Adapting the Australian livestock and wheat farms to climate change: value of adaptation at cross-regional scale

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CLIMATE ADAPTATION NATIONAL RESEARCH FLAGSHIP
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Department of Agriculture, Fisheries and Forestry
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Adaptation Value

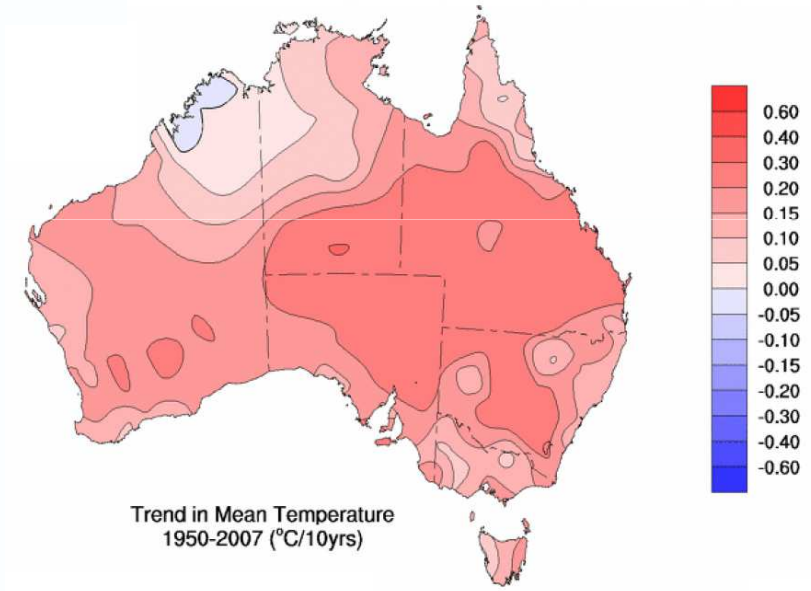
- Livestock & wheat farm systems
- Farm scale to a cross-regional (national) scale
- Adaptation value we going to see

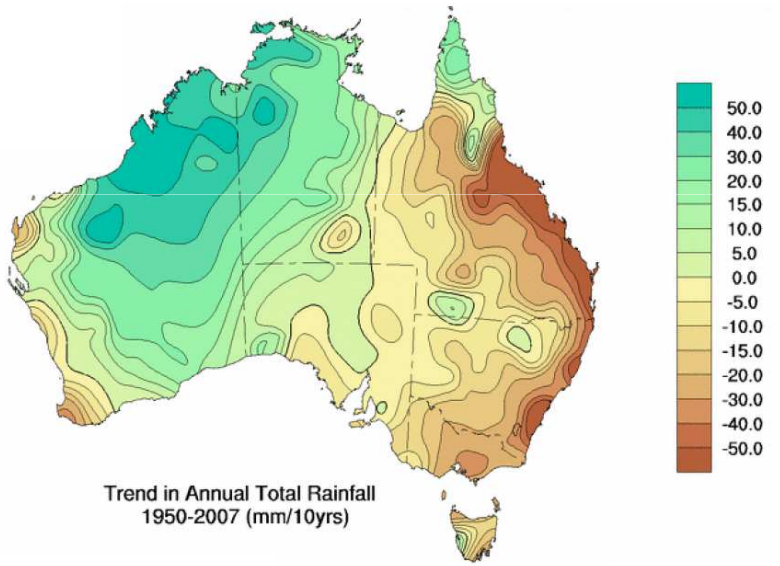
1- Value of interactive benefit from climate change

2- Just filling the yield gap

Observed climate changes in Australia

- 0.9 ° C warmer since 1950
- Increase in frequency of heat wave
- Rainfall decreased in south-west and south-east Australia





