Systemic adaptations to climate change in Western Australian mixed farm systems

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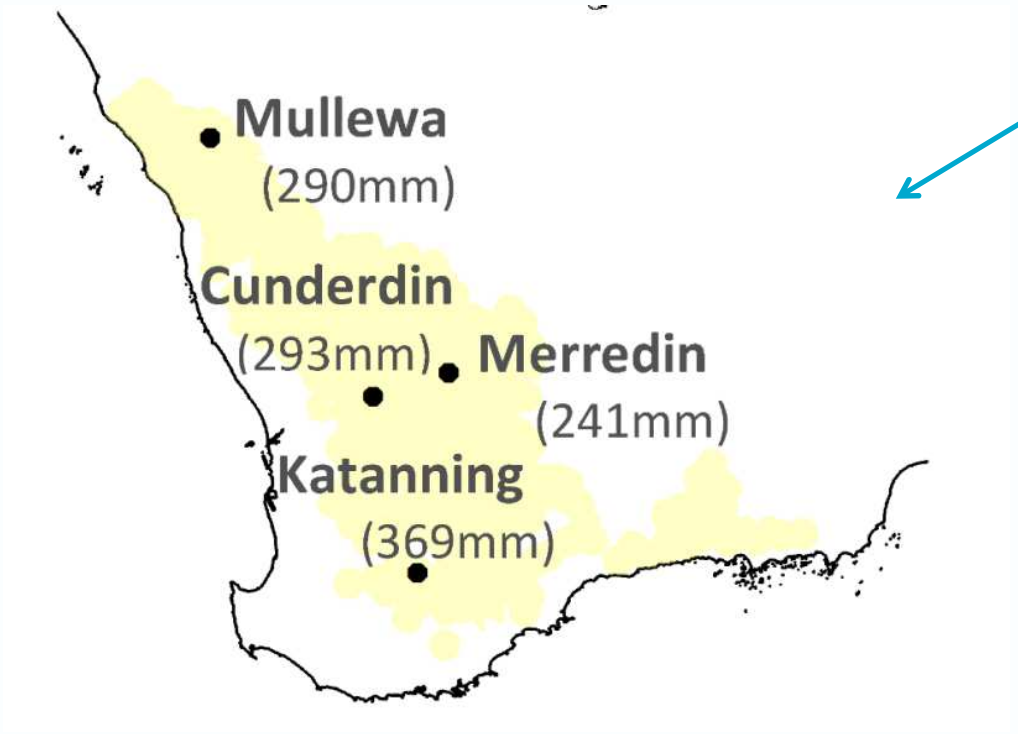
Agriculture in WA

- $3.9 billion grain export in 2012/13 (ABARES)
- $2 billion livestock at farm gate in 2011/2012 (DAFWA)

- Significant seasonal variability of rainfall (Smith et al., 2000)
- Overall decline in winter rainfall over the past century (Allan and Haylock, 1993)
- Farming profitably in the WA in recent years (McConnell & O'Hare, 2013),

