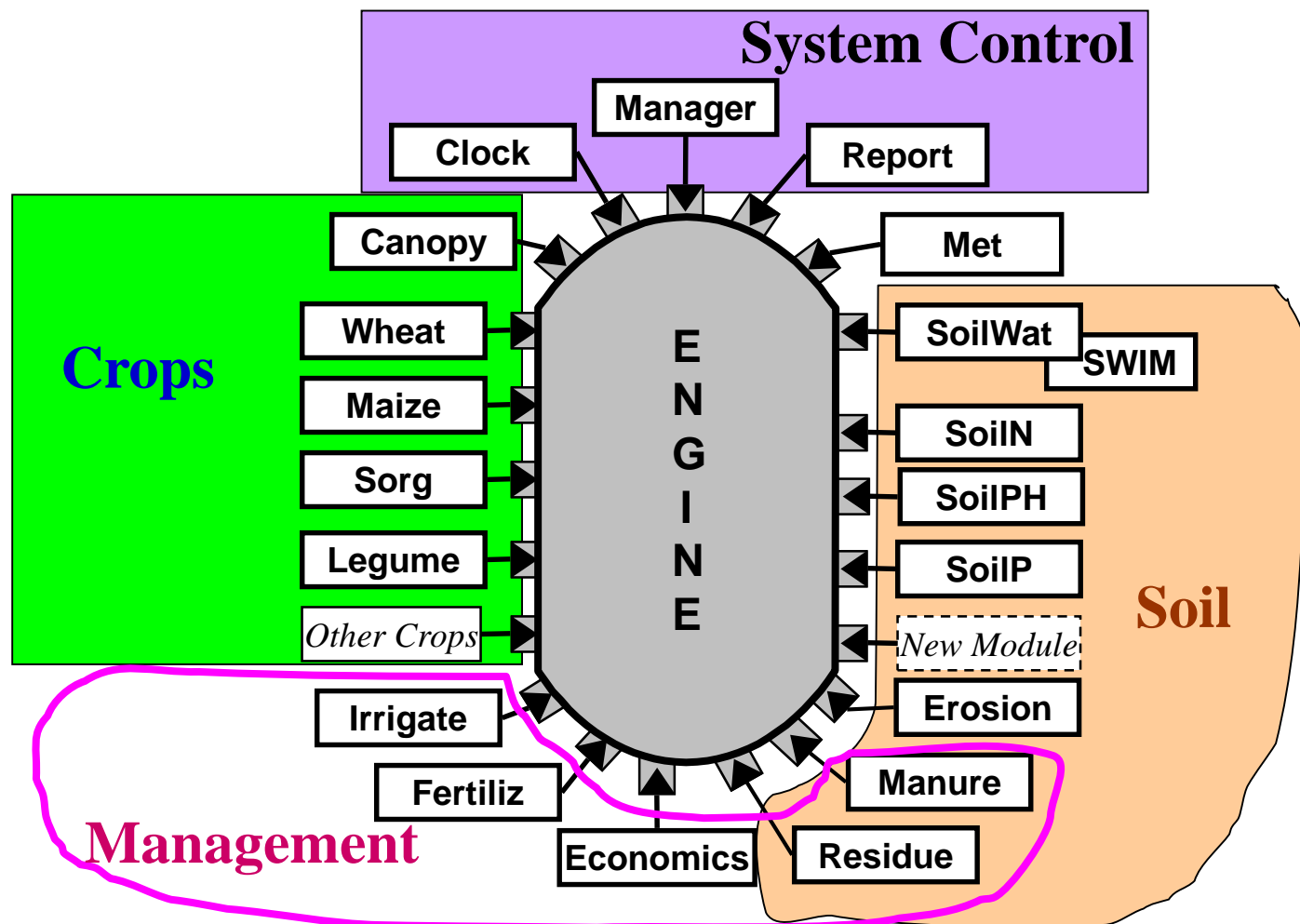
Assoc. Prof. Dr. Ahmad M. Manschadi

- APSIM
  - Design
  - Concept
  - Capabilities
- Testing and evaluation
- APSIM demonstration
- APSIM-Derived DSS Tools - WhopperCropper

- **APSIM development initiated in early 1990s**
- **APSRU (Agricultural Production Systems Research Unit)**
- **Investment: more than A\$ 13 million**

... the soil provides a central focus, crops, seasons and managers come and go, finding the soil in one state and leaving it in another .....

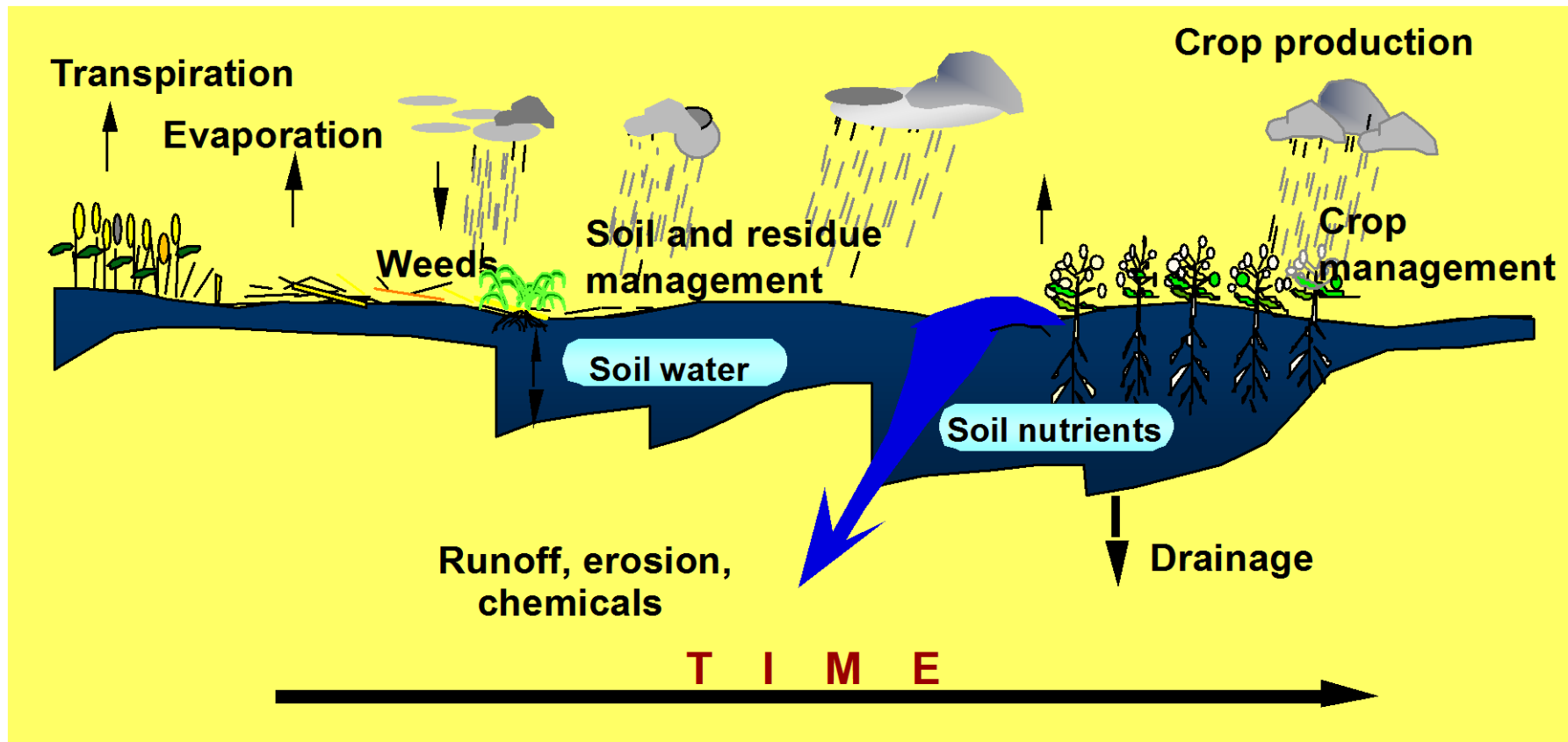
## □ APSIM – A farming systems modelling framework