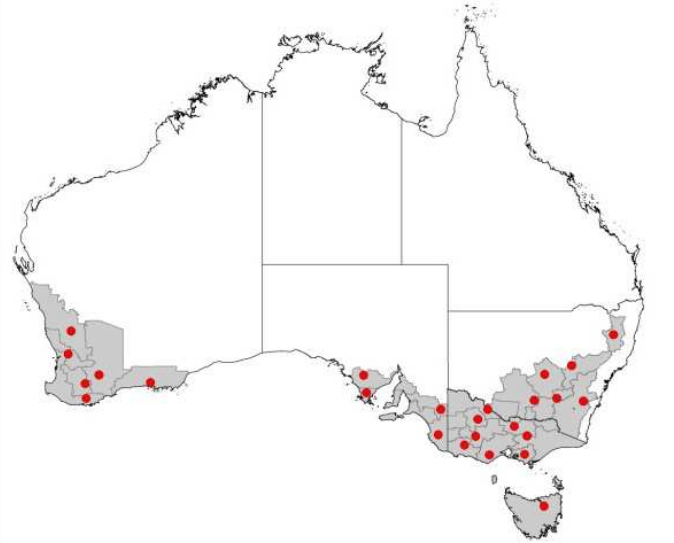
CSIRO/BoM 2010).

- More evidence of climate change and little evidence of mitigation *(e.g. Stafford Smith, 2011).*

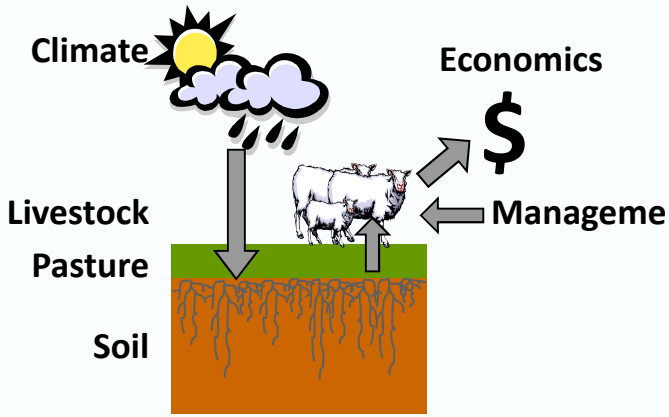
Representative Grazing Systems

- Sites across southern Australia
  - Representative of statistical regions
- 5 livestock enterprises
  Merino & crossbred ewes,
  wethers, beef cattle, steers

12 future climates considered:
A2 scenario



- Projections for **2030**, **2050**, **2070**
  Simulation of 2016 -2085
  1970-1999 (reference period)



- **4** GCMs (CCSM3, ECHAM5/MPI-OM, GFDL-CM2.1, and UKMO-HadGEM1)
  To capture "projection uncertainty"
  - CO_2:
    350 p.p.m (1970-1999), 451 (2030), 532 (2050), 635 (2070)
  - **GRAZPLAN**

Estimated change in climate of southern Australia (AR4)