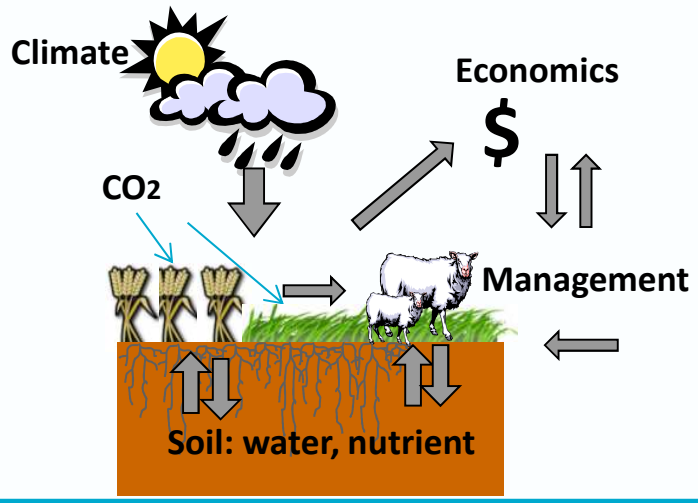
Representative mixed farms

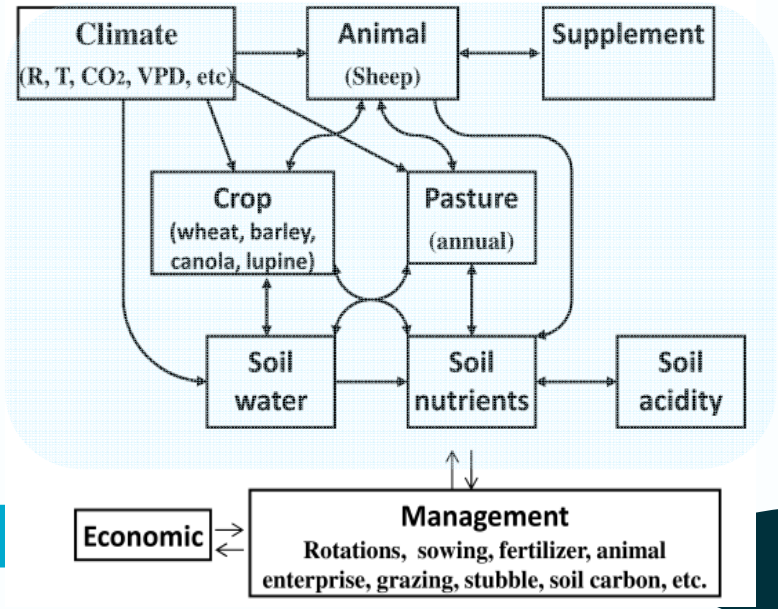


Methods

- Representative mixed farming systems (livestock-cropping)
  Validated
- APSIM model integrated with GRAZPLAN
- A historical baseline of 1970 -2010 projected for 2030 with AR5 climate scenarios

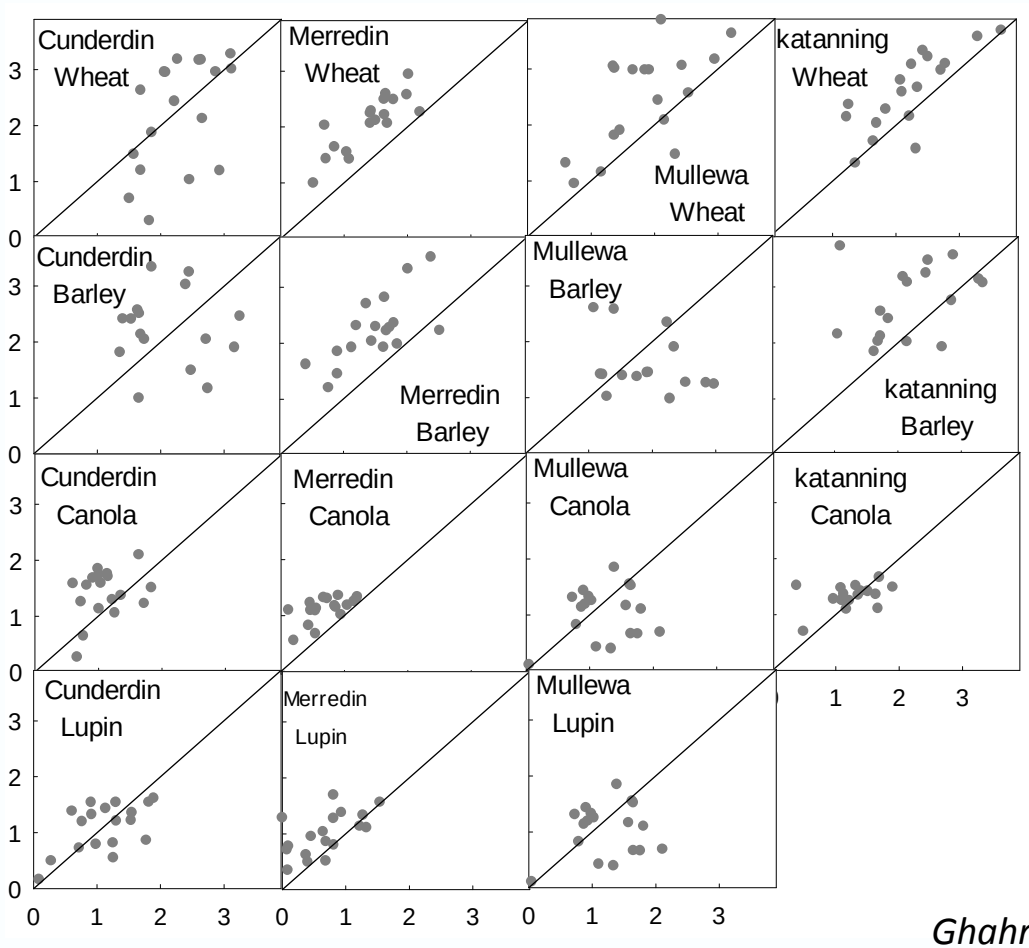
  eCO2 = 435 ppm (RCP 4.5) and 449 ppm (RCP 8.5)





