Fallow management, water storage and wheat yield in southern NSW

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Grains Research & Development Corporation

www.csiro.au

Stored water – valuable in dry seasons

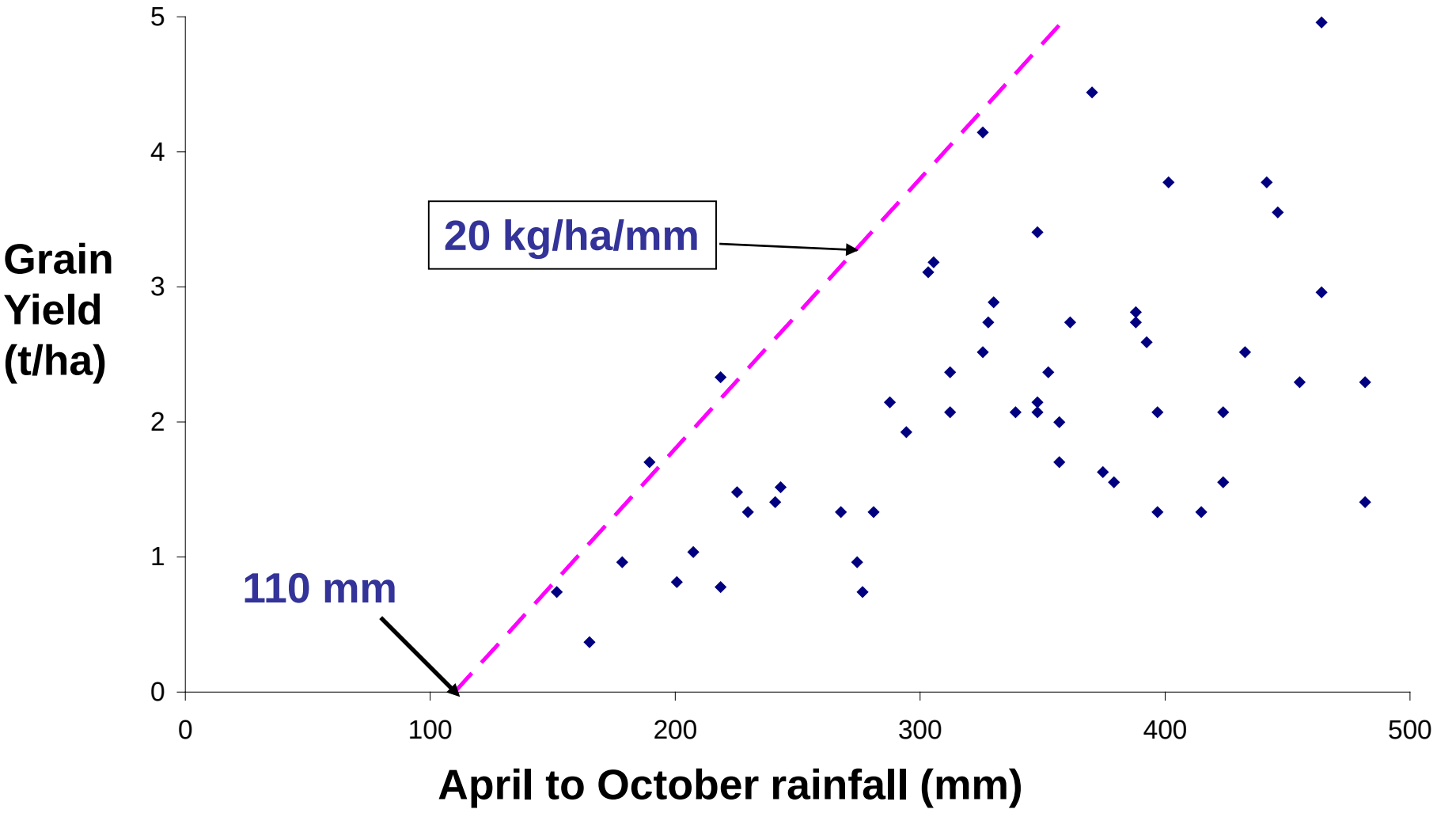
WUE – Advisers dilemma?

WUE = Yield / [(0.3 x fallow rainfall) + in-crop rainfall - 110]

WUE = 2000 / [(0.3 x 100) + 120 - 110]

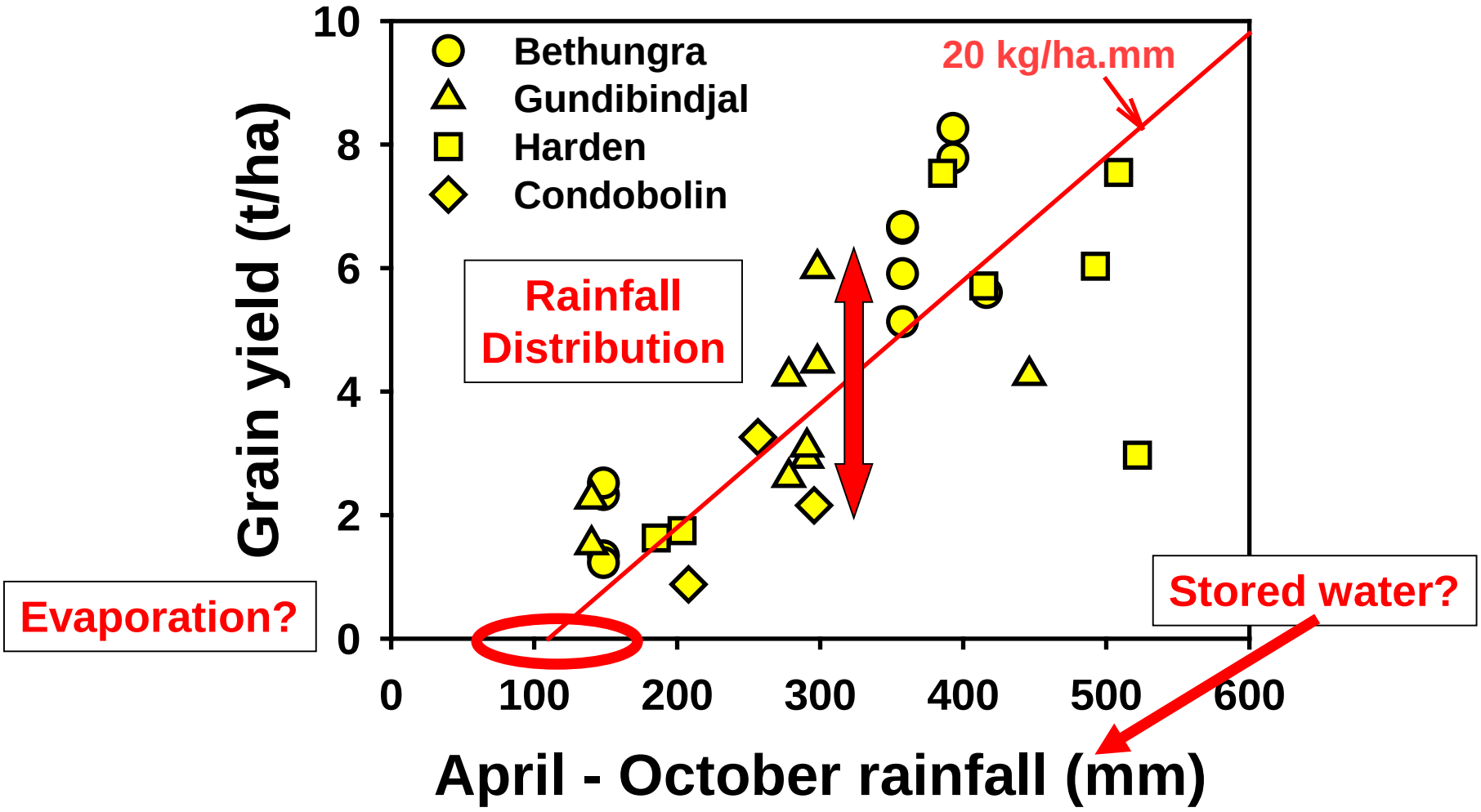
WUE = 50 kg/ha/mm

The French & Schultz water-use efficiency concept

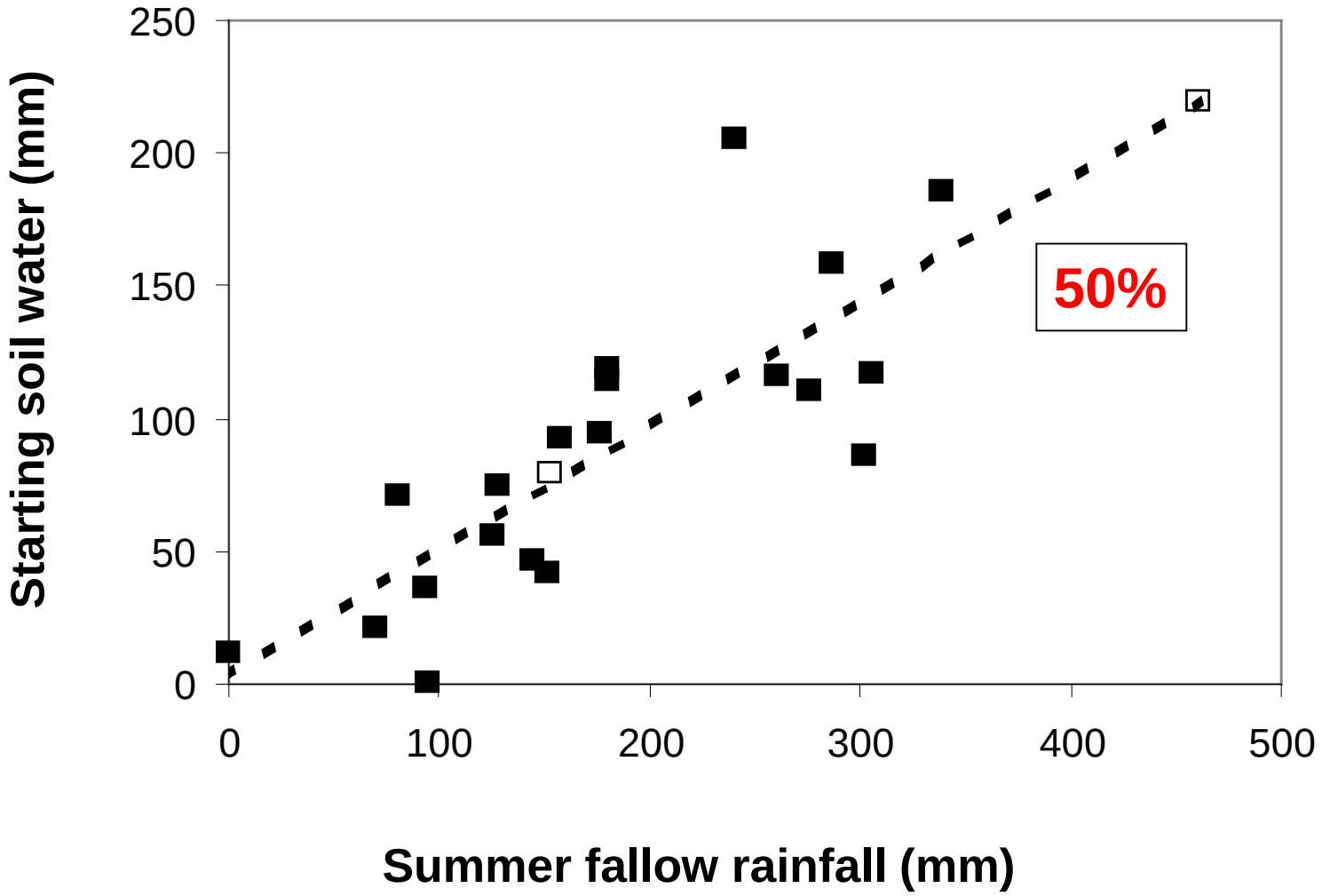


French and Schultz (1984)

WUE data – southern NSW 1990-2005



Fallow storage (measured – sth. NSW 1990-2005)



WUE – Advisers dilemma?