### □ **APSIM simulates**

- mechanistic growth of crops, pastures, trees, weeds ...
- key soil processes (water, solutes, N, P, carbon, pH)
- surface residue dynamics & erosion
- dryland or irrigated systems
- range of management options (fertilisation, tillage, irrigation, ...)
- crop rotations + fallowing + mixtures
- biotic stresses (parasitic weeds)
- dynamics of populations (eg. weed seedbank)
- short or long term effects
- high software engineering standards

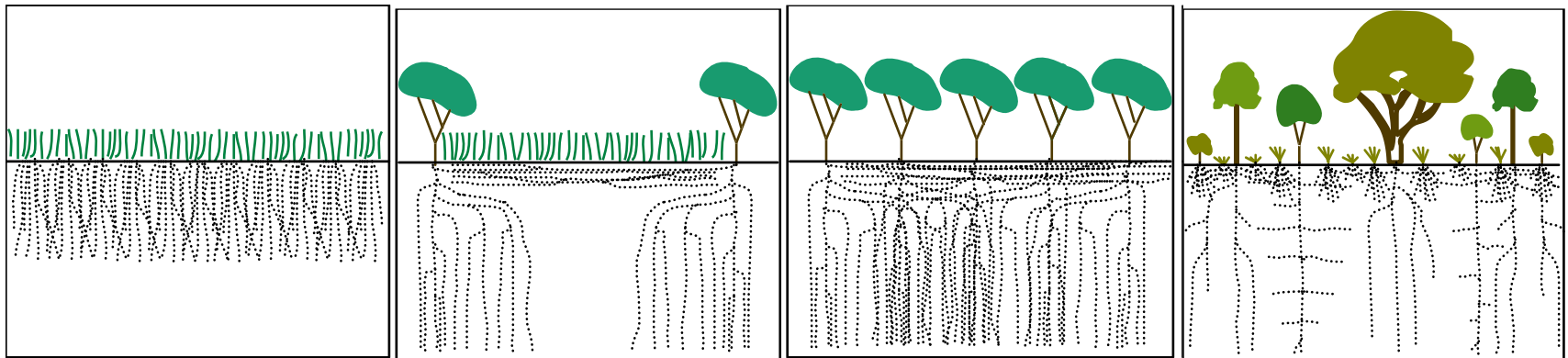
□ Systems simulation over time



□ Systems simulation across different scales

**gene – crop – farm – catchment - region**

□ Systems simulation of the cropping, novel agroforestry systems and native woodland