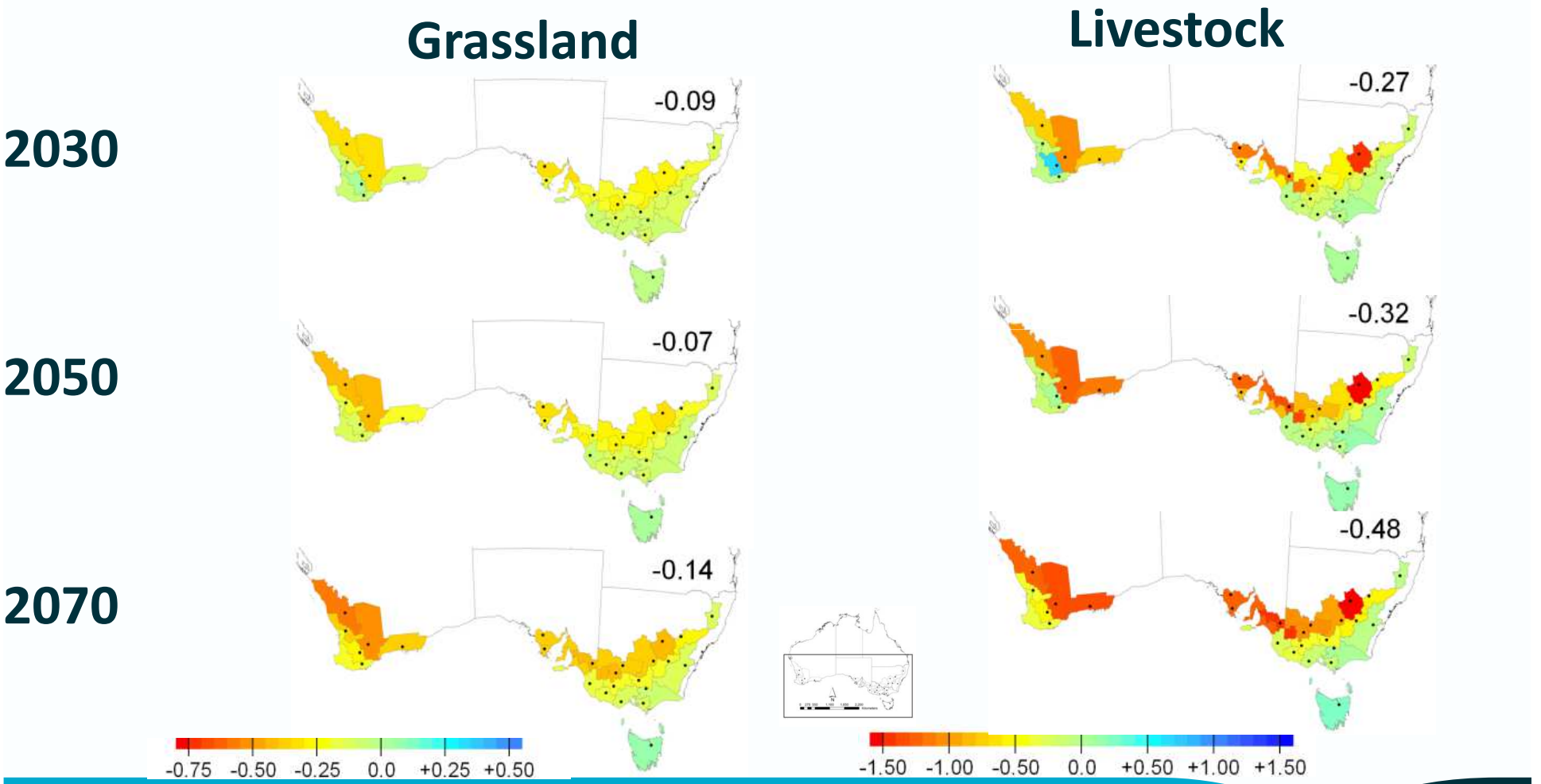
The SRES A2 scenario (a high-emissions future)

	2030	2050	2070
• Annual rainfall	-4%	-6%	-9%
• Temperature	+1.1°C	+1.6°C	+2.5°C
• CO_2	+28%	+52%	+81%

All compared to 1970-1999 climate.

Impact on grassland and Livestock

Relative change in total ANPP and profitability compared to the historical period



Moore and Ghahramani, 2013, Global Change Biology

Adaptation options

1. Grassland management (To increase pasture production & Minimize periods of low ground cover)

i) achieving higher soil fertility,

ii) confinement feeding in years with poor yield,

iii) sowing lucerne on a proportion of the land in response to a predicted shift to summer dominant rainfall in the future,

iv) removing annual legumes from pastures to improve ground cover and prevent soil erosion,

2. Animal genetic improvement (To increase forage conversion efficiencies)

v) increasing animal body size,

vi) achieving a greater conception rate,

vii) increasing potential fleece weight,

viii) increasing ram size,

3. Systemic combination of adaptations

To increase financial motivation

Ghahramani and Moore, 2013, C&PS
Moore and Ghahramani, 2013, APS
Ghahramani and Moore, 2014, submitted