Model validation

Simulated yield (t/ha)



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CBH Surveyed yield (t/ha)

CBH: “Co-operative Bulk Handling” group

Projected future climates

Likely future climate	abbreviation	Scenario	Sensitivity	GCM
Hot and dry	HD	RCP 8.5	High	GFDL CM3
Hot and moderate changes in rainfall	HMCR	RCP 8.5	High	MIROC5
Warm with least changes in rainfall	WLCR	RCP 4.5	Low	HADGEM2-AO

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Climate factor	Site	Baseline	Changes from the baseline		
			HD	HMCR	WLCR
MeanT	Katanning	15.8 (°c)	1.0	1.1	0.5
	Cunderdin	18.4 (°c)	1.1	1.3	0.5
	Merredin	18.1 (°c)	1.3	1.4	0.5
	Mullewa	20.0 (°c)	1.4	1.6	0.7
Rainfall	Katanning	470 (mm)	-11%	-9%	-3%
	Cunderdin	375 (mm)	-12%	-10%	-3%
	Merredin	325 (mm)	-12%	-8%	-4%
	Mullewa	358 (mm)	-12%	-7%	-4%

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Results of impact (baseline 1970-2010)

- **Projected crop yields**
- Declined for **most** of the crop × site x potential climate combinations
- Greatest declines for canola & lupin
- Wheat declined 19% under HMCR at Mullewa
- Wheat yield increased only in moderately high rainfall region by 6%

- **Cropping gross margin**
- -1% (Cunderdin) and -18% (Mullewa),
- Modelled to increase at the moderately high rainfall site (Katanning) up to 15%.

- **Livestock gross margin**
- declined in 50% of sites x potential climate,
- up to 90% increase in high rainfall margin

- **Whole farm gross margin declined in all sites except for Katanning**

- **Greater fertilisation effect of the elevated CO_2 on pasture** production than on crop [for 1980-1999 baseline]

Adaptations

1. **Alteration of the crop-livestock balance (Package 1)**

   Varying proportions of cropping & pasture, Stocking rates, Livestock joining and sale dates, Crop phenology (cultivar)

2. **Low risk and low return approach (Package 2)**

   Increase in pasture, Long fallow (*with weed control*), Low stocking rate, Low fertilizer rate, Adoption of earlier maturing cultivars(drought escape).

3. **Medium risk and medium return approach (Package 3)**

   Slightly higher inputs than baseline, higher stocking rates, Long fallow, Pasture termination in spring,

4. **High risk and high return approach (Package 4)**

   More cropping, Higher N inputs, Higher stocking rates, Pasture termination is in early spring, Crop variety consistent with current practise.