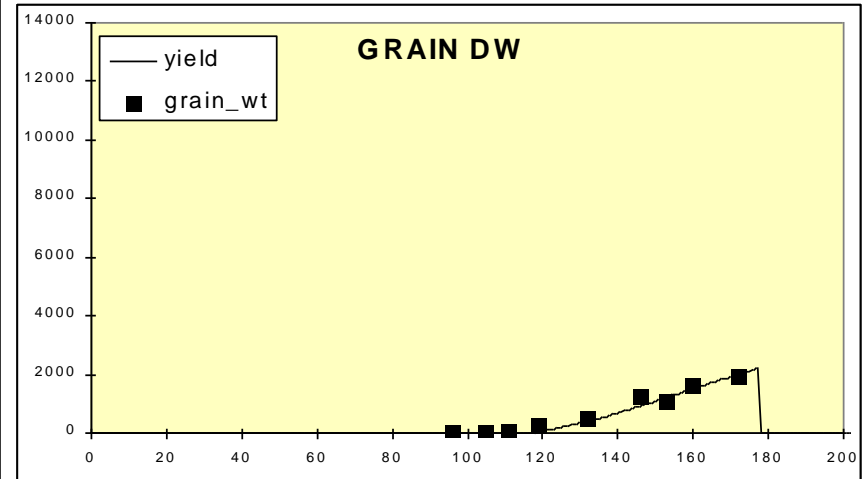
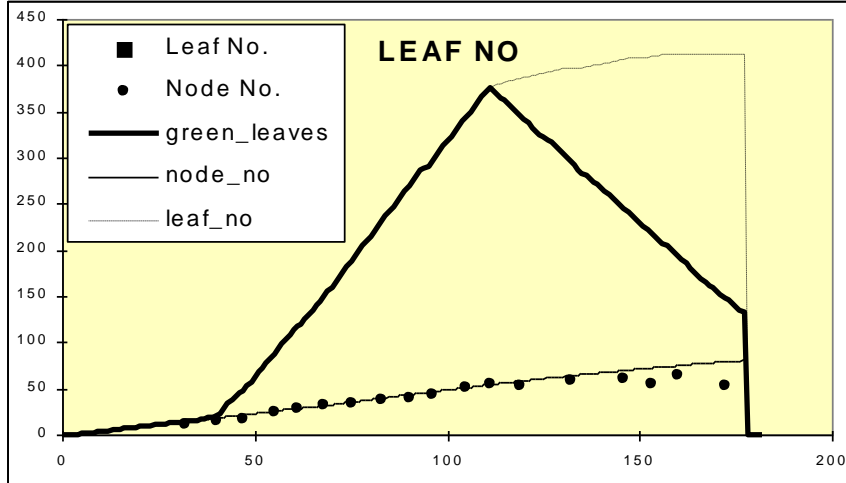
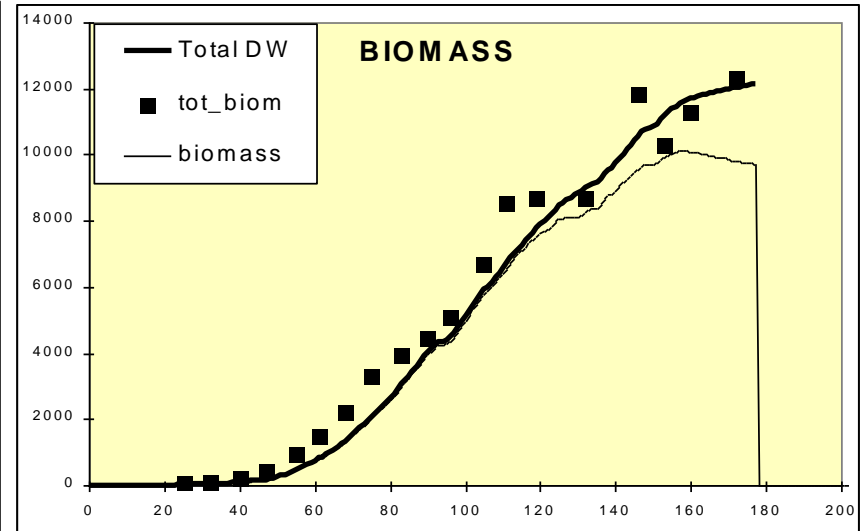
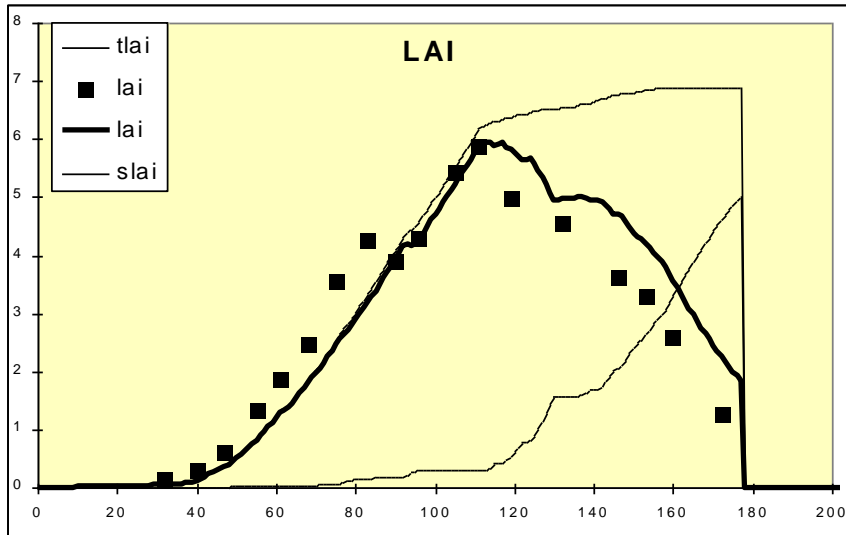


### □ Example APSIM applications

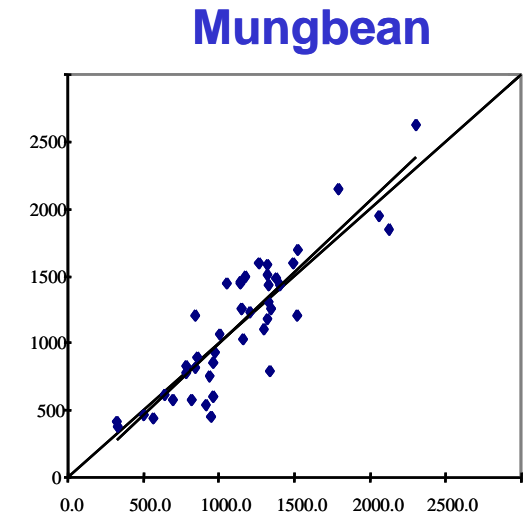
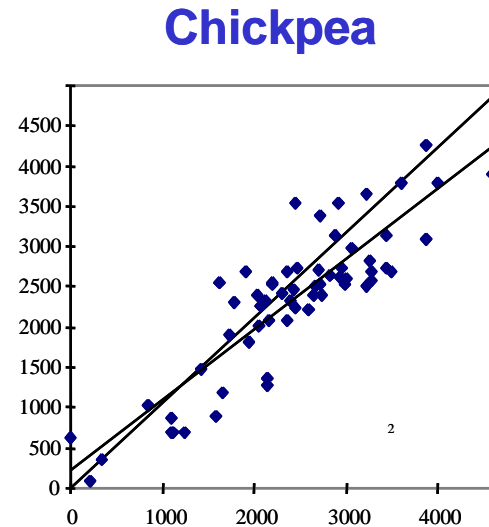
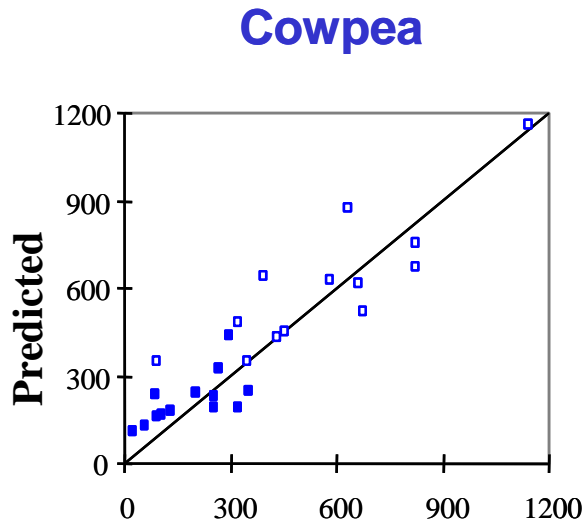
- **cereal-legume** rotations (**Probert et al.1995**)
- ley farming **systems** (**Carberry et al. 1996**)
- intercropping **systems** (**Carberry et al. 1996**)
- alley **farming systems** (**Nelson et al. 1998**)
- drought **policy formation** (**Keating & Meinke 1998**)
- erosion **impacts** (**Connolly et al. 1998**)
- **genetic** trait **identification** (**Robertson et al. 1999**)
- **seasonal** climate forecasting (**Hammer et al. 1999**)
- on-farm trial **analyses** (**Robertson et al. 1999**)
- agribusiness **value chain** (**Brennan et al., 2000**)
- climate change **impacts** (**Howden et al., 1999**)
- **tree** windbreak **systems** (**Carberry et al. 2001**)
- **deep** drainage **assessment** (**Keating et al., 2001**)
- **soil** acidification (**Verburg et al., 2001**)
- **risk assessment** of GMO (**Smith et al. 2001**)
- effluent **irrigation** (**Brennan et al., 2002**)
- agroforestry **systems** (**Huth et al., 2002**)
- crop-weed **competition** (**Keating et al. 1999**)
- parasitic weeds ***Orobanche*** (**Manschadi et al. , 2004**)
- smallholder **farming systems** (**Carberry, 2004**)



