Modelling Water Use by Organic and Conventional farms in the Murray-Darling Basin, Australia

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Overview

- Overview of Water Markets and water policy in Australia
- Define what is meant by water-use modelling and different ways to model it
- Compare the difference between hard technology adoption and soft technology adoption on farms
- Survey Design
- Results of water-use by farm-type: certified organic and conventional

Figure 1.1: Global Risks of Highest Concern - for the Next 18 Months and 10 Years

Source: Global Risks Perception Survey 2014, World Economic Forum.
Note: Survey respondents were asked to select up to five risks of highest concern for each time frame. The percentage indicates the share of respondents who selected the specific global risk among the five risks of highest concern for each time frame. In each category, the risks are sorted by the total sum of mentions. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated. See Appendix A for the full name and description.

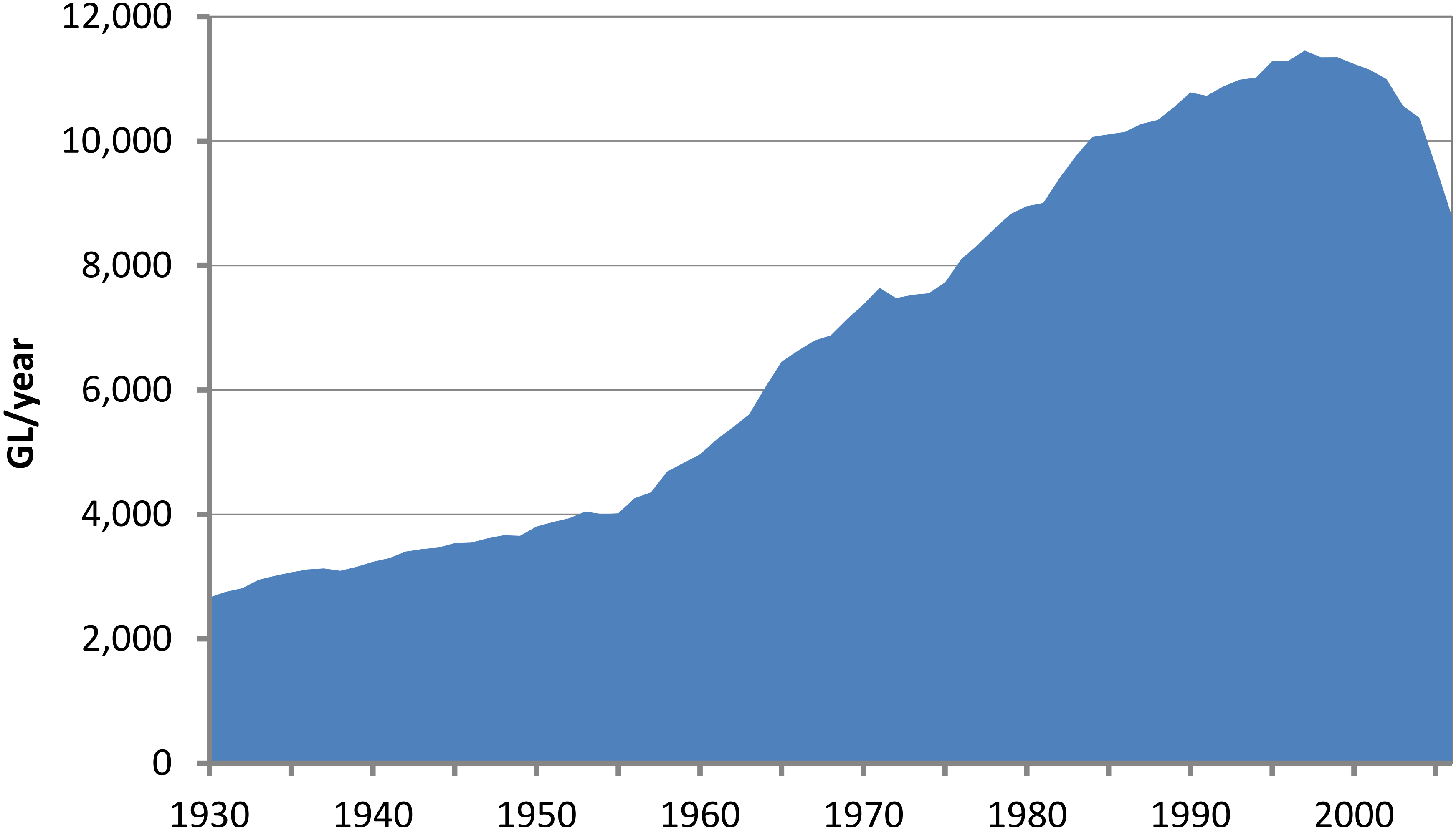
The Murray Darling Basin (MDB)