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Adaptations in Cunderdin

Relative change of long tern average Gross margin (1970-2010)
Projection for 2030 compared to historical

Cunderdin	Climate	Impact	P1	P2	P3	P4
Crop GM	HD	-11.2%	-61.3%	-52.5%	-7.2%	1.2%
Livestock GM	HD	-5.2%	100.7%	88.0%	44.5%	72.8%
Total Gross Margin	HD	-10.5%	-42.1%	-35.9%	-1.1%	**9.6%**
Crop GM	WLCR	-0.7%	-56.9%	-50.8%	-0.9%	10.7%
Livestock GM	WLCR	0.7%	112.5%	93.5%	41.8%	65.2%
Total Gross Margin	WLCR	-0.5%	-36.9%	-33.7%	4.1%	**17.2%**

Alteration of crop-livestock

Low risk & low return

Medium risk & medium return

High risk & high return

HD: Hot &dry

WLCR: Warm with least changes in rainfall

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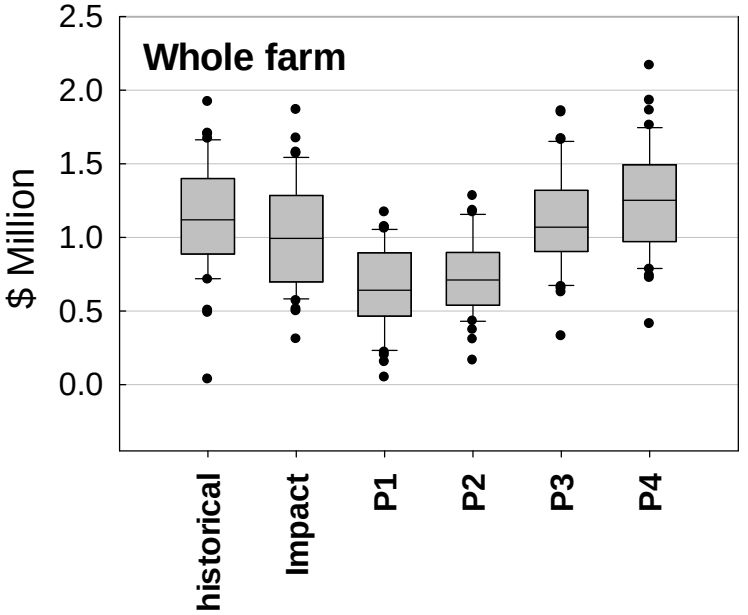
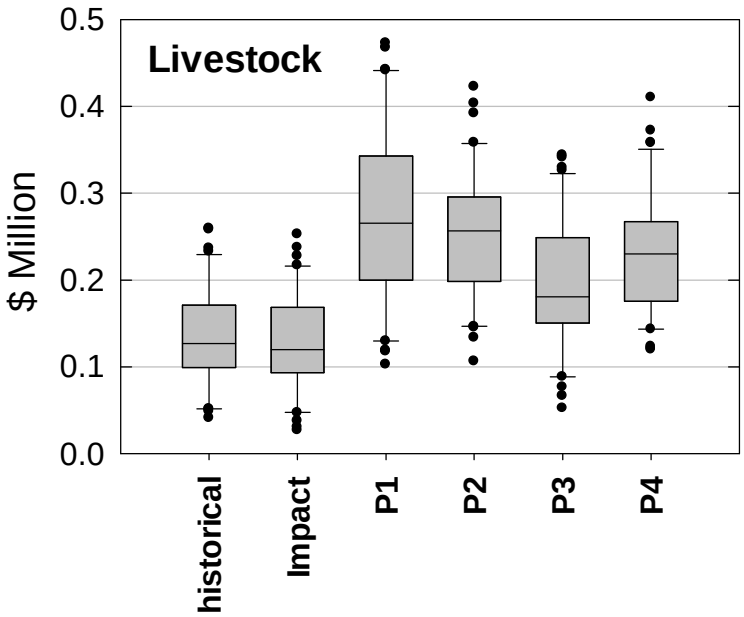
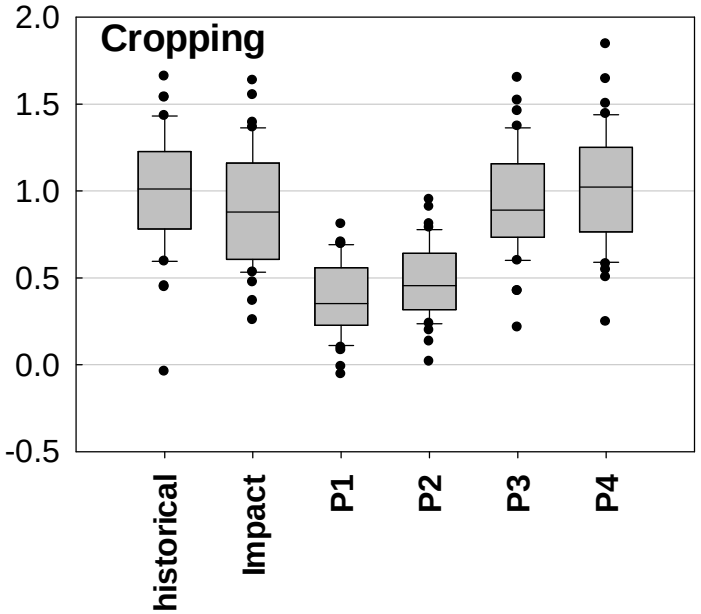
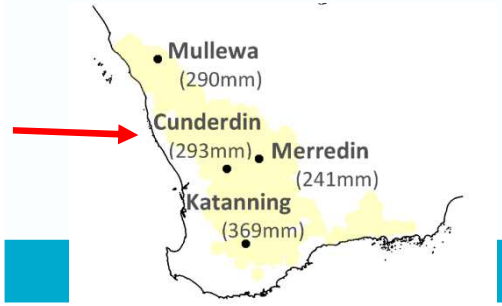
Variability of Gross margin Cunderdin