## □ ...crop growth & development



## □ ...yield of experimental crops

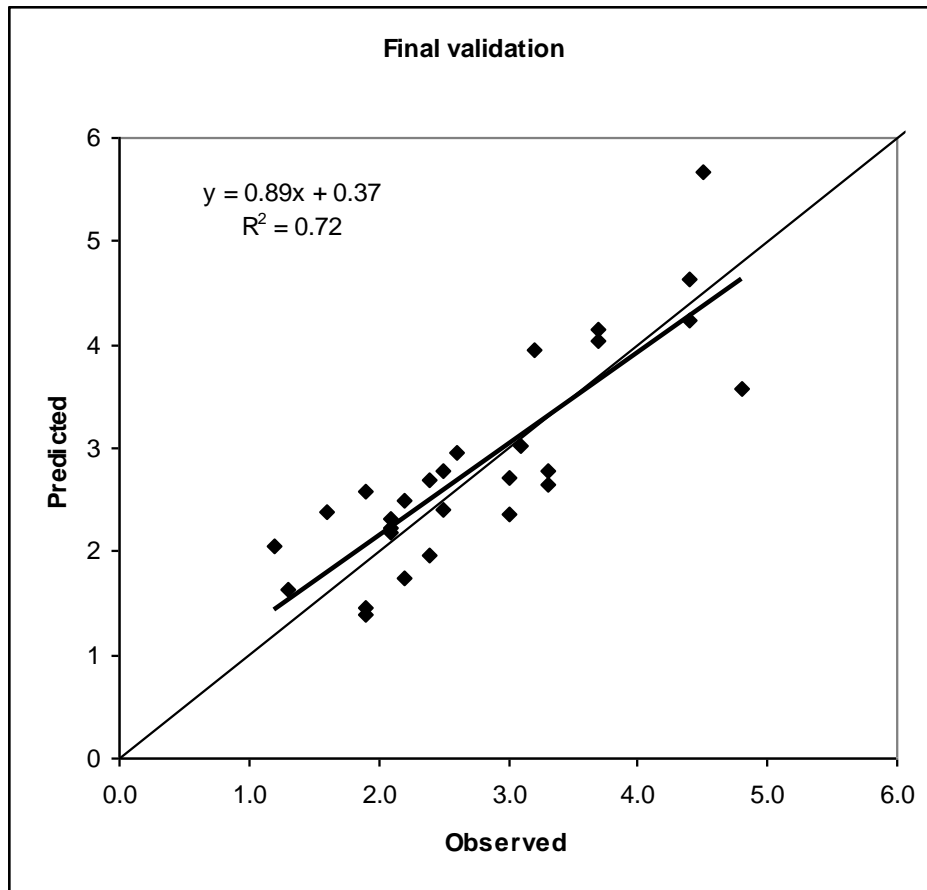


Observed

### Prediction

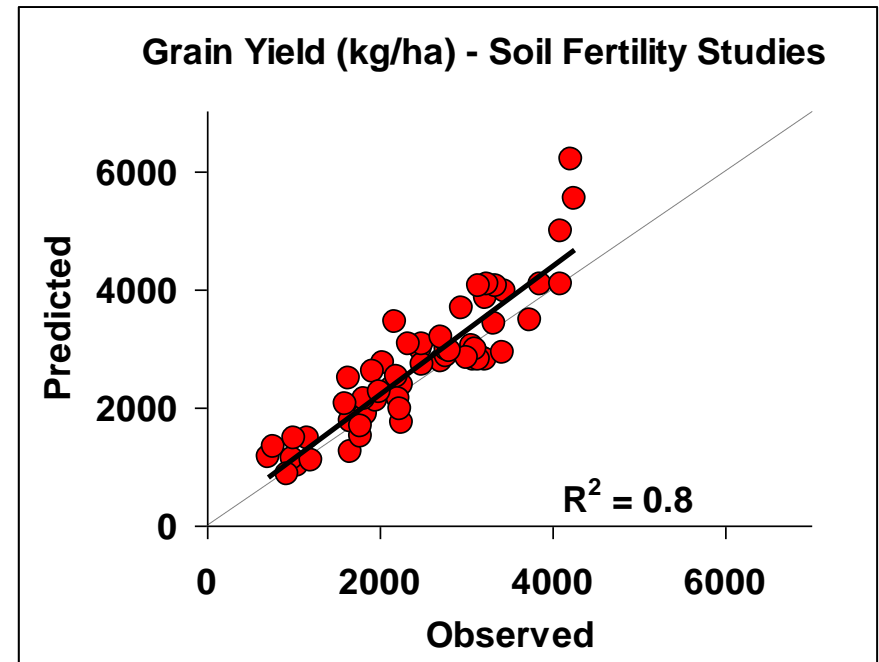
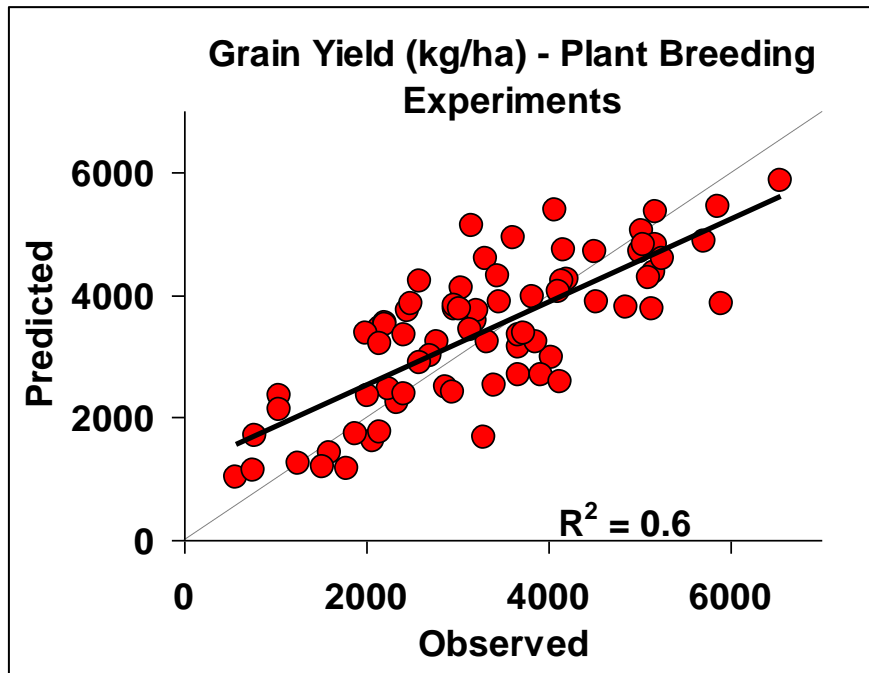
	<b>n</b>	<b>slope</b>	<b>regression line intercept</b>	<b>R<sup>2</sup></b>
wheat grain	43	1.07	-13.0	0.79
maize grain	111	0.98 (± 0.04)	-5.5 (± 240)	0.85
chickpea grain	60	0.90 (± 0.07)	163 (± 172)	0.76
mungbean grain	47	1.07 (± 0.10)	-27.2 (± 128)	0.72
cowpea grain	15	0.93 (± 0.08)	-31.6 (± 34.6)	0.91
stylo biomass	63	0.84 (± 0.06)	-131.7 (± 171)	0.78