- 1,000,000 km^2
- 14% of Australia
- 80% of basin is agric.
- 60% of Australia's irrigation
- "Food Bowl" of Aust.
- Population 2,000,000, supports 20 million
- 5 jurisdictions
- Signif. environ. values
- Aust. 3 longest rivers
- Home to 34 major Indigenous groups
- **Largest buyback of water in the world from consumptive to environ. use**

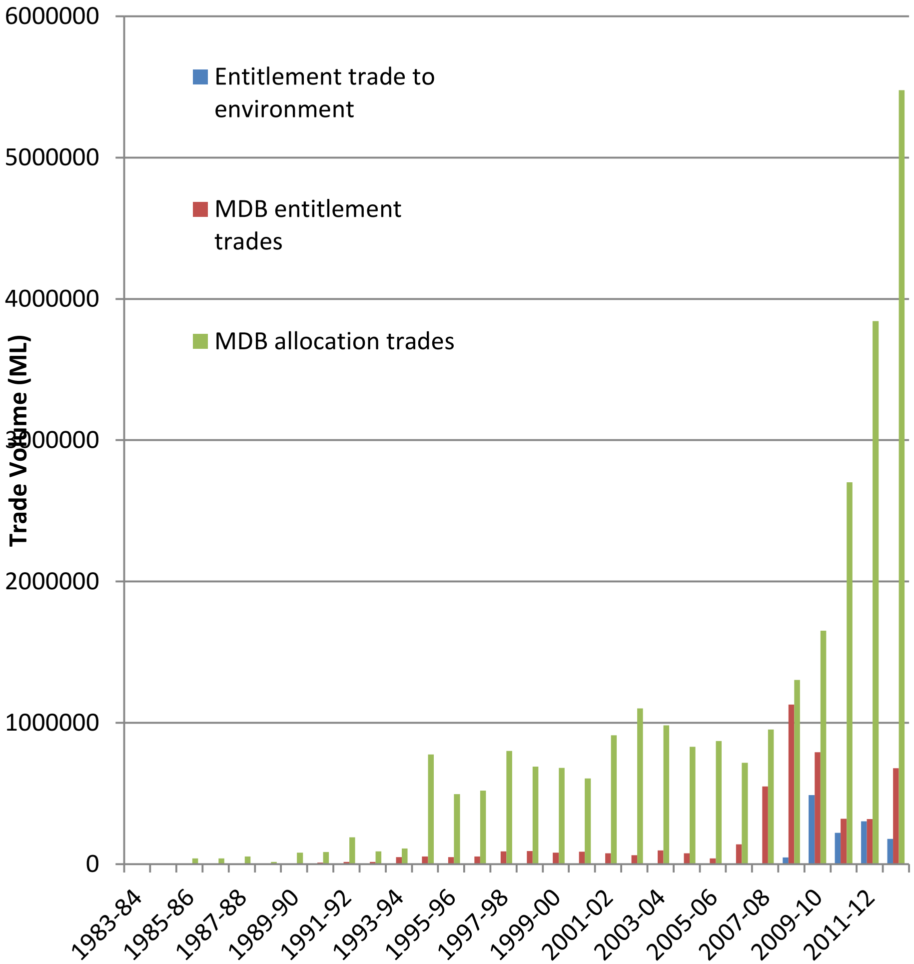
Australian Water reform: a movement from Supply-driven management to Demand-driven management over time