WUE = Yield / [(0.3 x fallow rainfall) + in-crop rainfall - 110]

WUE = 2000 / [(0.3 x 100) + 120 - 110]

WUE = 50 kg/ha/mm

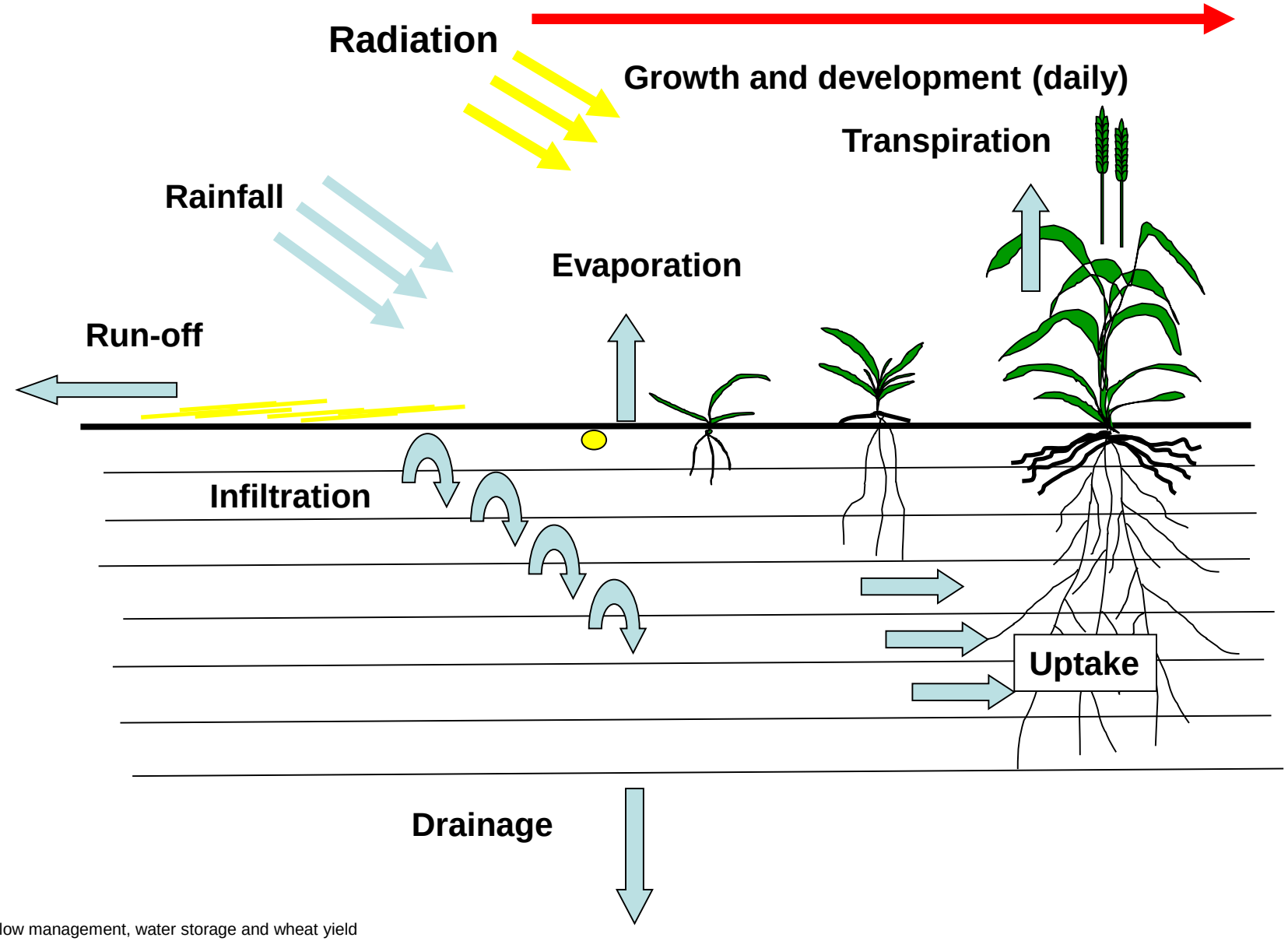
WUE = 2000 / [(0.5 x 130) + 120 - 70]

WUE = 17 kg/ha/mm

Key Message

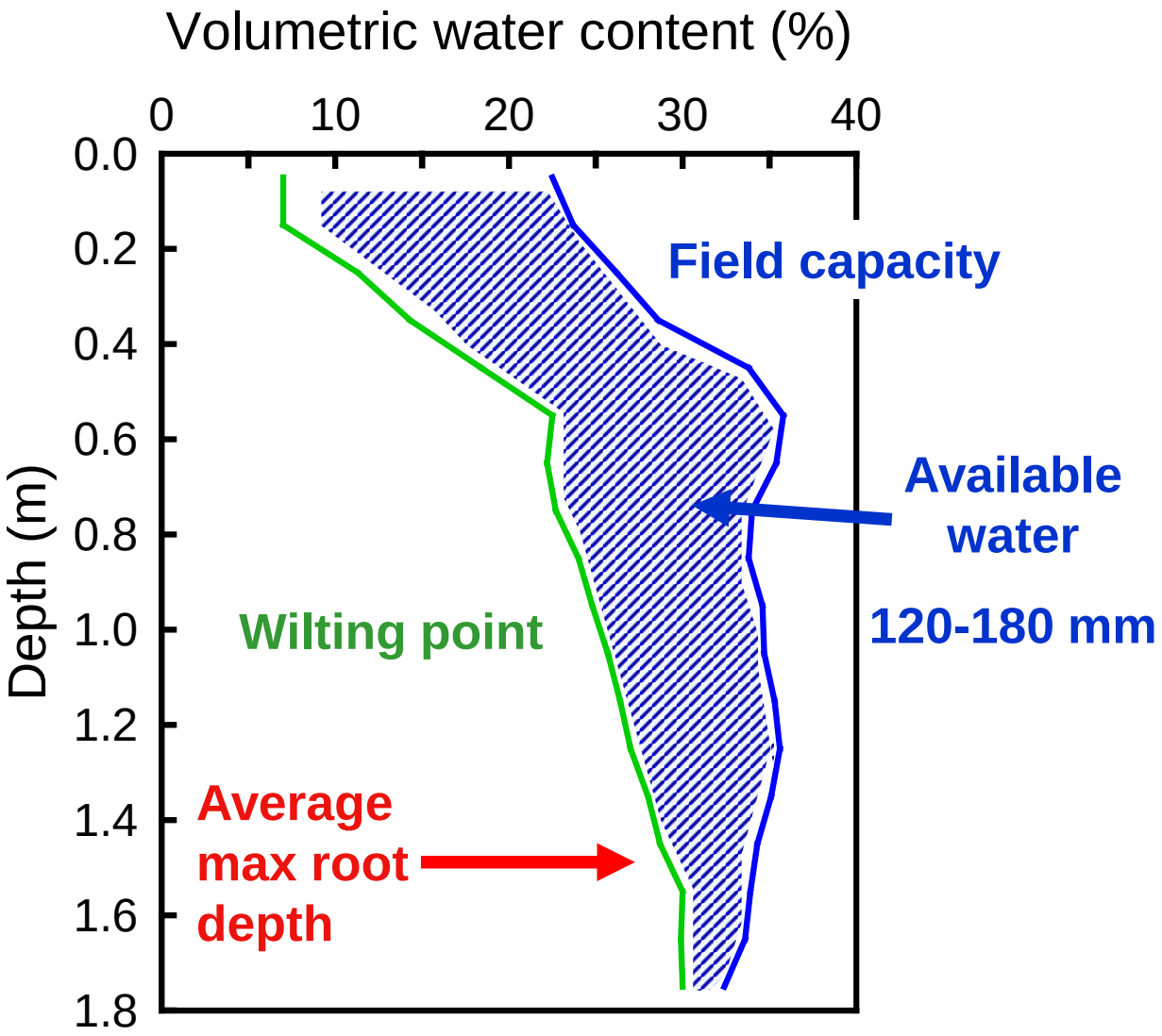
- **Stored water, in-season evaporation and rainfall distribution influence WUE**