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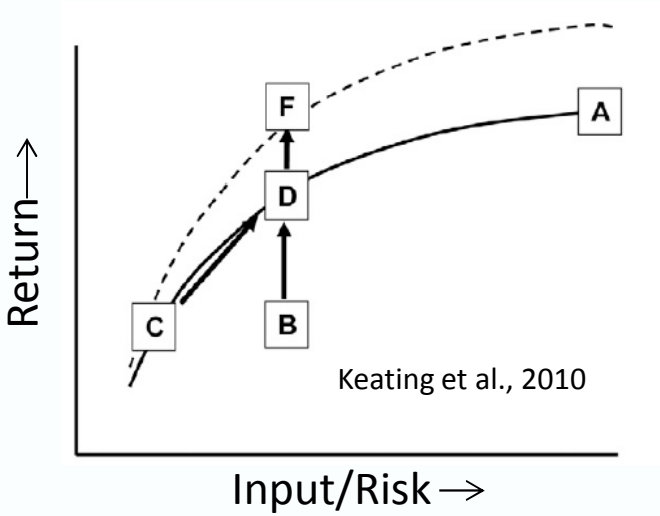

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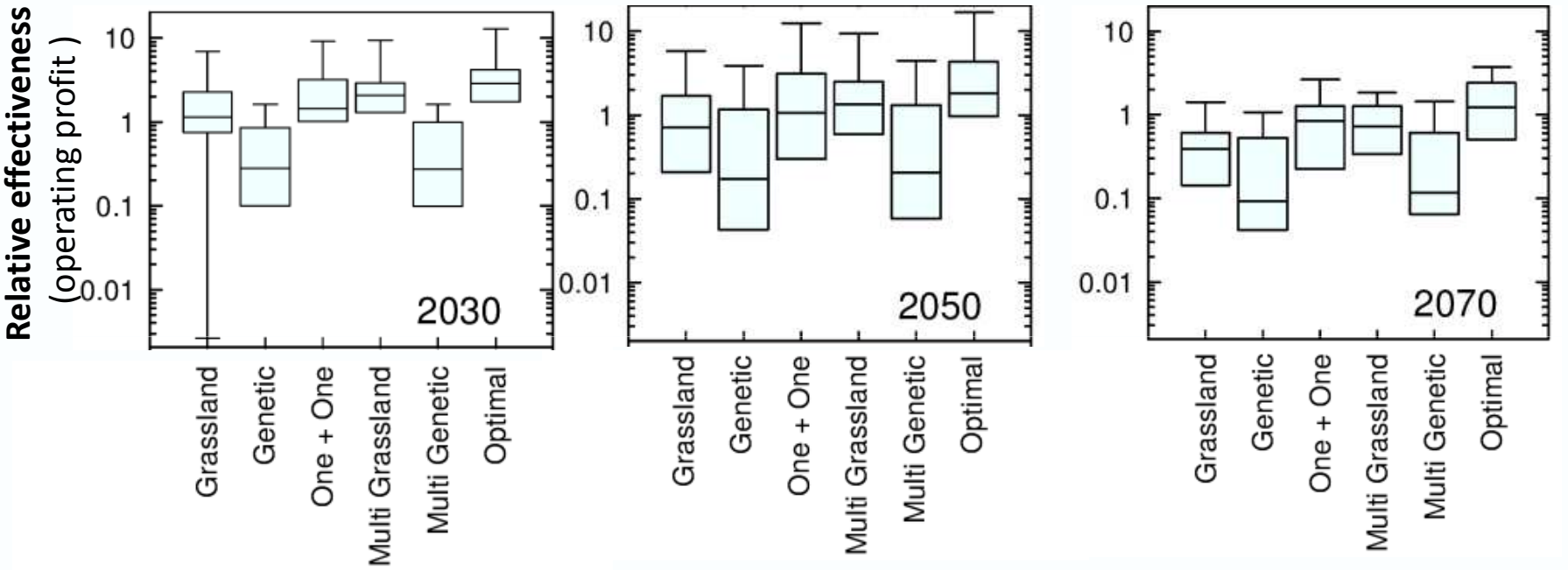
Effectiveness of systemic adaptation across regions



Relative effectiveness = $(OP_A - OP_N)/(OP_H - OP_N)$

OP_A :denotes long-term average operating profit after an adaptation,

OP_N :operating profit without any adaptation,

OP_H :is operating profit during the historical period

(0.0 = no benefit from system and 1.0 = a return to the 1970-1999 reference period).