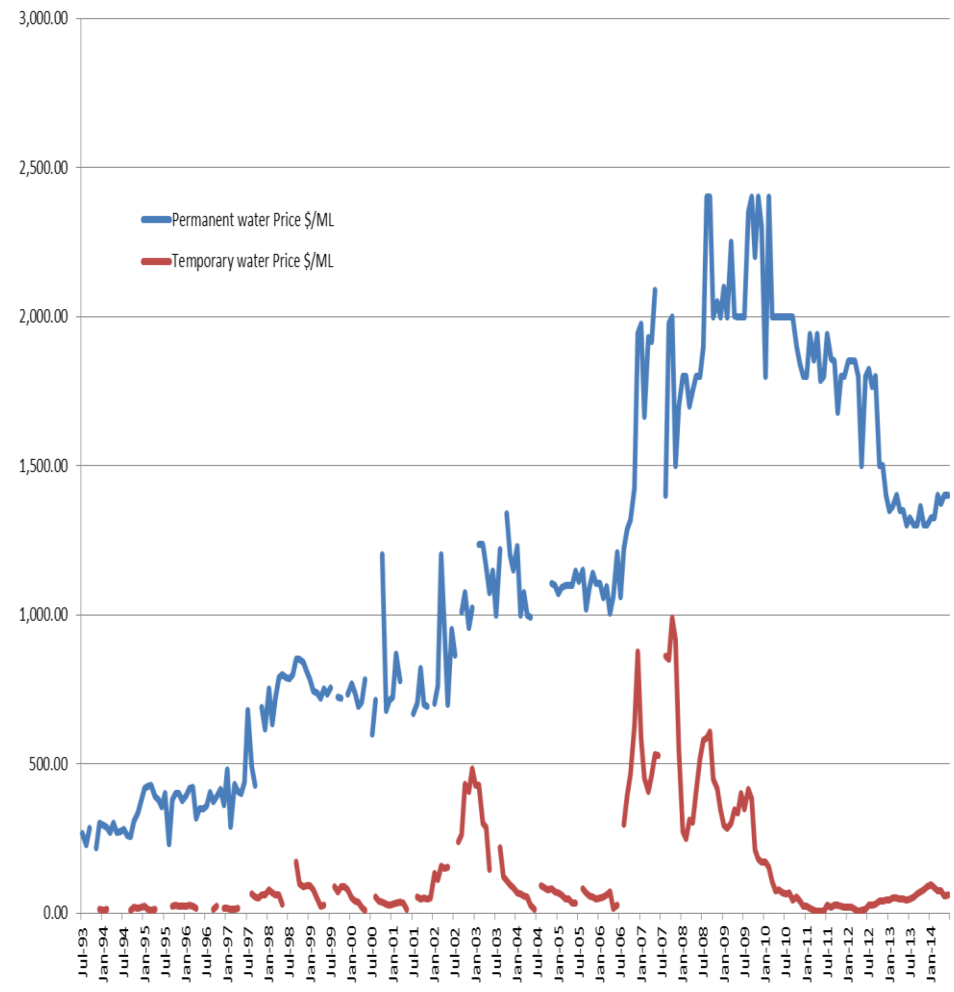
- **1901** Constitution
- **1914** River Murray Commission
- **1987** Murray-Darling Basin Commission
- **1990's** Diversion Cap, COAG, property rights & Water markets
- **2004** National Water Initiative & The Living Murray First Step
- **2007** Commonwealth Water Act & Murray-Darling Basin Authority
- **2008** COAG Agreement
- **2012** Murray-Darling Basin Plan