Simulation - APSIM Wheat model



Red Kandosols – water supply and wheat roots

Bulk density 1.65 g/cm^3

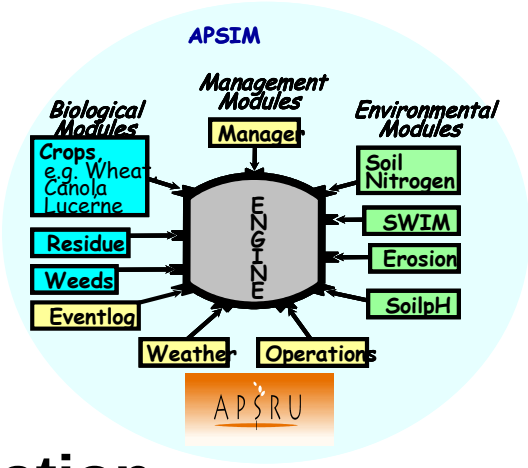


Summer fallow management effects

Field experimentation

and

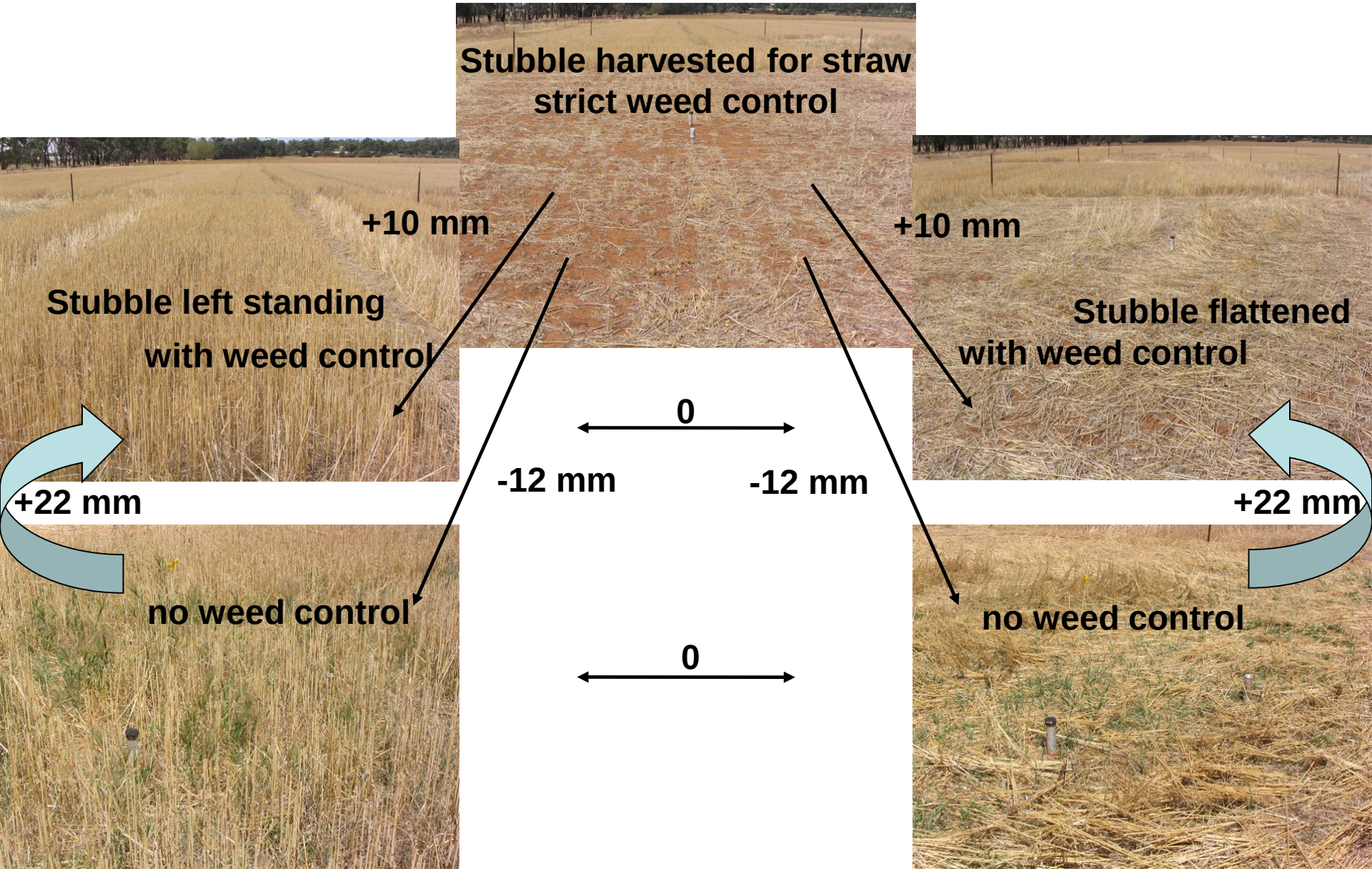
computer simulation



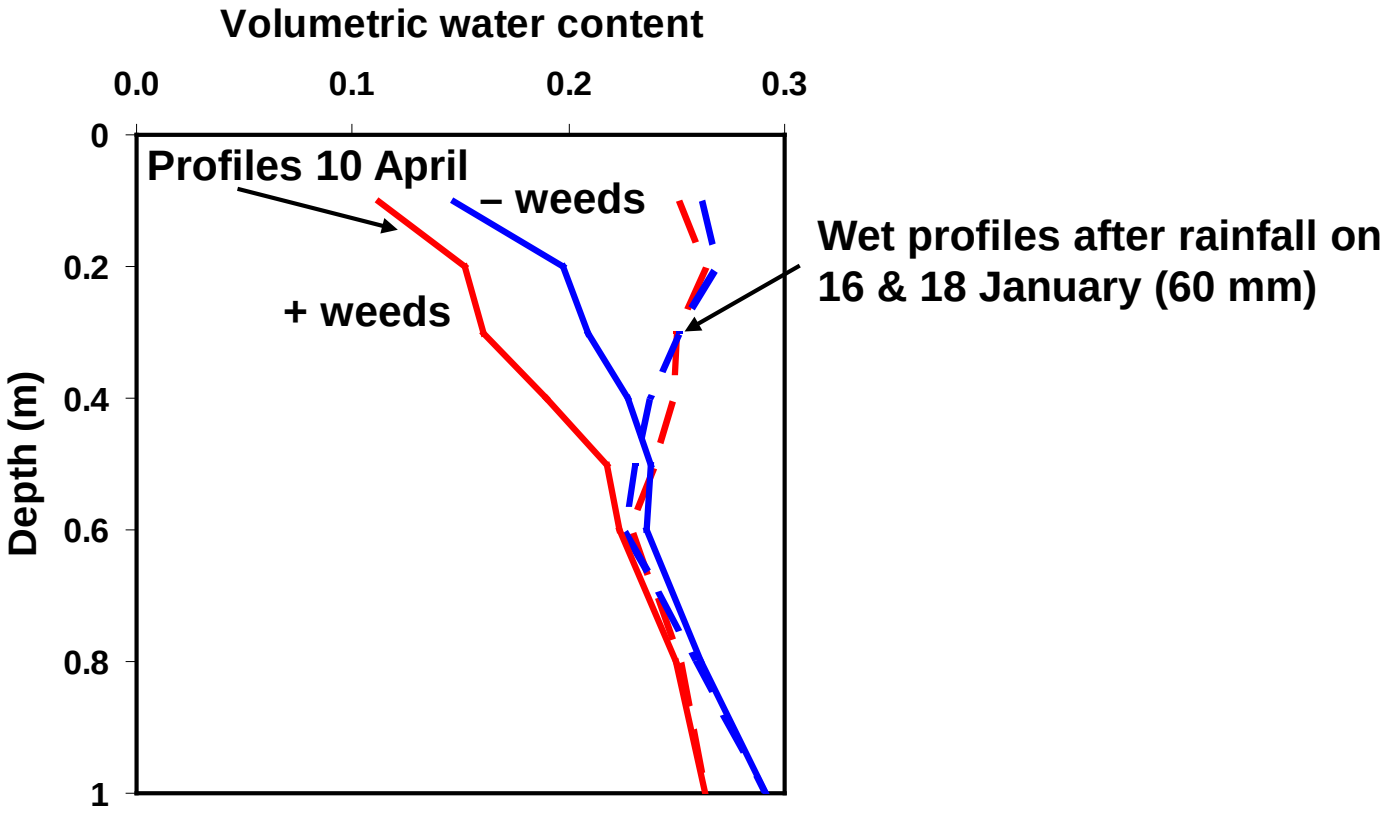
Fallow management, water storage and wheat yield

Experiment at Charles Sturt University

×(2003-04)
×(2004-05)
✓(2005-06)



Where did the water go?



Key Message

- **Rainfall stored in top 30 to 40 cm *may* partially be lost through evaporation, but this will depend on timing of follow up rain.**
- **Below the evaporation front it can only be lost through plant uptake**

Simulation analysis: scenarios + historical climate data

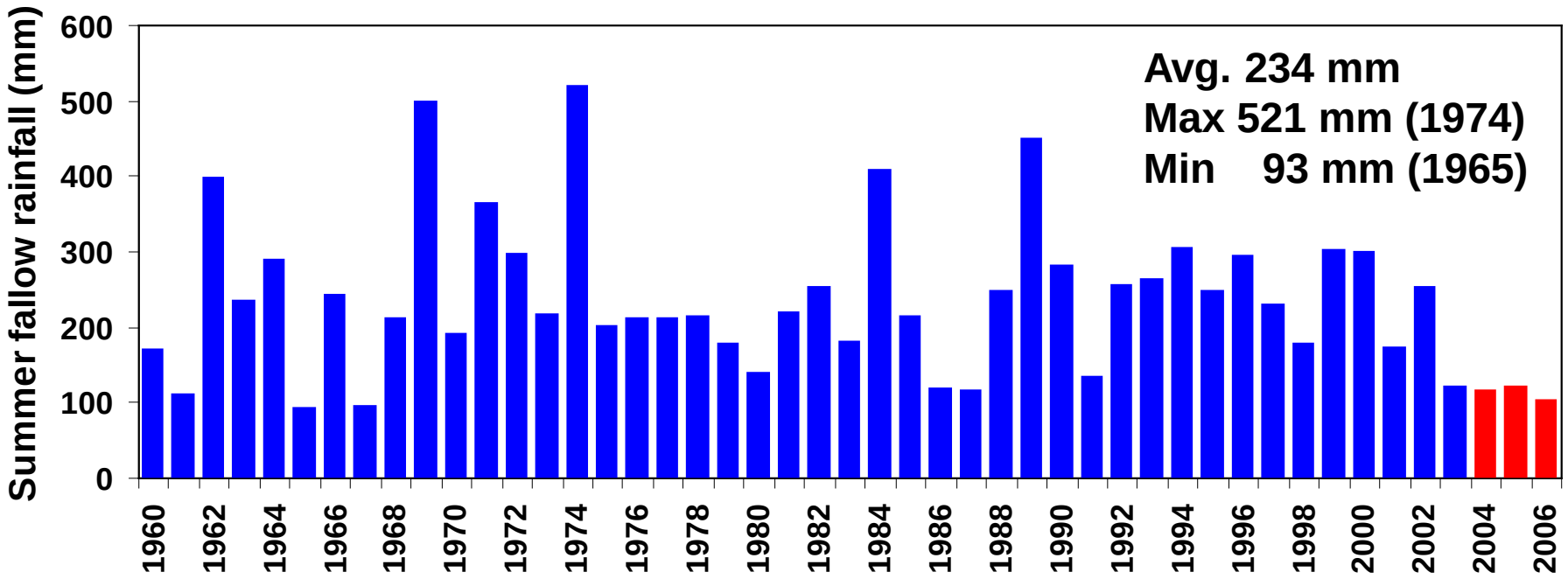
Scenario = Sequence of instructions to the model