Ghahramani and Moore, 2014, submitted

Impact on soil

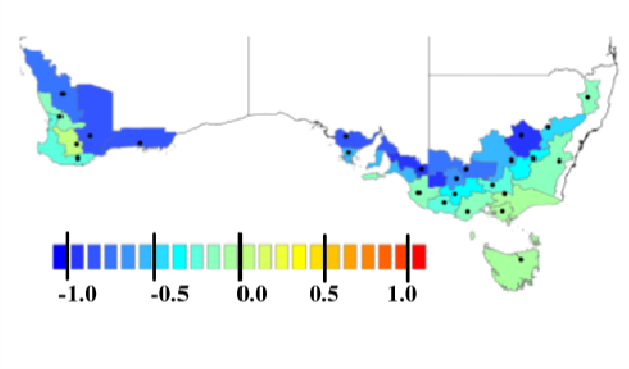
While production/profitability increased by systemic adaptation under OSSR, compared to the historical period Soil environment & grassland improved:

- Decrease in days of year with ground cover less than 0.7 (prevent soil surface from erosion and evaporation),
- Increase in total ANPP,
- Increase in water use efficiency,

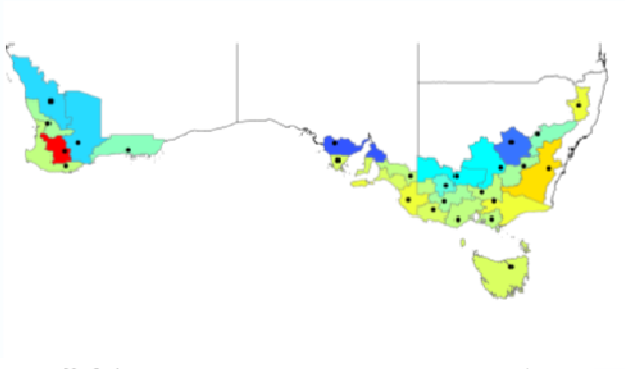
Ghahramani and Moore, 2014, submitted

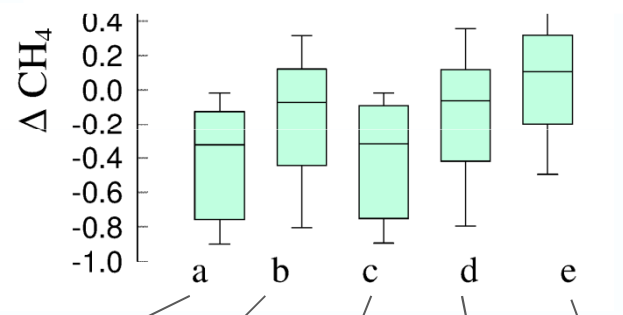
Impact and adaptation effect on CH_4 in 2050