Growth in MDB water diversions



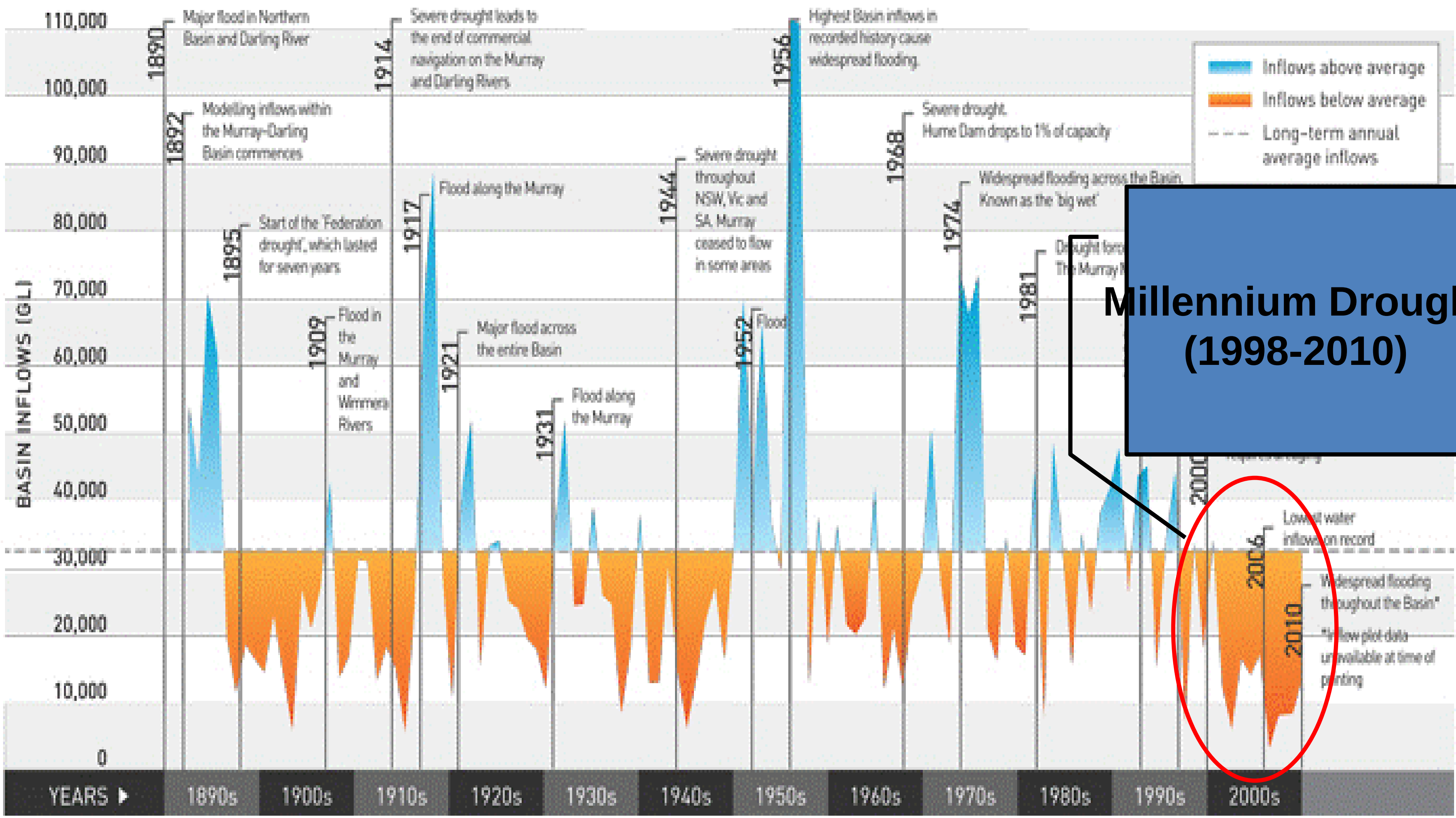
MDB Water Markets – Vol & Prices





(Source: Wheeler et al 2015

Flows in the MDB over time



(Source: MDBA 2012)

2012 MDB Plan

– The development and implementation of the MDB plan has caused significant unrest
– MDB Plan was passed into law in 2012, with all states finally signed up Feb 2014
– Overall objective of the Plan is to coordinate water policy across 4 states and one territory
– 2,750 GL reduction in consumptive use
– 450 GL of additional water for the environment is also to be recovered through infrastructure investment expenditure
– The Commonwealth has committed billions of dollars since 2007-08 to funding water recovery.

Importance of the Research

- The biggest water policy reform and water reallocation in the world requires voluntary participation of MDB irrigators
- Irrigators in the MDB need to understand how to irrigate with less water, for reasons of a) selling permanent water entitlements to government or b) climate change and future water scarcity issues
- Government policy in Australia to date has concentrated on reducing water use of farms through subsidising irrigation infrastructure
  - However, concentrating on ‘hard technology’ adoption ignores the following:
    1. The ‘rebound’ effect of irrigators improving irrigation infrastructure and correspondingly using more water (as they put in more crops, switch crop type, sell water entitlements)
    2. Reduced irrigation water losses may increase field-level water use efficiency but decreases basin level efficiency as reflows into groundwater decline
- There is evidence that organic farms may use comparatively less water than conventional farms due to soil management practices that build greater soil content