to mimic an agricultural system

with rules for the different management options

e.g. sowing based on rainfall events

Historical climate data: Wagga Wagga Agricultural Institute



Simulated results for different management controls

1960-2006

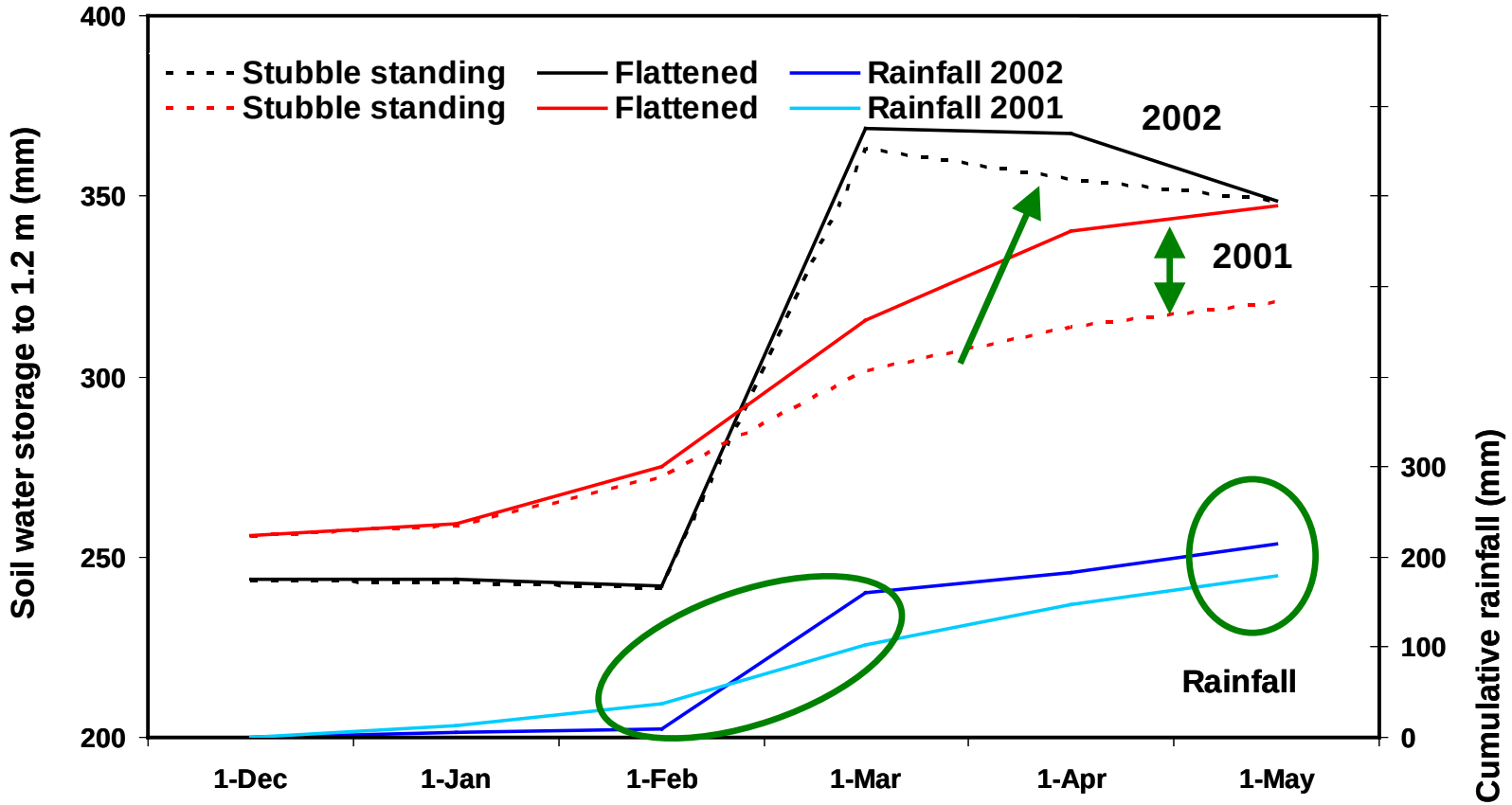
	Average effect	Proportion of years in which effect is		
		< 5 mm	> 20 mm	> 30 mm
Weed control (standing stubble)	+12 mm	41%	24%	17%
Flattening stubble (with weed control)	+ 6mm	54%	9%	0%
Harvest straw (with weed control)	-12 mm	24%	22%	1%

Key Message

- Summer fallow weed control is the most effective way to increase soil water storage
  - higher average effect than flattening of stubble
  - more frequent occurrence of larger effects

… but highly variable outcomes

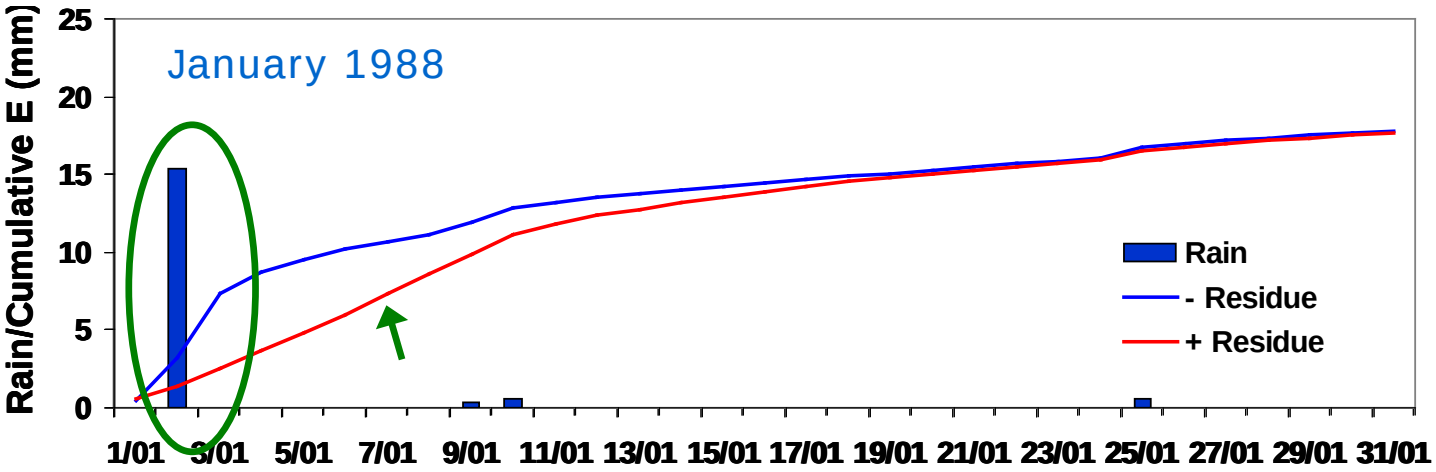
A few large events or several smaller rainfall events - effect of flattening stubble

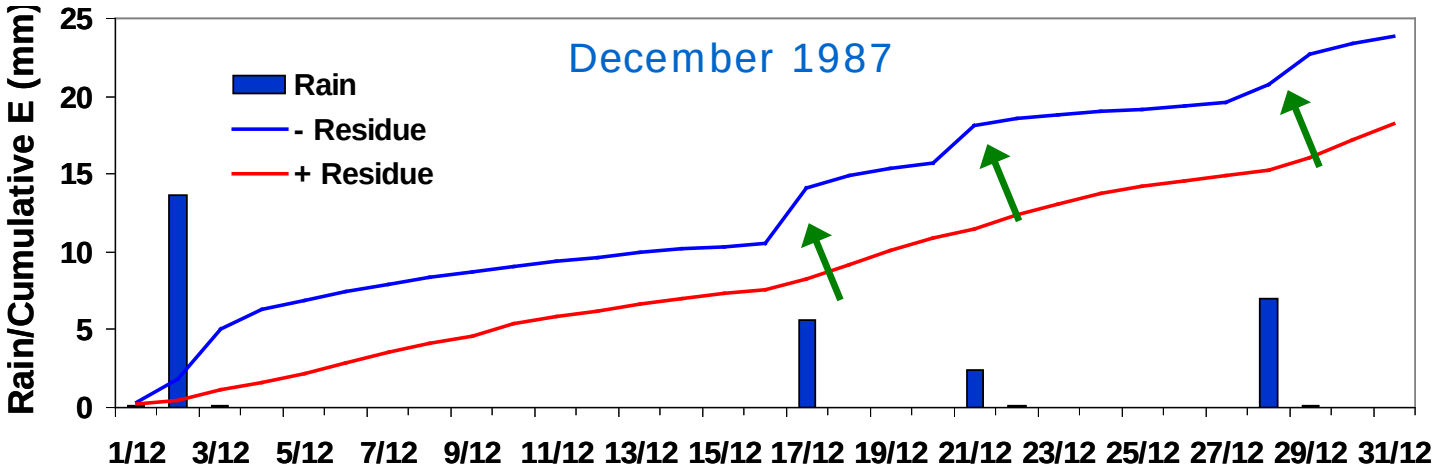


Key Message

- **Flattening stubble had a bigger impact in years with several rainfall events rather than a few large events**