Impact



Adaption





a.impact b.Grassland c.Genetic d.b+c e.Most profitable

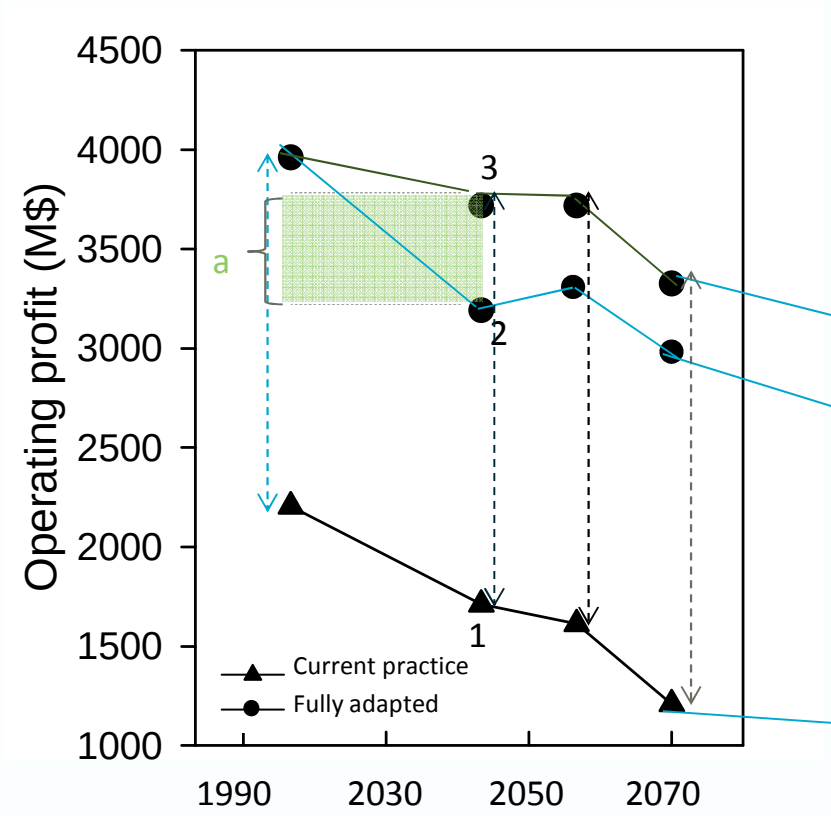
70 (historical), 55 (2030), 51 (2050), 42 (2070) kg ha^{-1} yr^{-1}

Adaptation: 85 (2030), 85 (2050), 74 (2070) kg ha^{-1} yr^{-1}

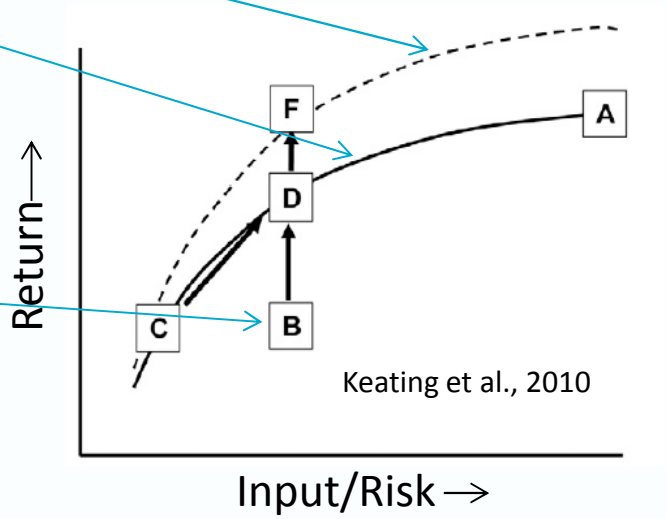
Ghahramani and Moore, 2014, submitted

Adaptation value (livestock industry)

with effect of the elevated atmospheric CO2



a: Effect of animal genetic improvement



- **Increase in yield gap under climate change but attainable peak point is less than current climate**
- **Interactive benefit only in 2030**

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Adaptation value (livestock industry)