### □ ...yield of commercial crops

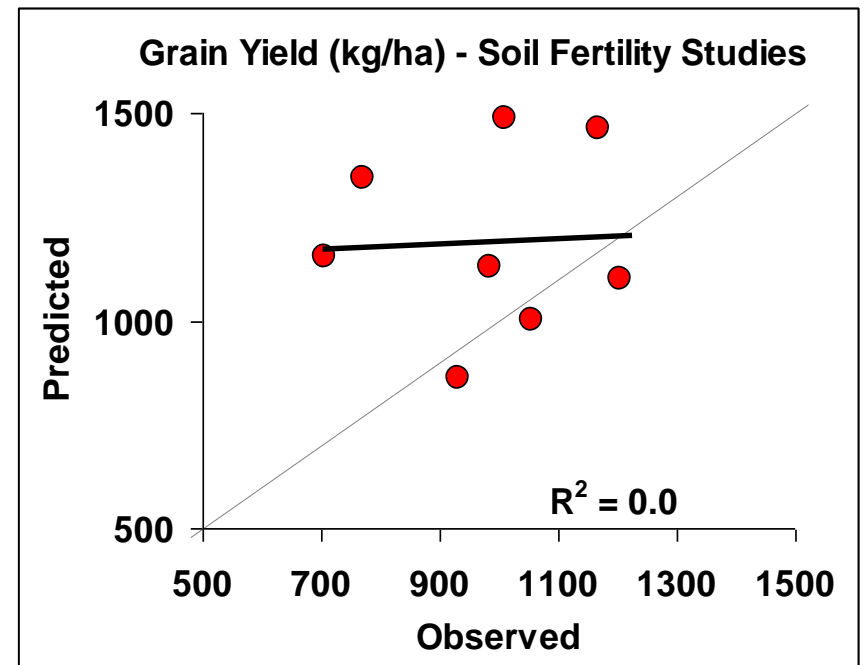
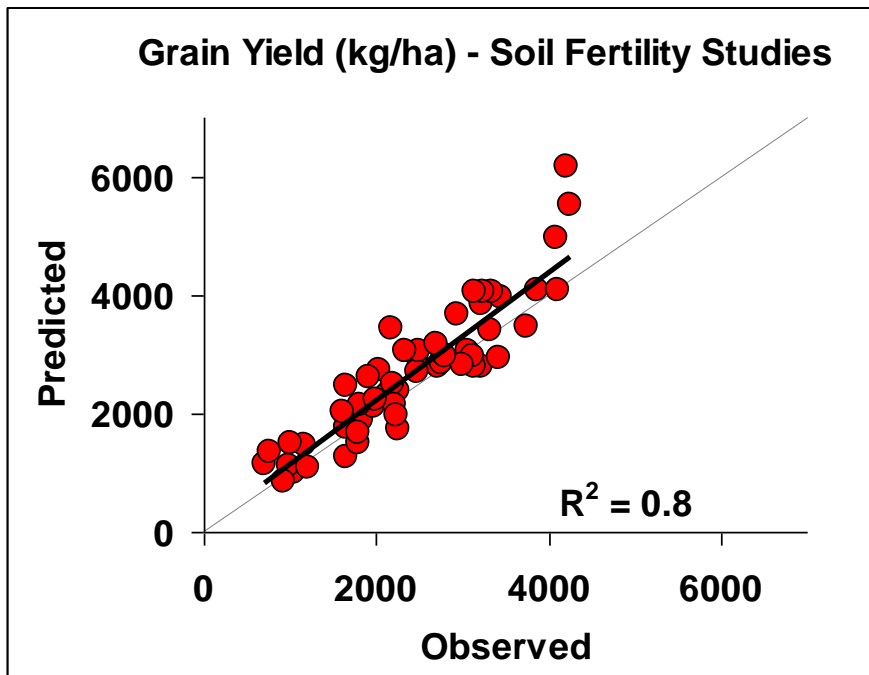


- **Vic Mallee / Wimmera**
  - **Wheat in 31 paddocks**
  - **Yields ranging from 1 – 5 t/ha**
  - **APSIM simulated >70% variation**
- => confidence to promote as a commercial service in 2004**