Rainfall followed by a prolonged dry period - effect of stubble cover

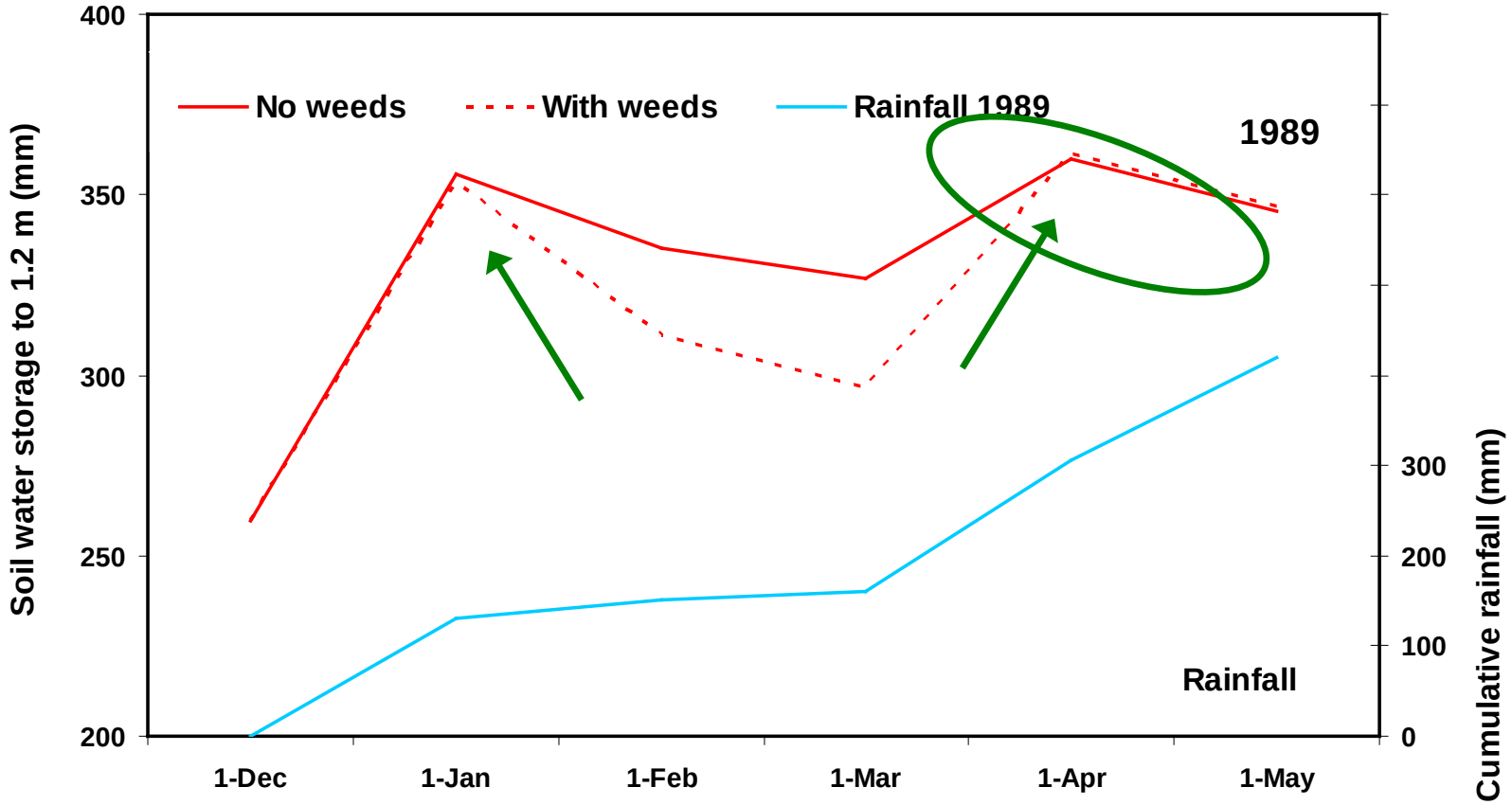




Key Message

- **Prolonged dry periods minimise the effect of stubble cover**

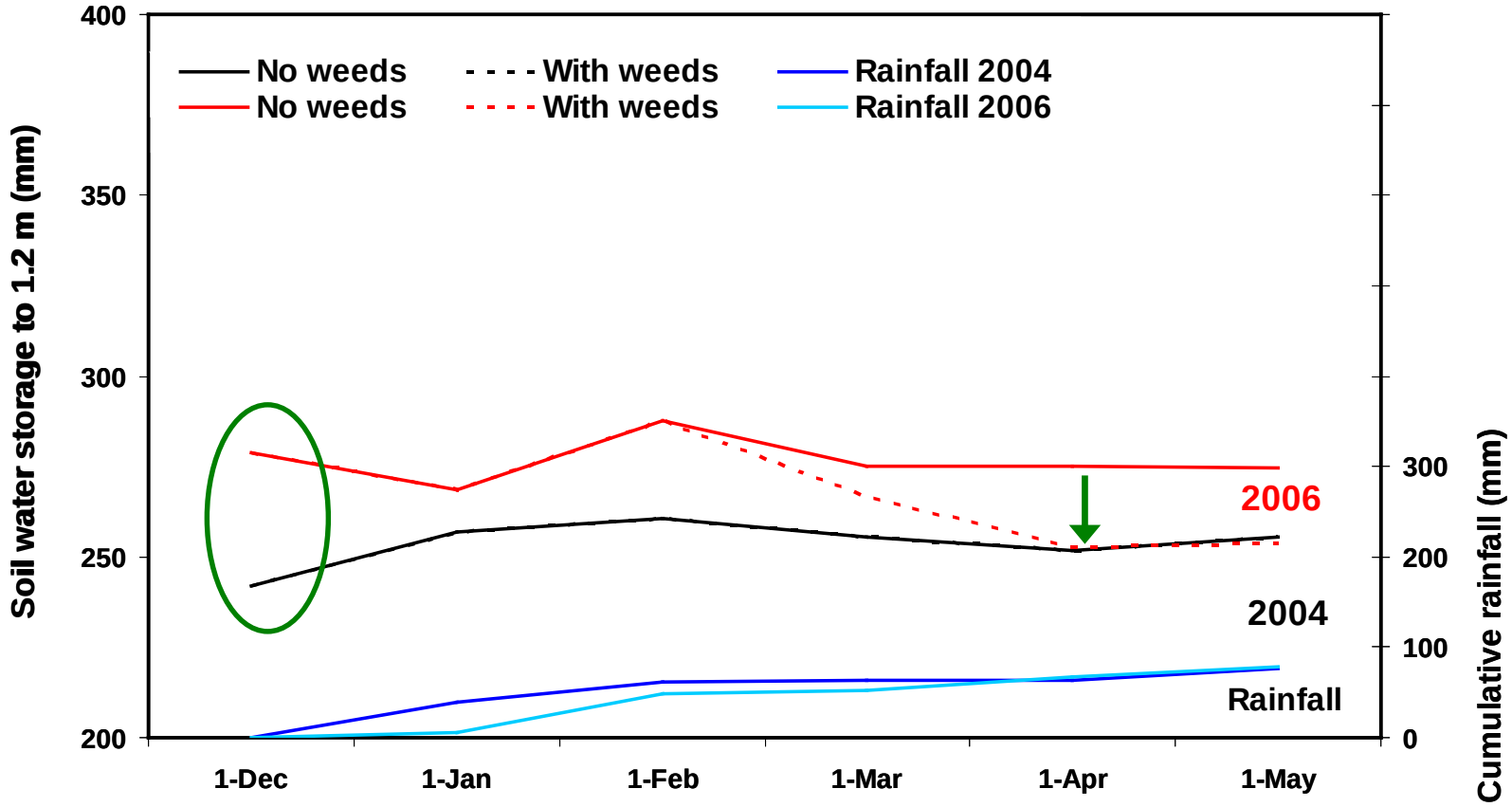
Effect of weeds – amount and timing of rainfall and weed germination



Key Message

- Largest effects with early wetting of the profile and early weed germination
- In wet summers the effects may disappear when the profile refills

Effect of weeds - Dry summers (around 100 mm rain)



Key Message

- **Fallow rainfall alone is not a good predictor of the benefits of weed control**
- **Carry-over from the previous growing season needs to be taken into account.**

What was the impact of the 2006 differences in soil water storage?

	April available soil water	October biomass	
	Stubble harvested for straw, with weed control 34 mm	2.1 t/ha	
	Stubble left standing, with weed control 45 mm	2.7 t/ha	
	Stubble left standing, no weed control 22 mm	1.9 t/ha	
	Stubble flattened, with weed control 44 mm	2.1 t/ha	
	Stubble flattened, no weed control 23 mm	1.7 t/ha	

What is the additional stored water worth?

Simulation Studies

Sites

- Cootamundra (624 mm), Ardlethan (484 mm)

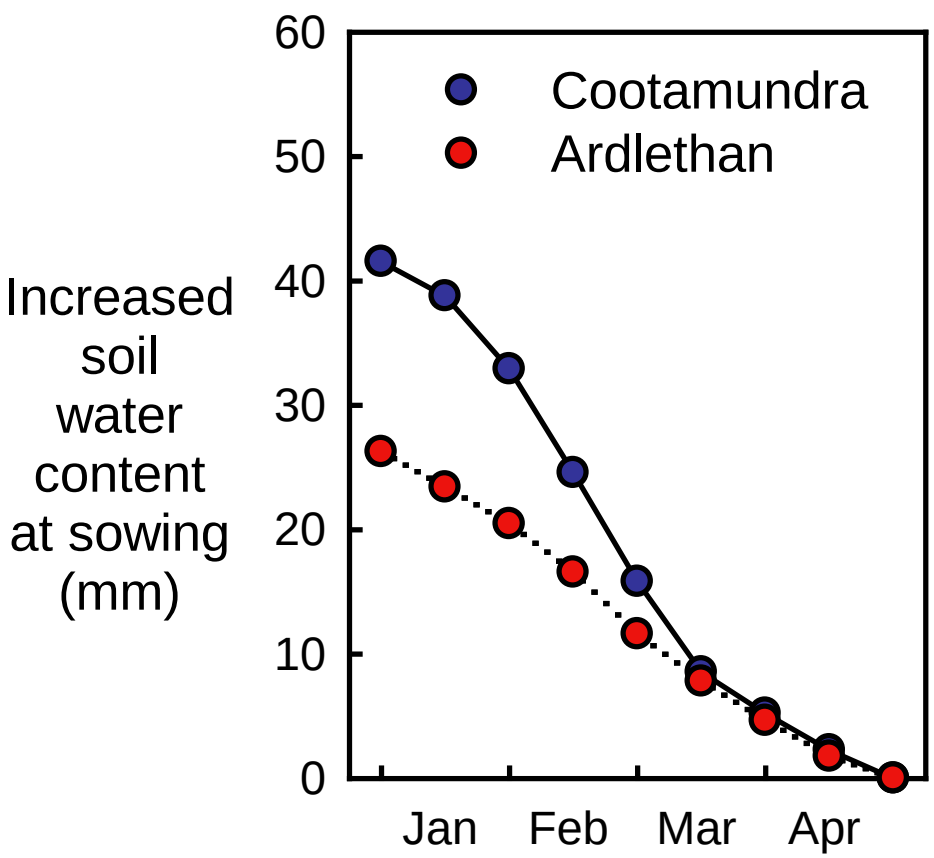
Soil

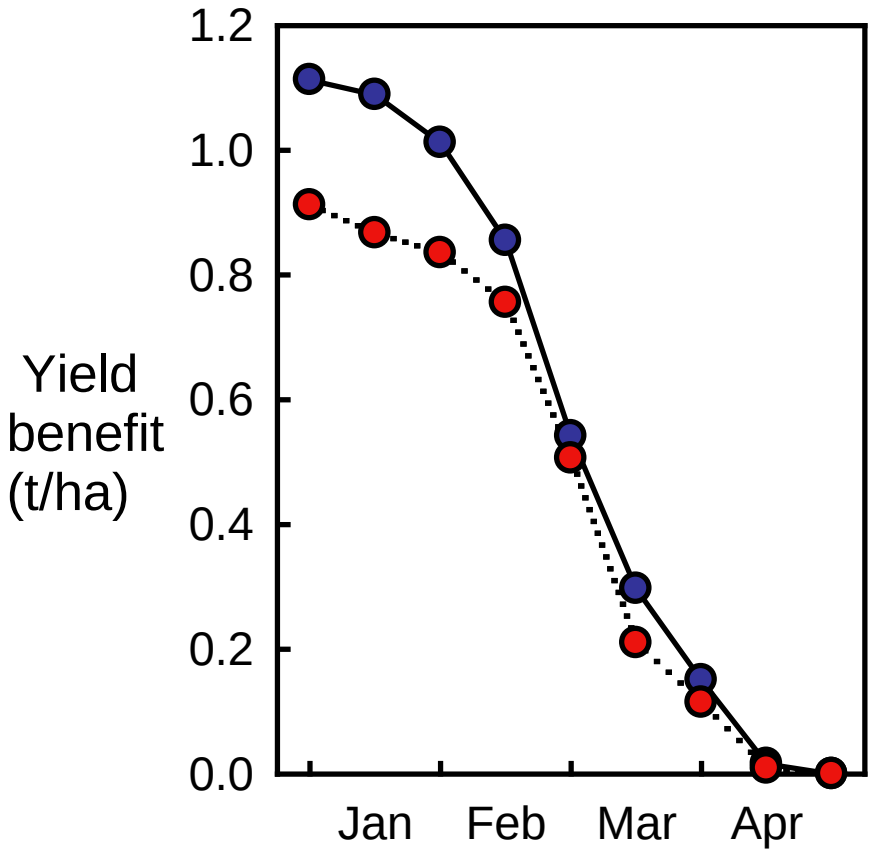
- Bethungra Red Kandosol (174 mm available water)