Water-Use Definitions

- Irrigation water-use can be estimated via agronomic, engineering or economic approaches:
- *Irrigation efficiency* is the ratio between water diverted and water consumed by crops
- *Field application efficiency* is the ratio of crop irrigation water requirements and water delivered to fields
- *Water-use efficiency* is crop yield per unit of water diverted (e.g. kg/m3 or ML/tonne); and
- *Water-use productivity* refers to the dollar value of water produced per unit of water applied (ML/$)
- These definitions are not directly comparable
  - Agronomic and engineering approaches only measure water-use often to gauge the performance of irrigation technology, while economic concepts of water-use efficiency assess farm management (e.g. yield)

Extent of Certified Organic Production

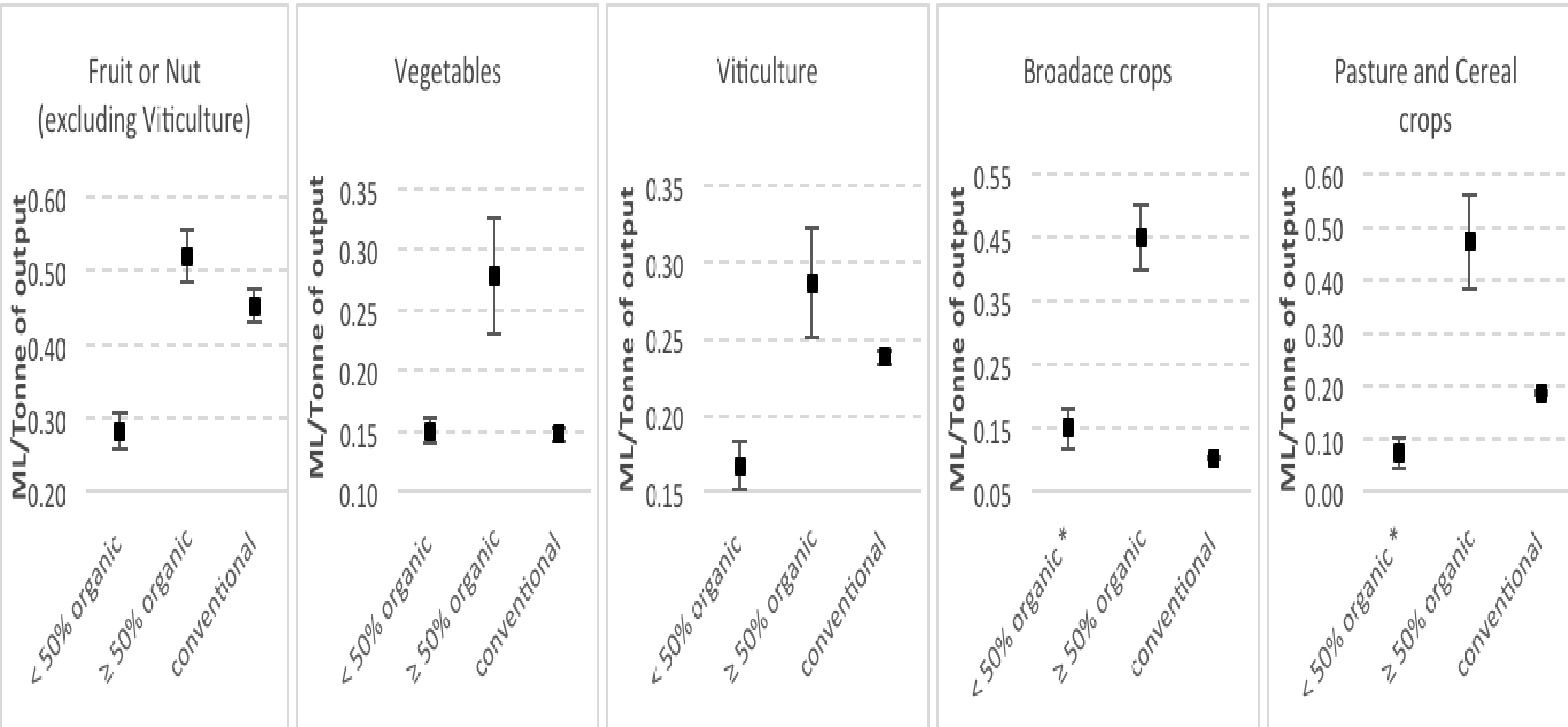
- In 2013:
  - 4% of land in Australia was certified-organic with 1,707 producers
  - 1% of land in New Zealand was certified-organic with 987 producers
- Most of the certified land in Australia is rangelands in South Australia
- 15% of Australian certified organic farms are in the southern MDB