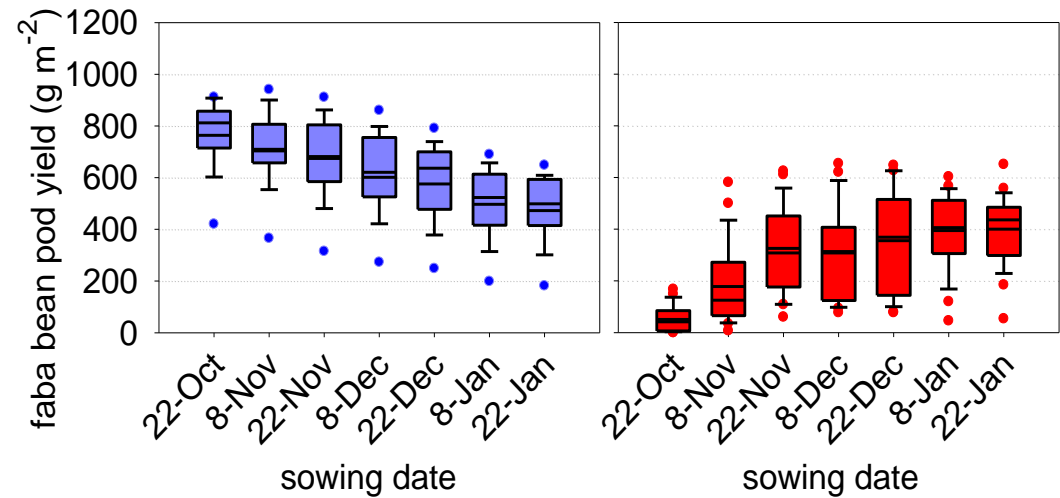
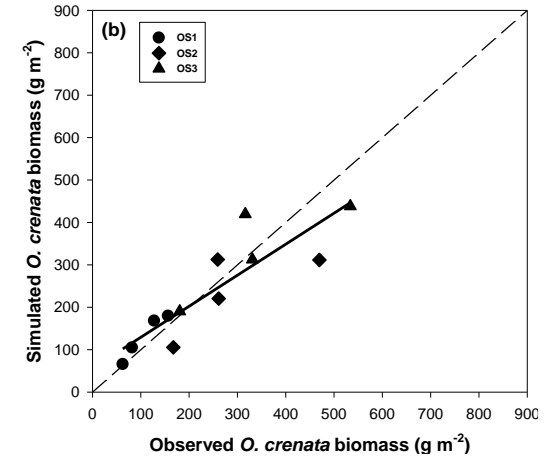
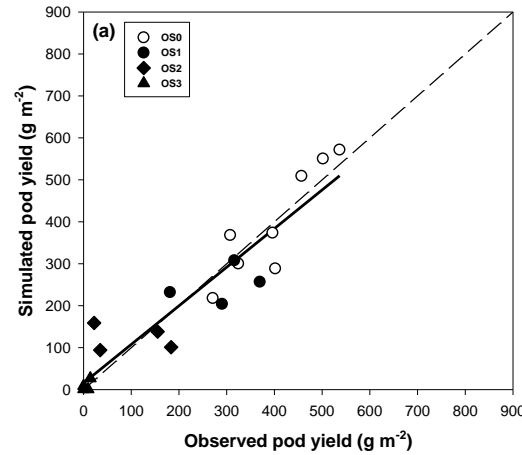
□ ...performance of wheat module



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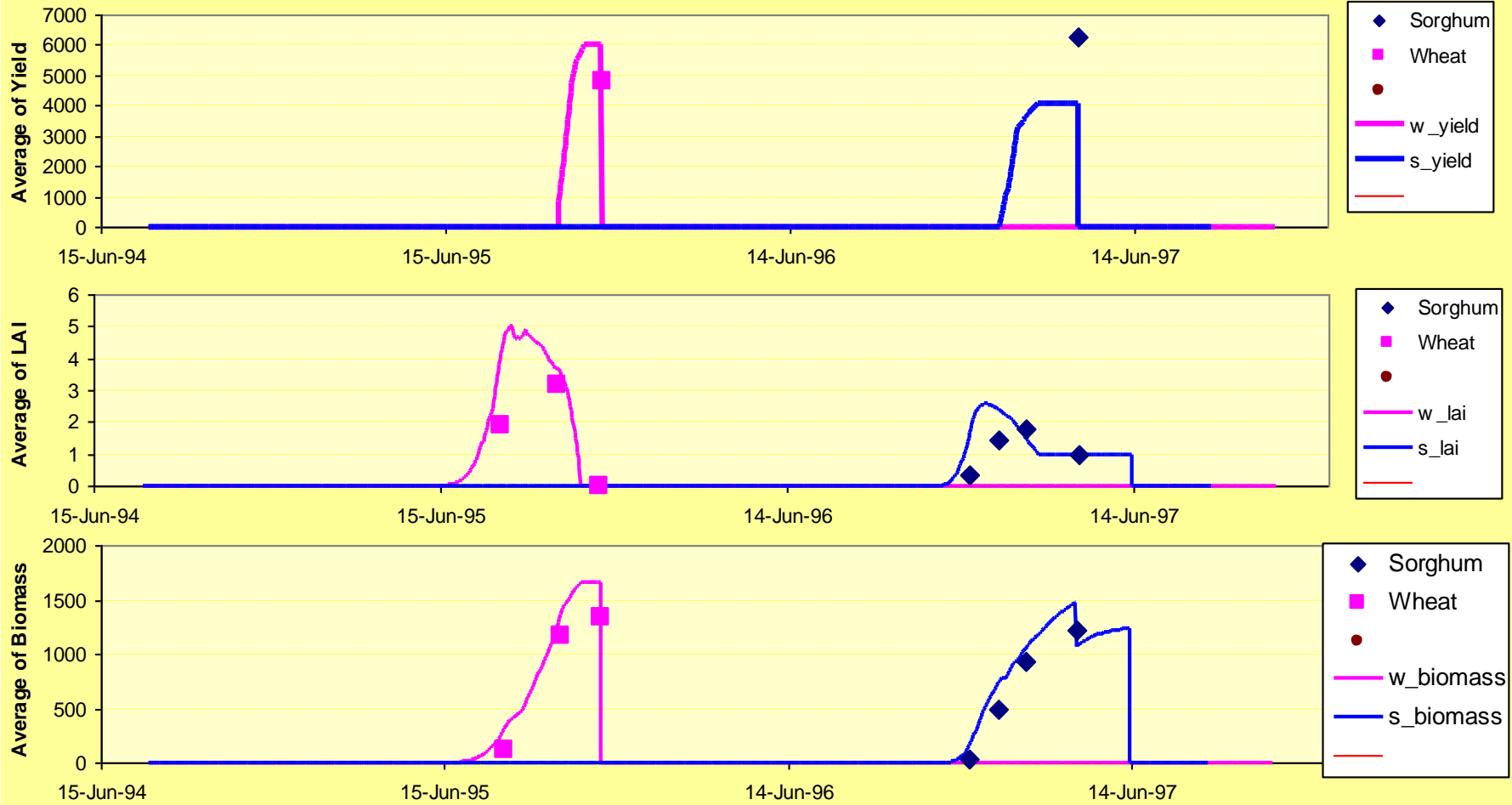