Scenarios

- Range of stored soil water at sowing

Impact of weed removal date on sowing soil water content

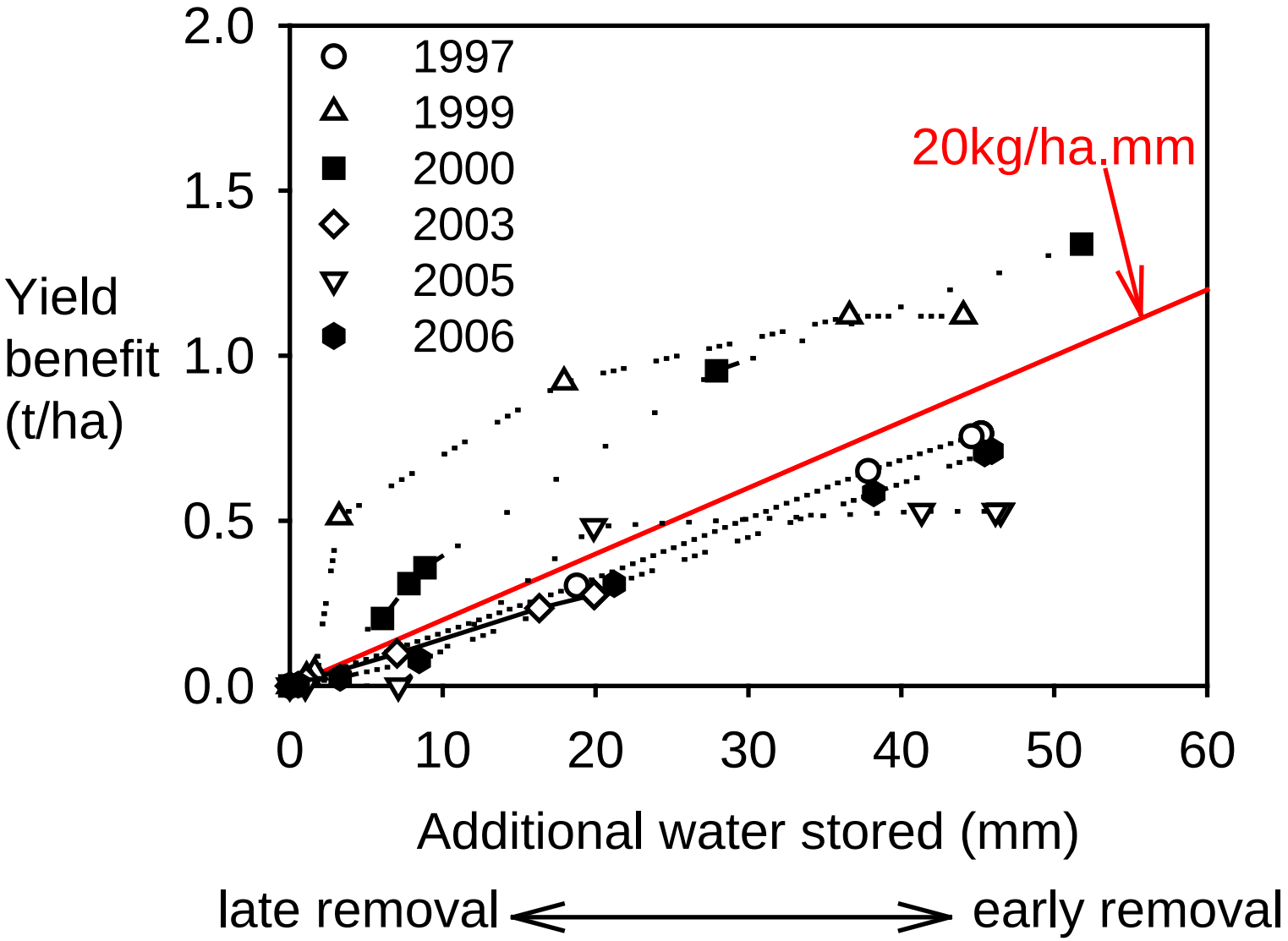




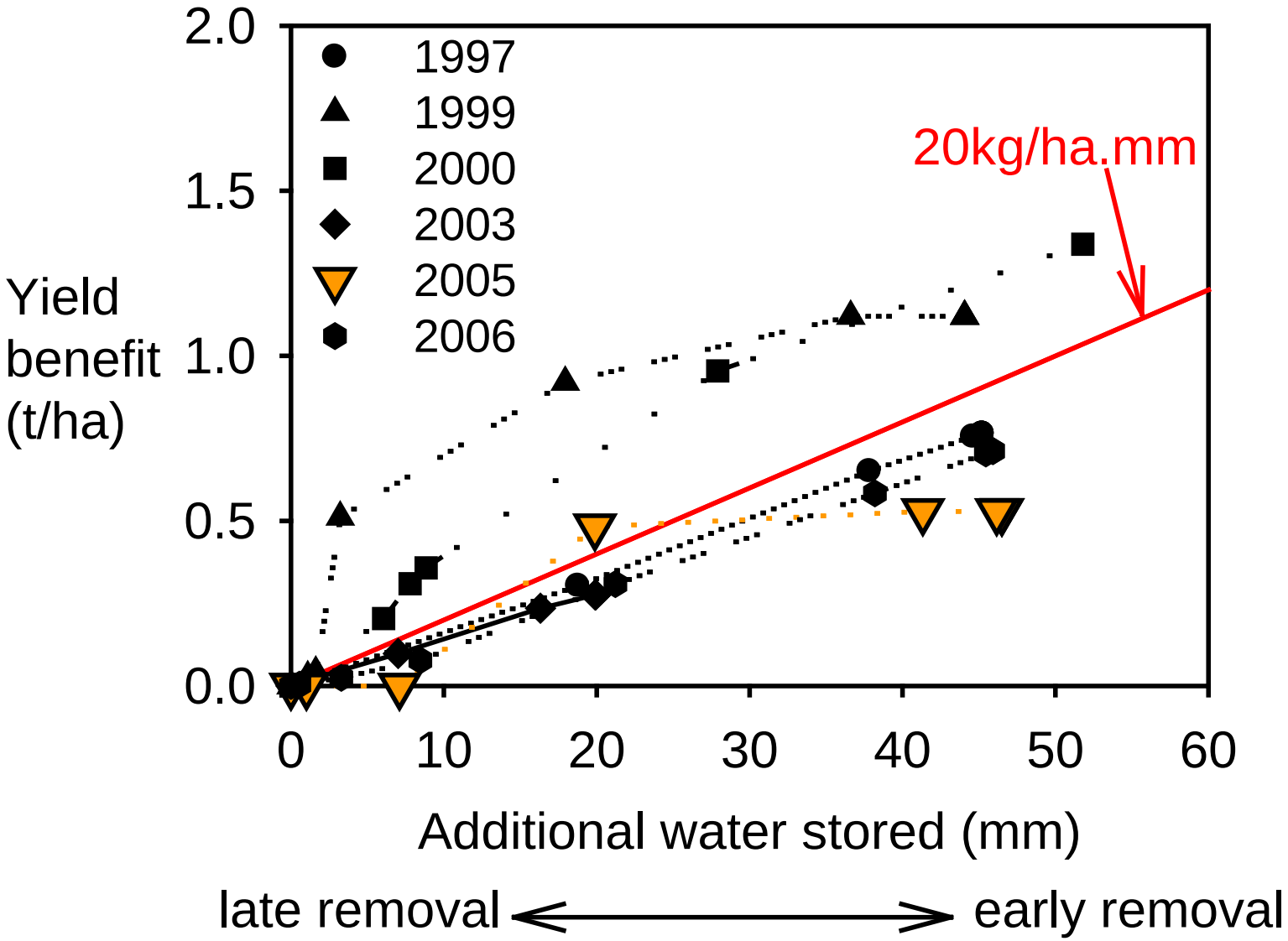
Key Message

- **weed control in February has most impact on stored soil water and yield**

Impact of sowing soil water content on yield