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Adaptations in Mullewa

Relative change of long tern average Gross margin (1970-2010)
Projection for 2030 compared to historical

Mullewa	Climate	Impact	P1	P2	P3	P4
Crop GM	HD	-18.9%	-10.5%	-42.3%	-18.8%	17.3%
Livestock GM	HD	-11.8%	110.6%	21.5%	22.0%	108.5%
Total Gross Margin	HD	-17.6%	10.6%	-31.2%	-11.7%	**33.2%**
Crop GM	WLCR	-1.7%	12.8%	-31.7%	-0.9%	52.2%
Livestock GM	WLCR	-25.3%	115.3%	47.9%	21.1%	108.5%
Total Gross Margin	WLCR	-5.8%	30.6%	-17.8%	2.9%	**62.0%**

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Medium risk & medium return

High risk & high return

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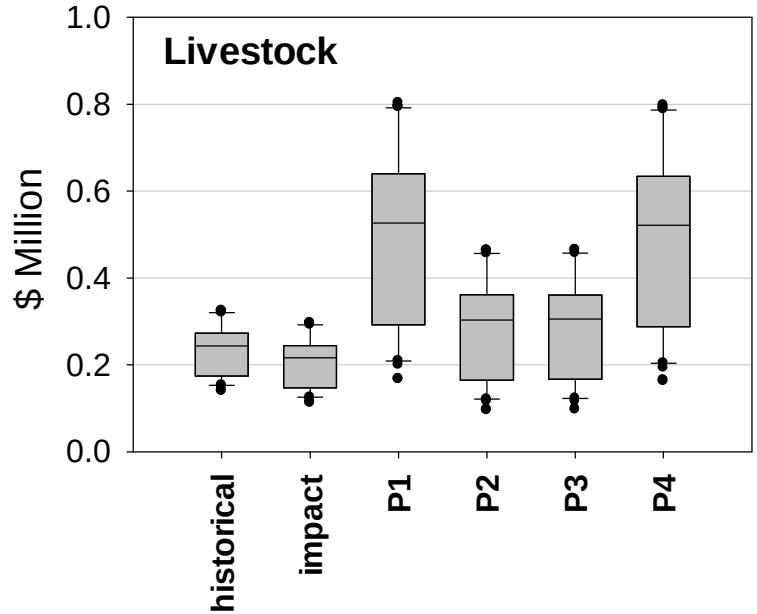