## □ ... yield responses to biotic stresses

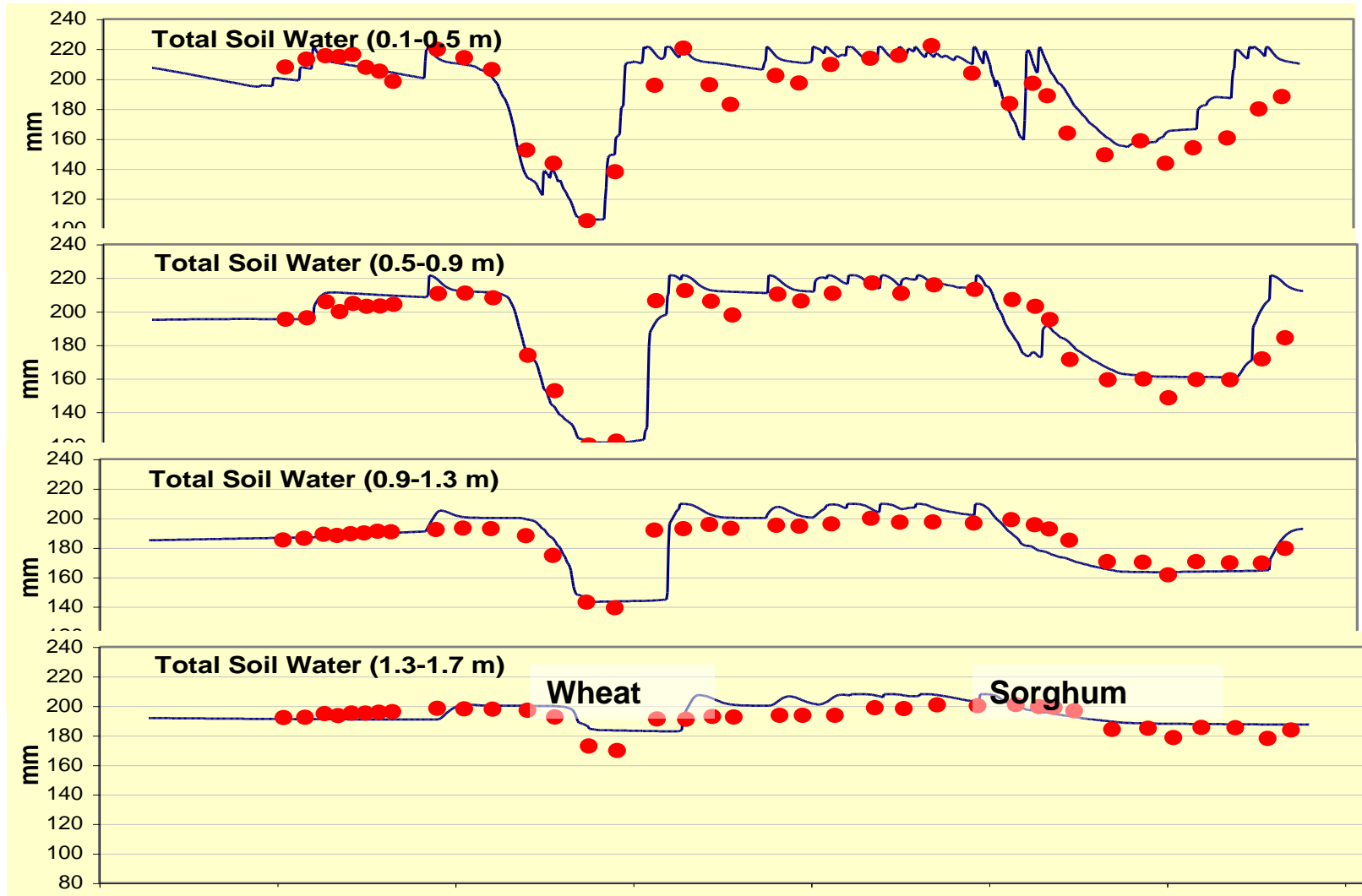


# Testing and evaluation

## □ ... yield of crops in rotation



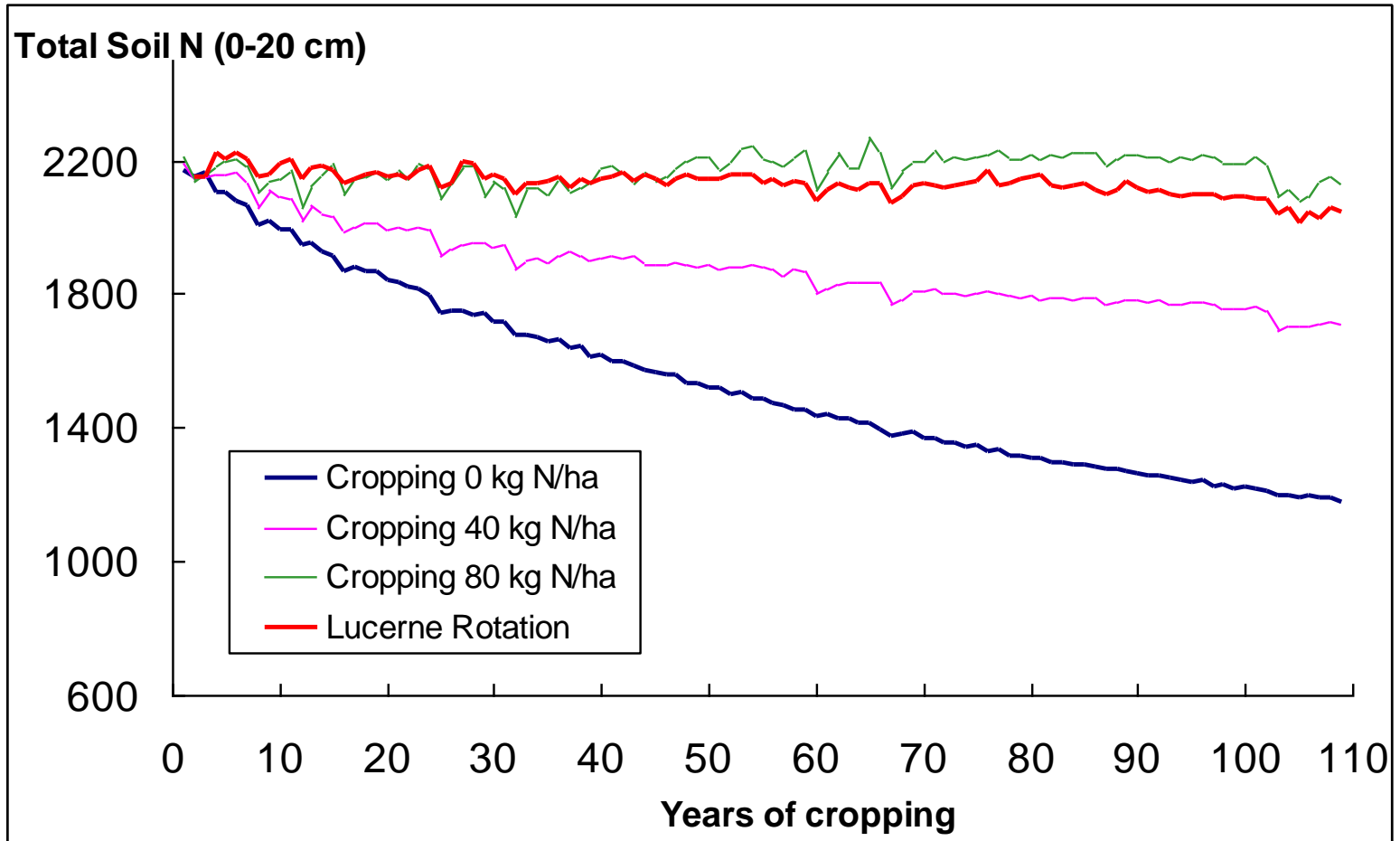
□ ... soil water of crops in rotation





□ ... soil organic matter changes

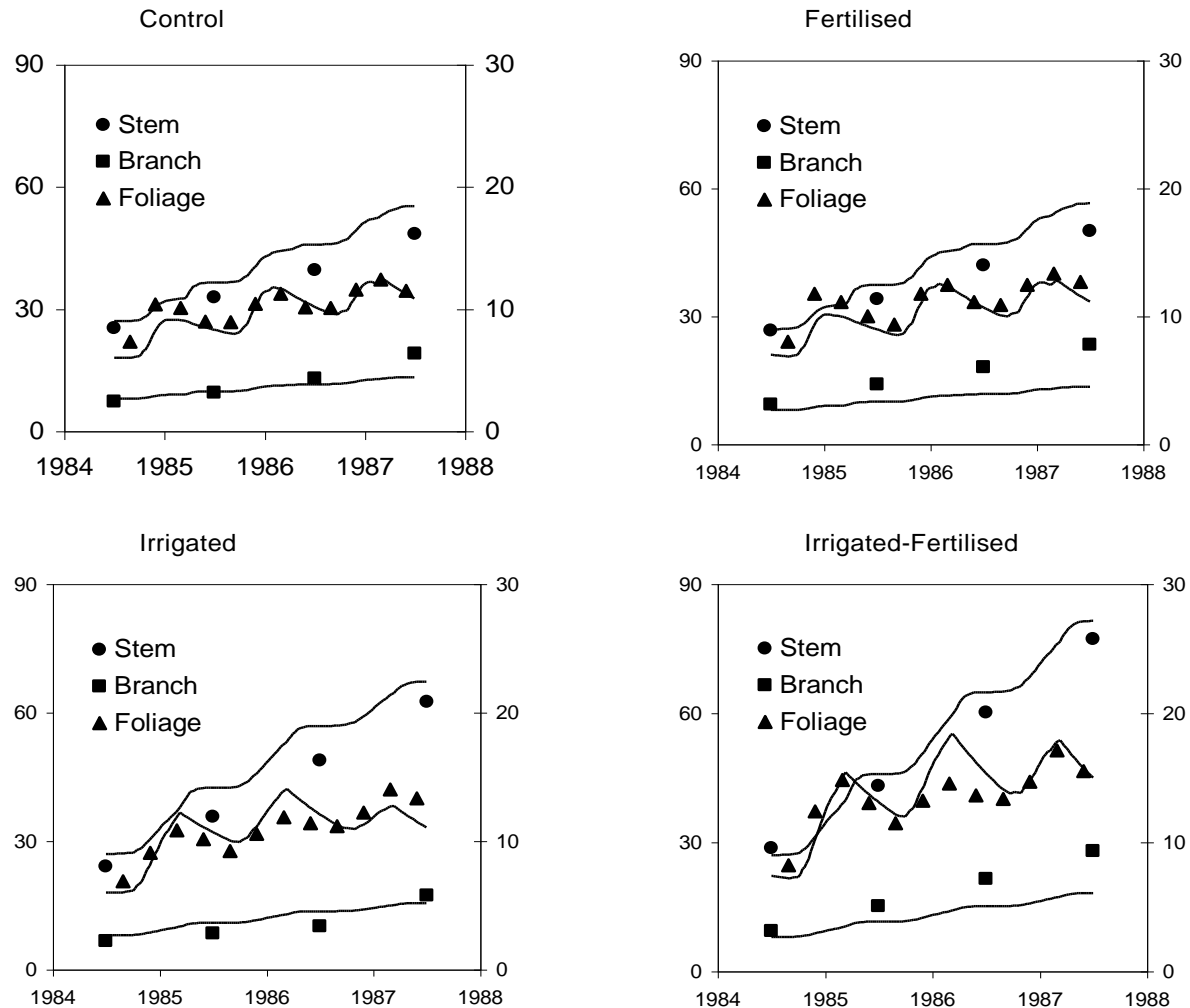
Farming systems on a vertisol at Dalby, Qld.



## □ ... tree growth

- Pierces' Creek
- near Canberra (35° 21'S, 148° 56'E)
- Annual Rainfall 790mm
- 10 y.o. *Pinus Radiata*
- Stocking Rate 700/ha

### Forest productivity in response to management



## □ Further information:

Keating, Carberry, Hammer, Probert et al. (2003). "An overview of APSIM, a model designed for farming systems simulation." *European Journal of Agronomy* 18(3-4): 267-288.

## APSIM Homepage (<https://www.apsim.info>)

The screenshot shows the APSIM homepage with a navigation menu at the top: **Navigation: News, Intro, APSIM Versions, Licensing, Documentation, Other Products, Publications, Forum, Bugs&Tasks.** There are also links for **Categories, AllPages, GoogleSearch, WikiSearch** and a **Create a new Page** button. The main heading is **APSIM Introduction**, with **Discuss (0)** and **History** buttons. The text describes APSIM as a modular modelling framework developed by APSRU in Australia, designed to simulate biophysical processes in farming systems. It lists the components of the APSIM modelling framework:

- A set of biophysical modules that simulate biological and physical processes in farming systems.
- A set of management modules that allow the user to specify the intended management rules that characterise the scenario being simulated and that control the simulation.
- Various modules to facilitate data input and output to and from the simulation.
- A simulation engine that drives the simulation process and facilitates communication between the independent modules.

In addition to the science and infrastructure elements of the APSIM simulator, the framework also includes:

- Various user interfaces for model construction, testing and application
- Various interfaces and association database tools for visualisation and further analysis of output.

The diagram on the right illustrates the APSIM modelling framework. It shows a central vertical cylinder labeled **ENGINE**. To the left, **Maize** and **Cowpea** crop modules feed into the engine, along with an **Arbitrator** module. **Surface Residue** also feeds into the engine. To the right, the engine outputs to **Soil pH**, **Soilwat**, **SWIM**, **SoilN**, **SoilP**, and **Erosion** modules. A **Manager** module at the top interacts with the engine, and a **Report** module at the top left receives output from the engine.