Impact of sowing soil water content on yield



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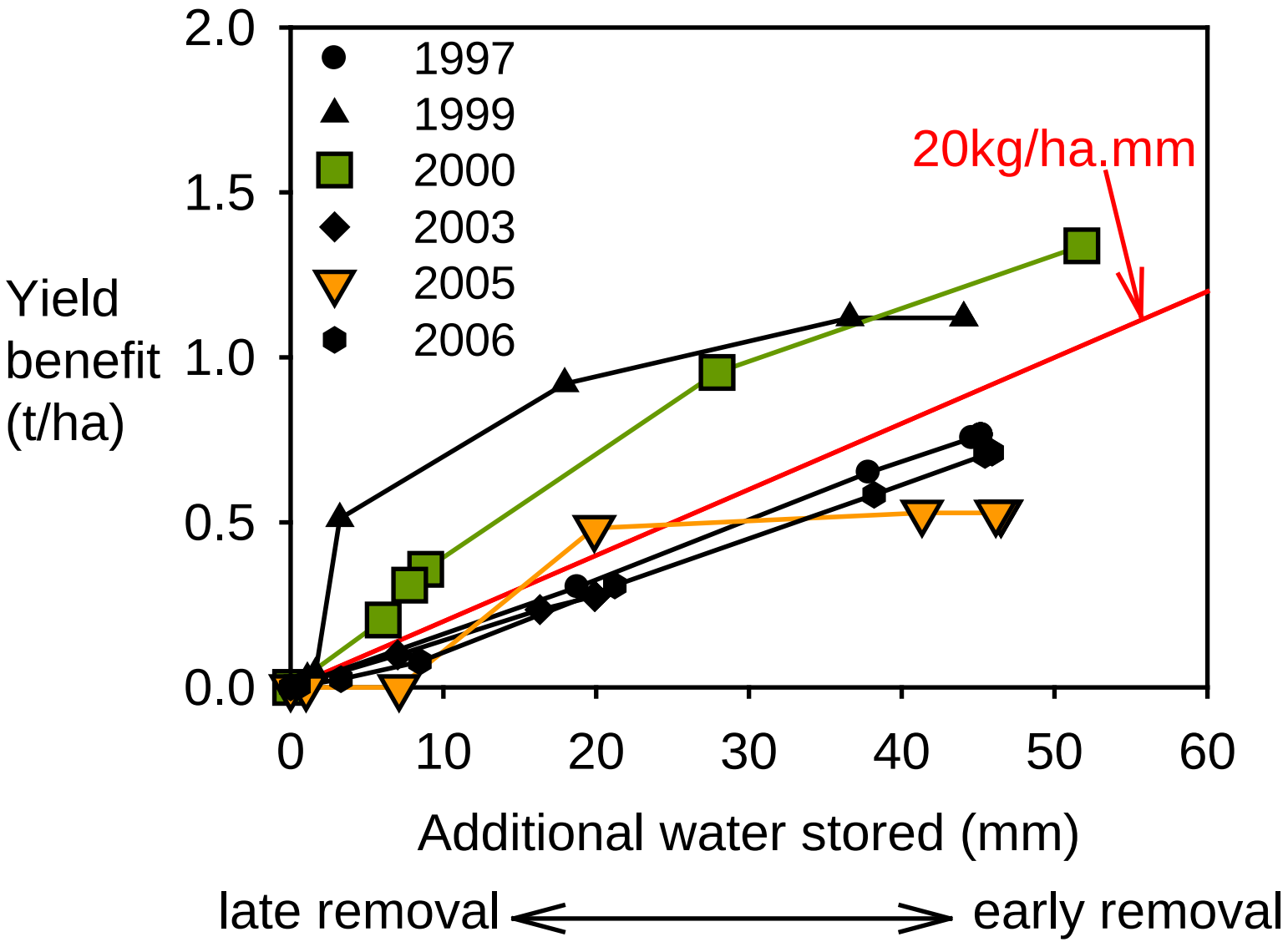
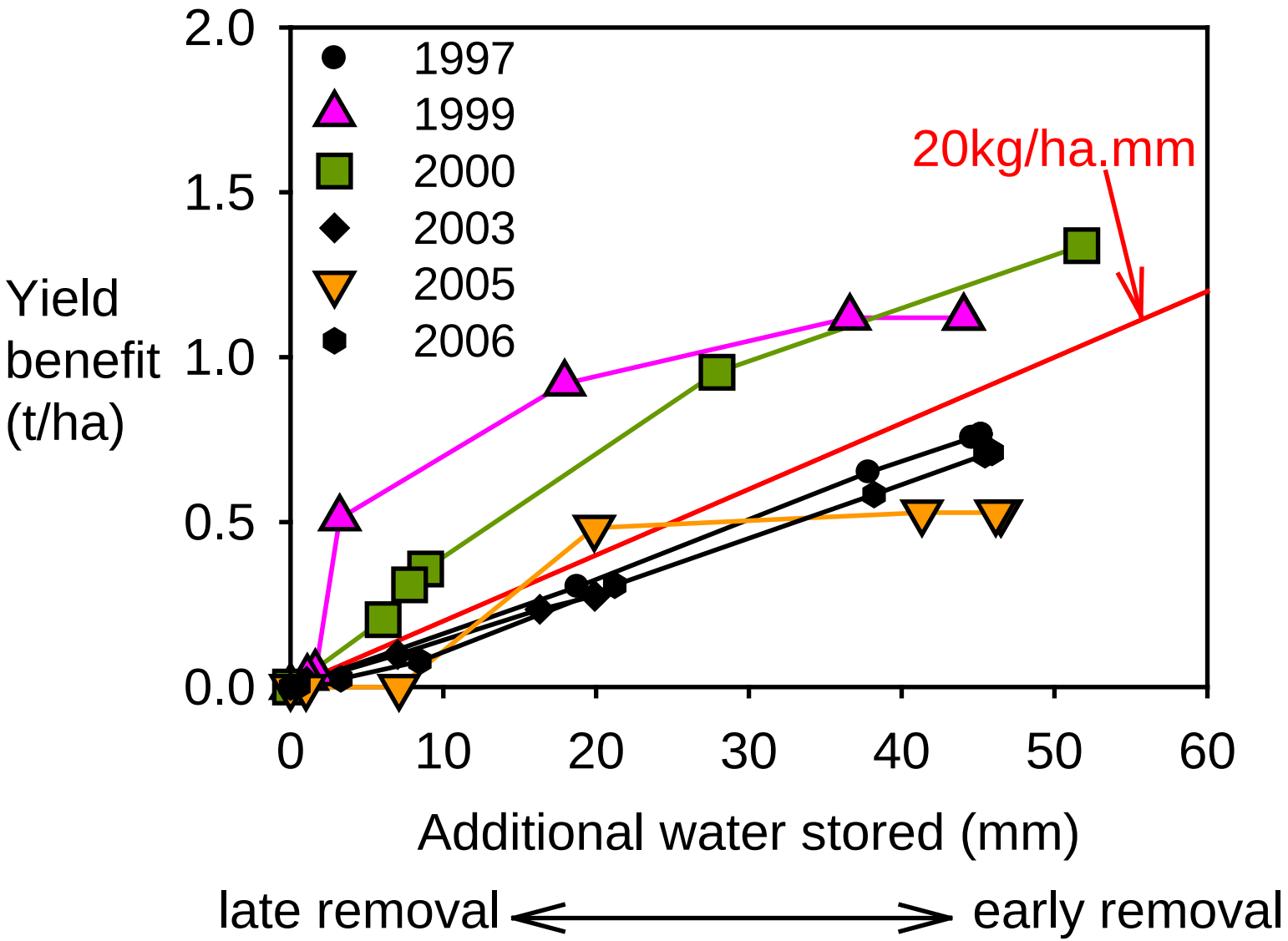


Impact of sowing soil water content on yield

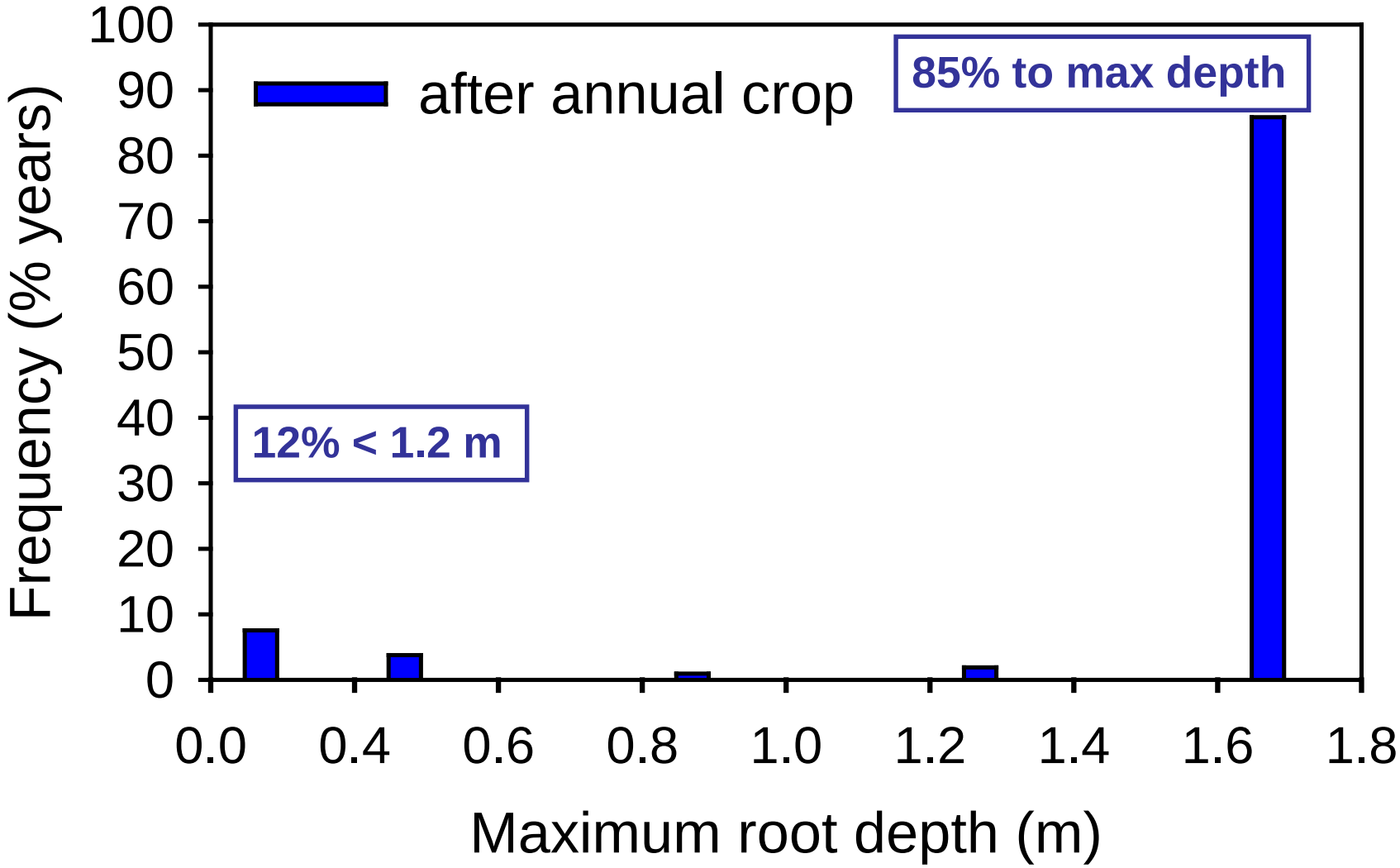


What is subsoil water worth?