Methodology (1)

- Compared water-use per hectare and water-use per tonne of production of conventional and organic farms via two methods.
  1) ABS Agricultural Census 2010-11 of all farms in Australia

ABS Results – Water-Use Efficiency

Figure 2 Agricultural census comparisons of ML/Tonne of MDB irrigated industries in 2010-11, by system*



Notes: * MDB industry numbers include: ***pasture*** *(includes cereal crops cut for silage, grazing and hay)* ((organic <50% (n=5); organic ≥50% (n=60); conventional (n=6430)); ***broadacre*** ((organic <50% (n=10); organic ≥50% (n=26); conventional (n=3259)); ***fruit and nut*** (excluding viticulture) (organic <50% (n=34); organic ≥50% (n=46); conventional (n=1987); ***vegetable*** ((organic <50% (n=13); organic ≥50% (n=57); conventional (n=720)); and ***viticulture*** (organic <50% (n=16); organic ≥50% (n=41); conventional (n=2948). Estimates of the 95% confidence interval for the <50% organic farms in pasture needs to be treated with caution as it has a RSE >10%, namely 26% in Figure 1 and 21% in Figure 2. Broadacre has a RSE of 11% in Figure 2.

Methodology (2)

- Regression analysis of farm surveys of irrigated farms in the Murray-Darling Basin

$$\text{Water-use}_i = \alpha + \beta_0 * \textit{organic} + X_{1*i}\beta_1 + \varepsilon_i$$

Where water-use was modelled five different ways:

1) water-use volume (ML);

2) water-use volume by hectare irrigated (ML/ha);

3) water-use volume per dollar of farm net income (ML/$);

4) water-use as a percentage of total water allocations received (%); and

5) water-use per unit of output produced (ML/tonne—only calculated for horticultural sector to allow similar yield unit comparisons).