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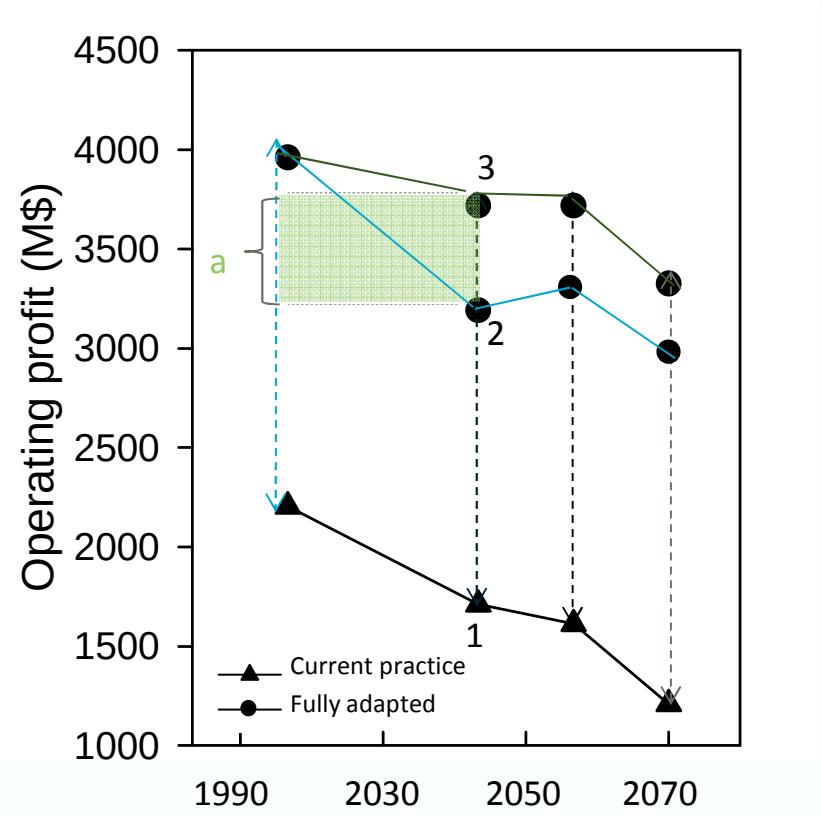

a: Effect of animal genetic improvement

Adaptation value with different definitions

Addition	Million $
to current climate by feedbase adaptation	1755
2030: + historical	1512
2030: +no adaptation	2006
2030: +adapted historical (Apple vs. Apple)	**-243**
2050: + historical	1513
2050: +no adaptation	2105
2050: +adapted historical (Apple vs. Apple)	**-243**
2070: + historical	1120
2070: +no adaptation	2116
2070: +adapted historical (Apple vs. Apple)	**-635**

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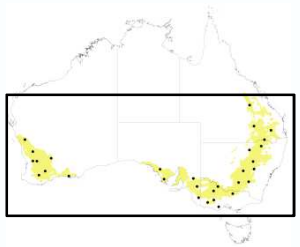
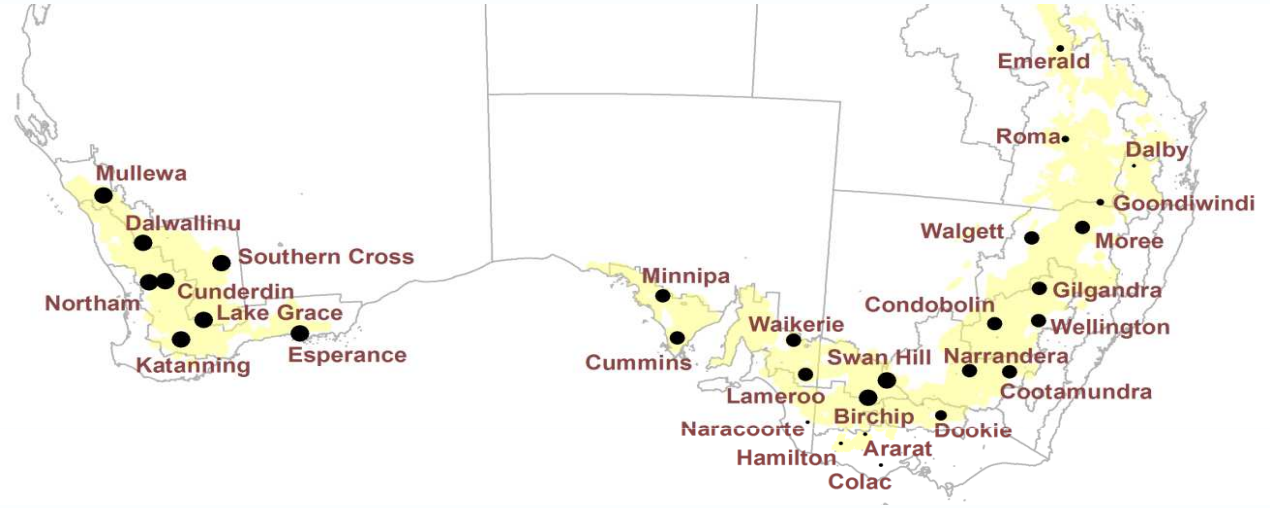
Adaptation value in wheat production at 2030