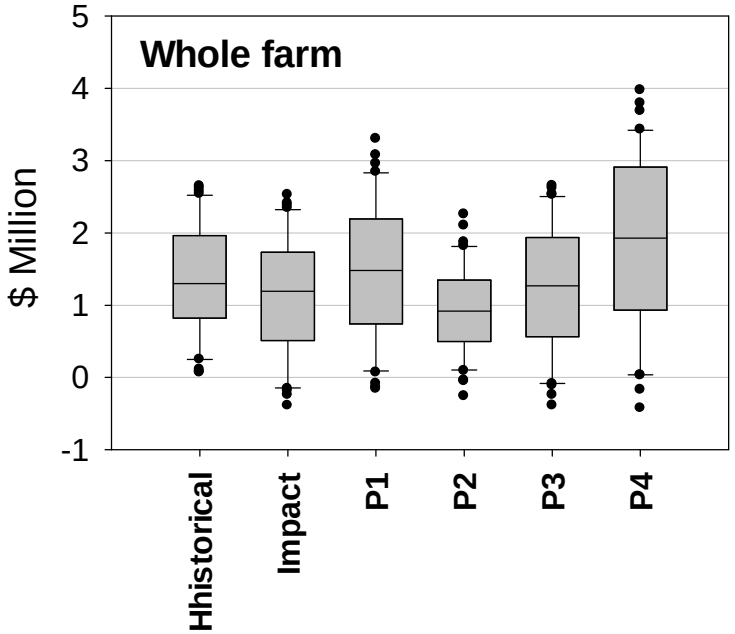

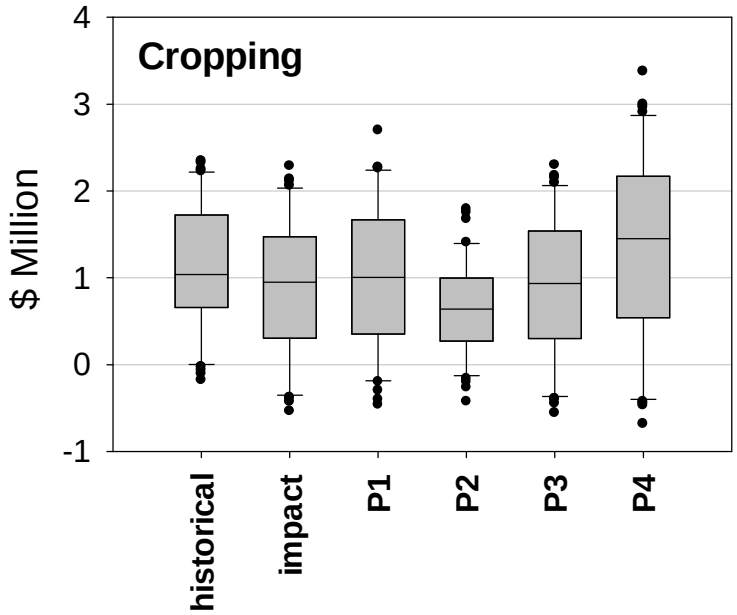

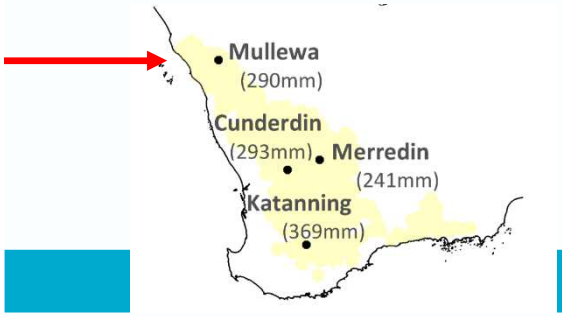

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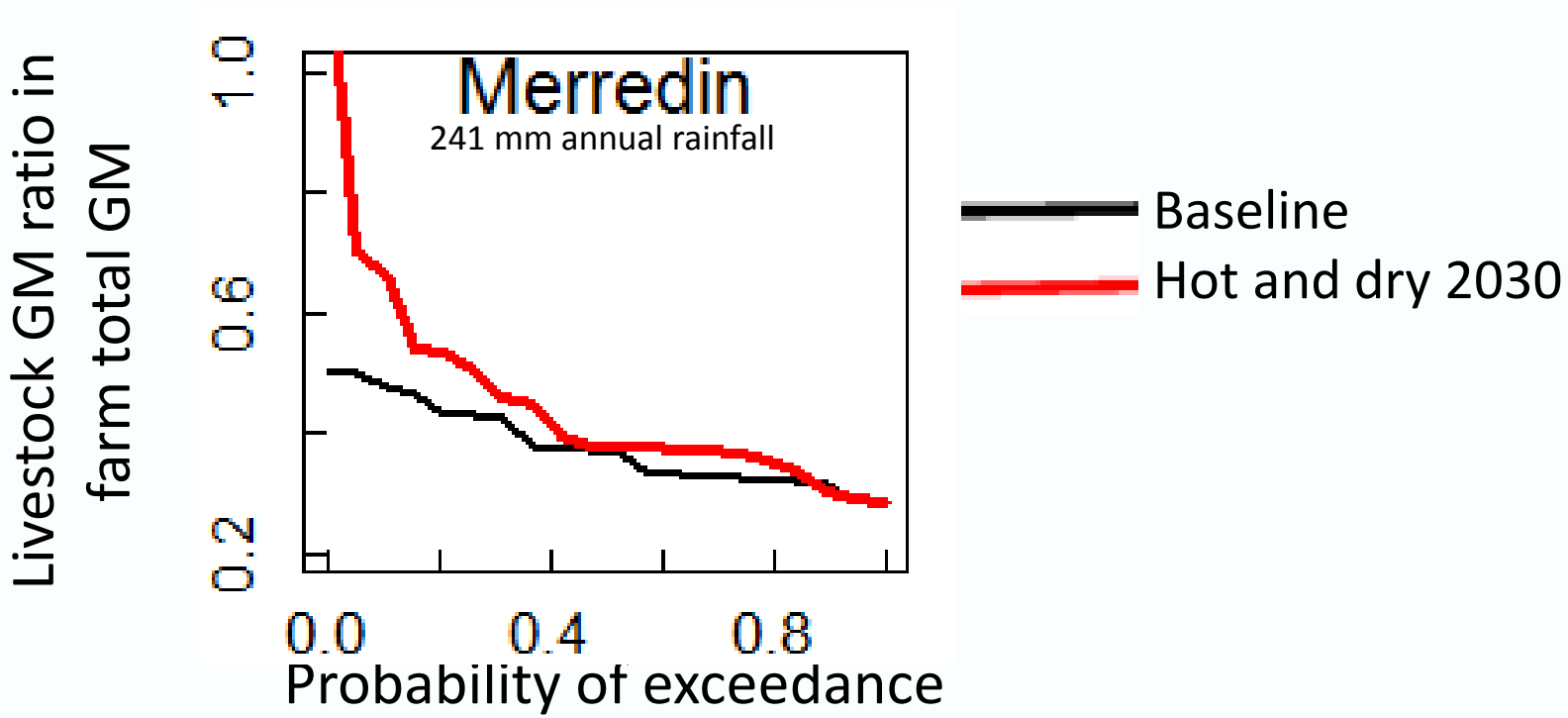
Results of impact

Interactions between financial outputs of Livestock & cropping (1980-1999 baseline)

- livestock is a risk avoiding enterprise
- Less sensitivity of livestock enterprises under Climate change for drier sites



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Conclusion

- Negative impact of climate change is likely for mixed farming except for relatively high rainfall margin
- It is likely to offset negative impact of climate change by systemic combination of adaptations
- Livestock will be less sensitive to climate change particularly in low rainfall zone – a risk avoiding strategy
- Climate risk will remain an issue despite long term average effectiveness of adaptations

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Thank you very much

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