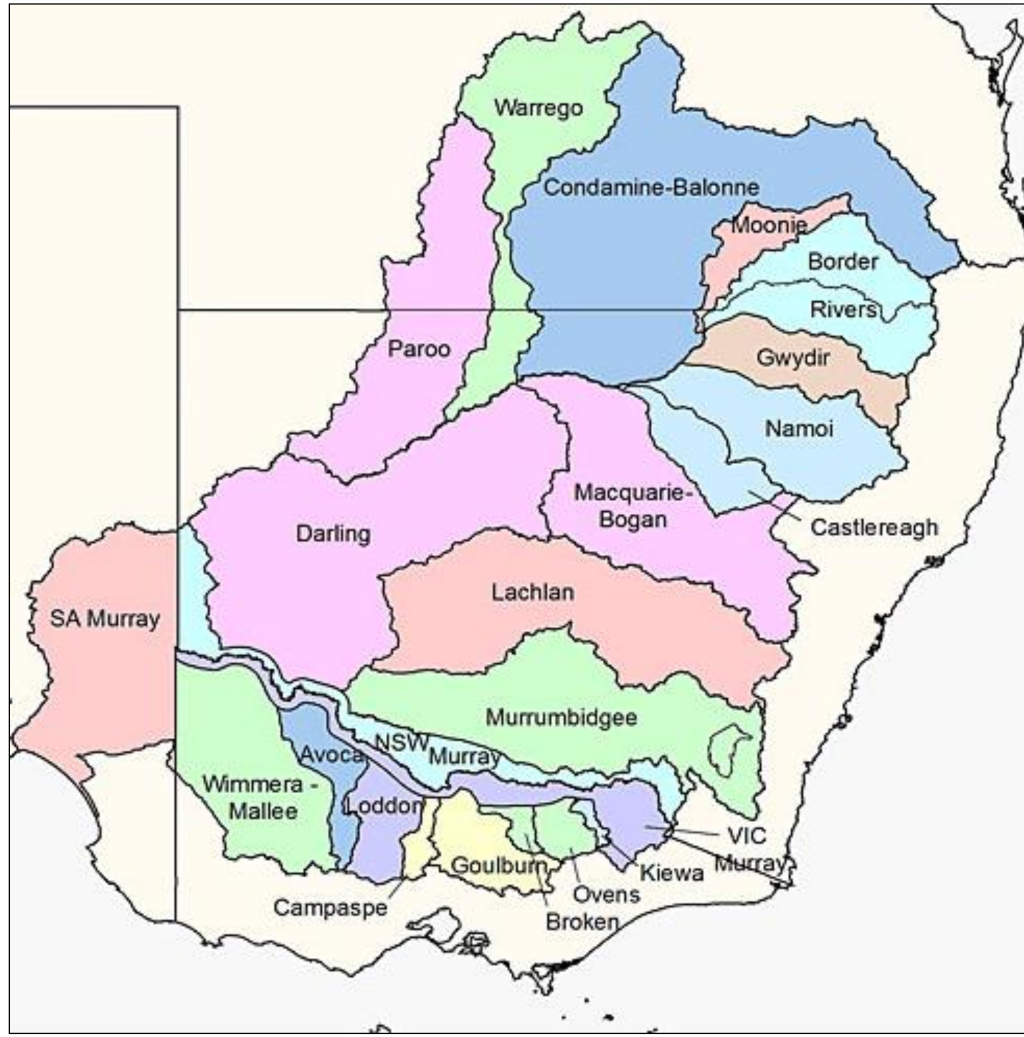
Study Area – southern MDB

Extensive qualitative research conducted (2007-2011)

- on-farm interviews, focus-groups

Extensive quantitative research conducted:

- 946 telephone surveys in irrigation districts across SA, NSW and VIC in 2010-11
- A targeted sample of 64 organic irrigators was collected
- Irrigators re-surveyed by mail in 2011 (63% total response rate)



	Water-use Volume (ML)	***Water-use per hectare (ML/ha)***	***Water-use productivity (ML/$)***	***Water-use % from allocations***	***Water-use efficiency (ML/tonne)***
Age	-0.01**	-0.002	0.002	-0.18*	-0.008
Temporary-trade seller	-0.38***	-0.22***	0.009	-20.11***	-0.12
Whole-farm plan	0.80***	0.09*	0.44***	9.69***	-0.16
Off-farm income (%)	-0.01***	-0.001**	0.002	-0.04*	-0.01
Organic farm dummy	**-3.21*****	**0.03**	**-2.53*****	**-8.05***	**0.52**
Irrigated hectares	0.001***	-0.001***	-0.0001	0.01**	-0.005***
Total water entitlement ownership (ML)	0.0003***	0.0002***	0.0001	-0.002***	0.001***
Laser-graded (%)	0.005***	0.001	0.002	0.02	n.a.
Reuse infrastructure (%)	0.002	0.0003	0.003	0.02	0.02
Spray infrastructure (%)	-0.002	0.001	-0.002	0.01	0.001
Horticulture (%)	0.005**	0.004***	-0.001	0.05	-0.04**
Broadacre (%)	-0.001	-0.0004	-0.005**	-0.04	n.a.
Dairy (%)	-0.0004	-0.001*	-0.005**	-0.03	n.a.
Water charge $/ML[3]	-0.01***	-0.001	-0.004	0.18***	-0.01
Summer Soil moisture[4]	-0.01***	-0.01***	-0.01***	-0.14***	-0.02
Year 2011	1.001***	0.50***	0.15	-1.03	n.a.
Victoria	0.19	-0.02	-0.06	-4.95**	0.45
Constant	5.202***	1.64***	2.01***	71.71***	5.52**
Observations	1284	1284	1195	1229	132
F-stat/Chi-2 stat	537.11***	30.22***	67.74***	20.49***	120.05***
Adjusted-R^2	—	0.34	—	0.2	—

Conclusions

- Organic farming does better than conventional farming in terms of using less water (in volumes); being more water-use productive (ML/$earned), using less water than they receive in allocations (%)
- Organic farming may do worse than conventional farming in terms of water-use efficiency (ML/tonne produced): but evidence is mixed and different across industries. More likely to do worse in broadacre
- Water trading has played a significant role in reallocating water to more efficient users
- No evidence that infrastructure adoption plays any significant role in reducing water use across the farm surveys
- Water pricing does play a significant role in reducing some water use
- What seems to be more important is ‘what farmers “do” on their farm’ rather than ‘what infrastructure farmers adopt’.

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