Representative wheat farms





- Representative site
- Biophysical modelling at farm scale
- Statistical upscaling to cross-regional scale
- Validation – at statistical region scale
- AR4 projections (A1Fi & A2, 6 selected GCMs)
- Maximum temperature change +0.4° ~ +1.8°
- Annual rainfall -0.13 and -0.01

<u>Adaptation options:</u>

- Planting date adjustment
- Cultivar adjustment
- Fertiliser optimisation (current cultivars)

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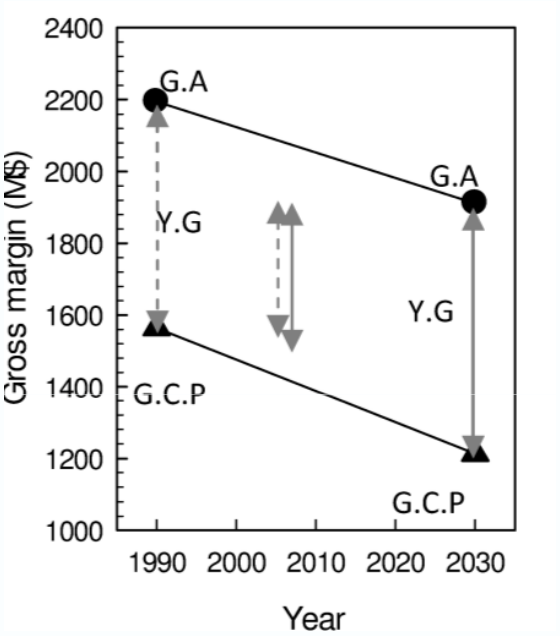
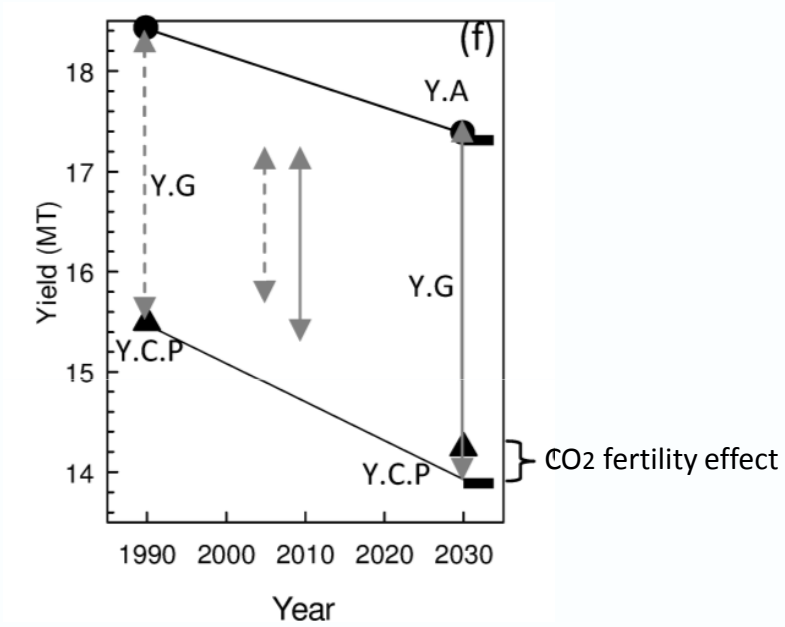
Adaptation value in wheat production at 2030





G.A: Gross margin attainability,

G.C.P: Gross margin from current practice,

Y.A: Yield attainability,

C.P: Yield from current practice.,

Y.G: Yield gap.

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Conclusion

- There is negative impact of climate change on livestock & wheat production

- Full adaption of systemic adaptations could potentially offset decreasing production and profit or even increase over the majority of southern Australia, BUT not in most of the drier regions

- There is potential (gap) to increase production (e.g. up to +25% meat in 2050) and profitability

- Adaptation helps to fill yield gap

Thank you very much