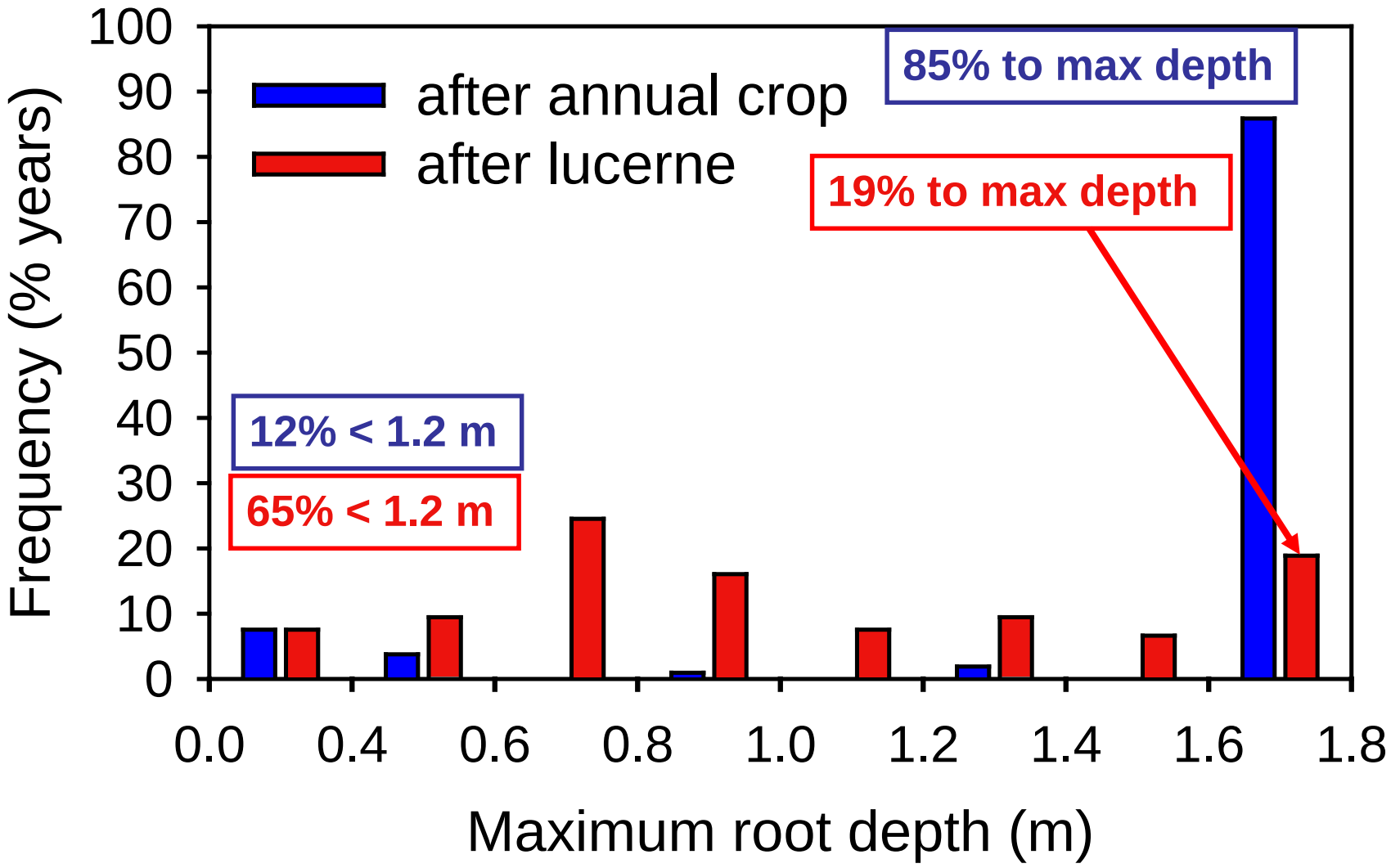
Simulation study to assess value of subsoil water

- **Two initial soil water profiles**
  1. **Dry – following lucerne removed in December**
  2. **Wet – following annual crop (top 1.2 m dry, subsoil wet)**

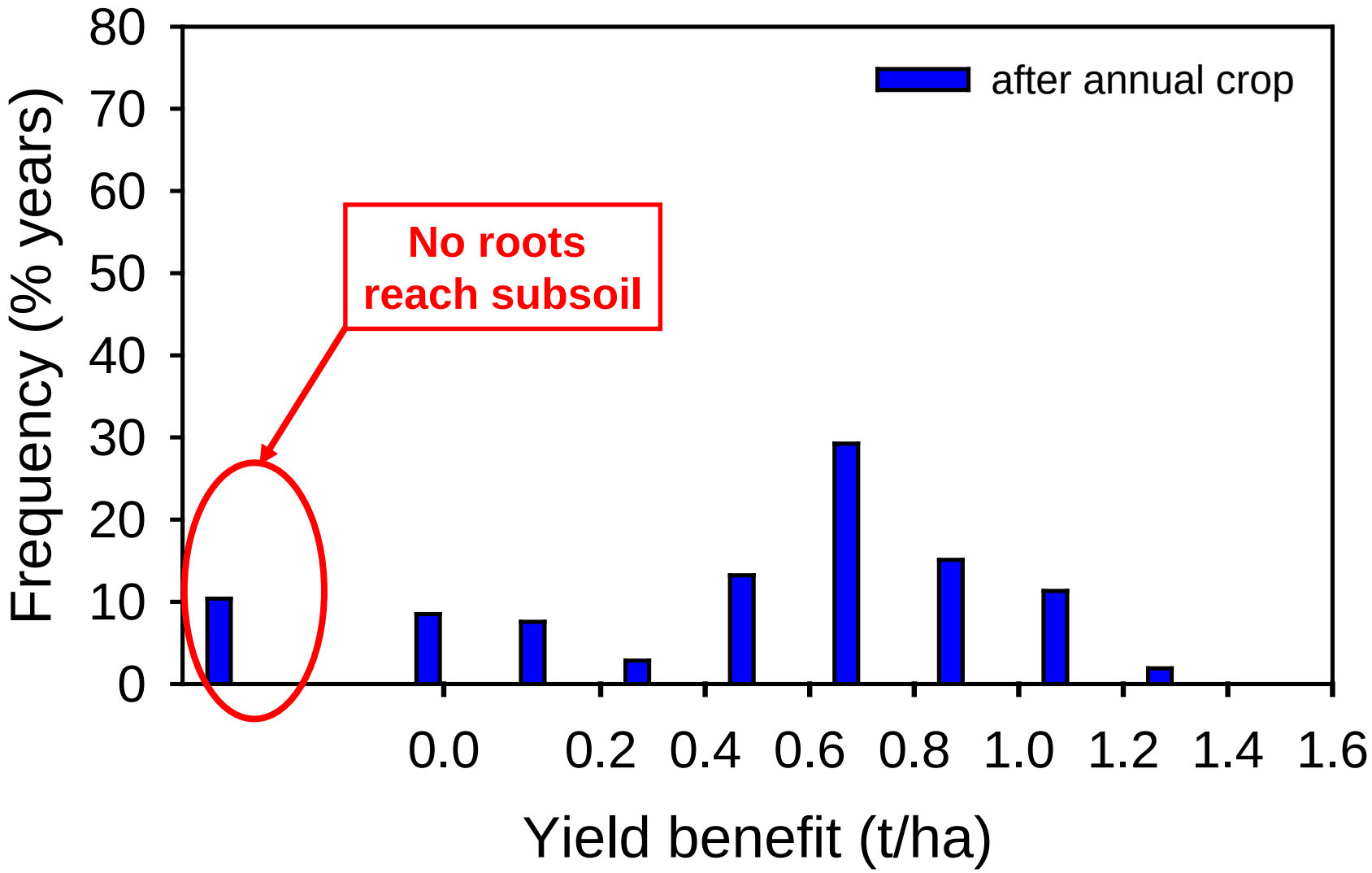
Rooting depth of wheat



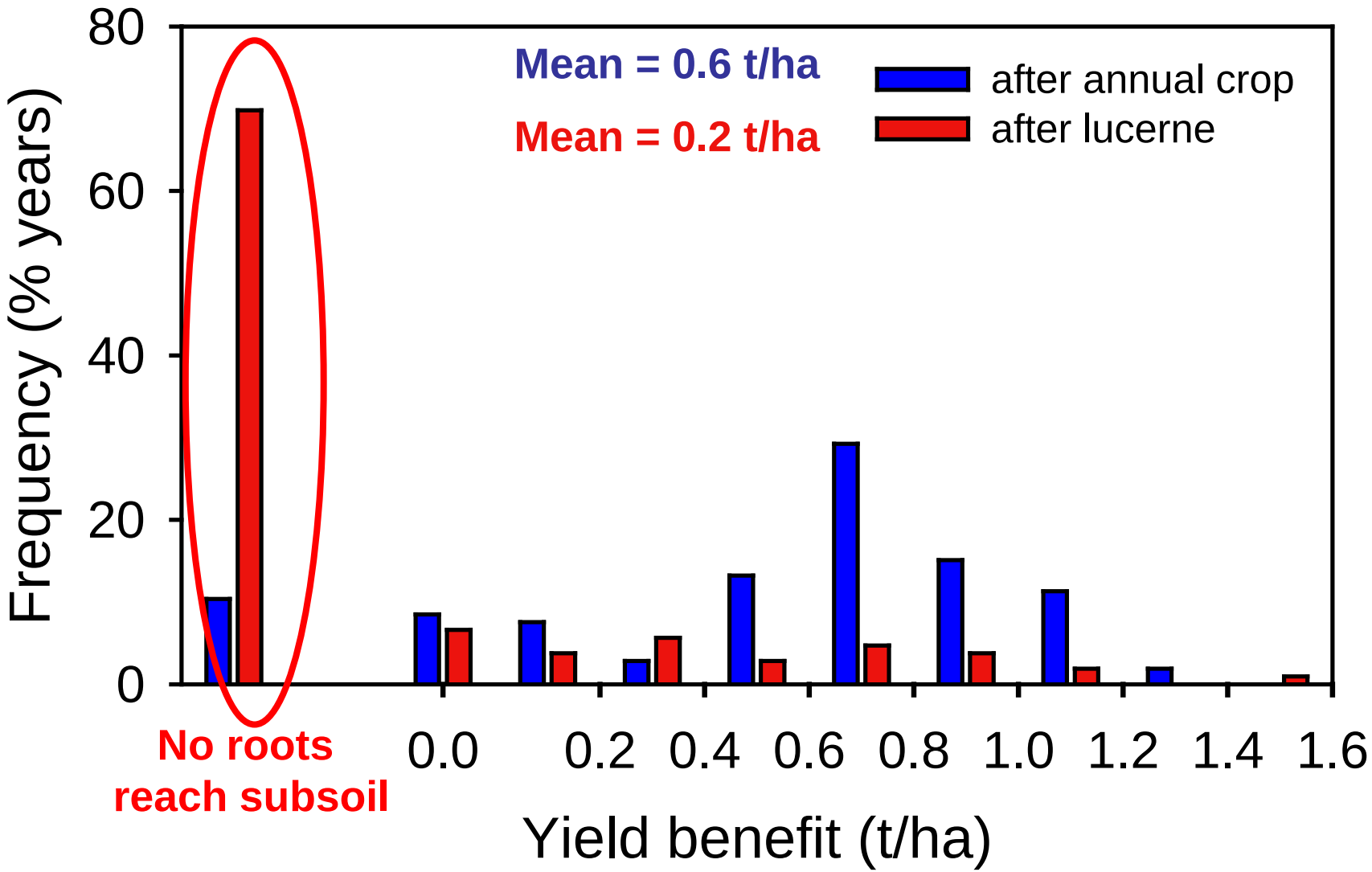
Rooting depth of wheat



Yield benefit from subsoil water



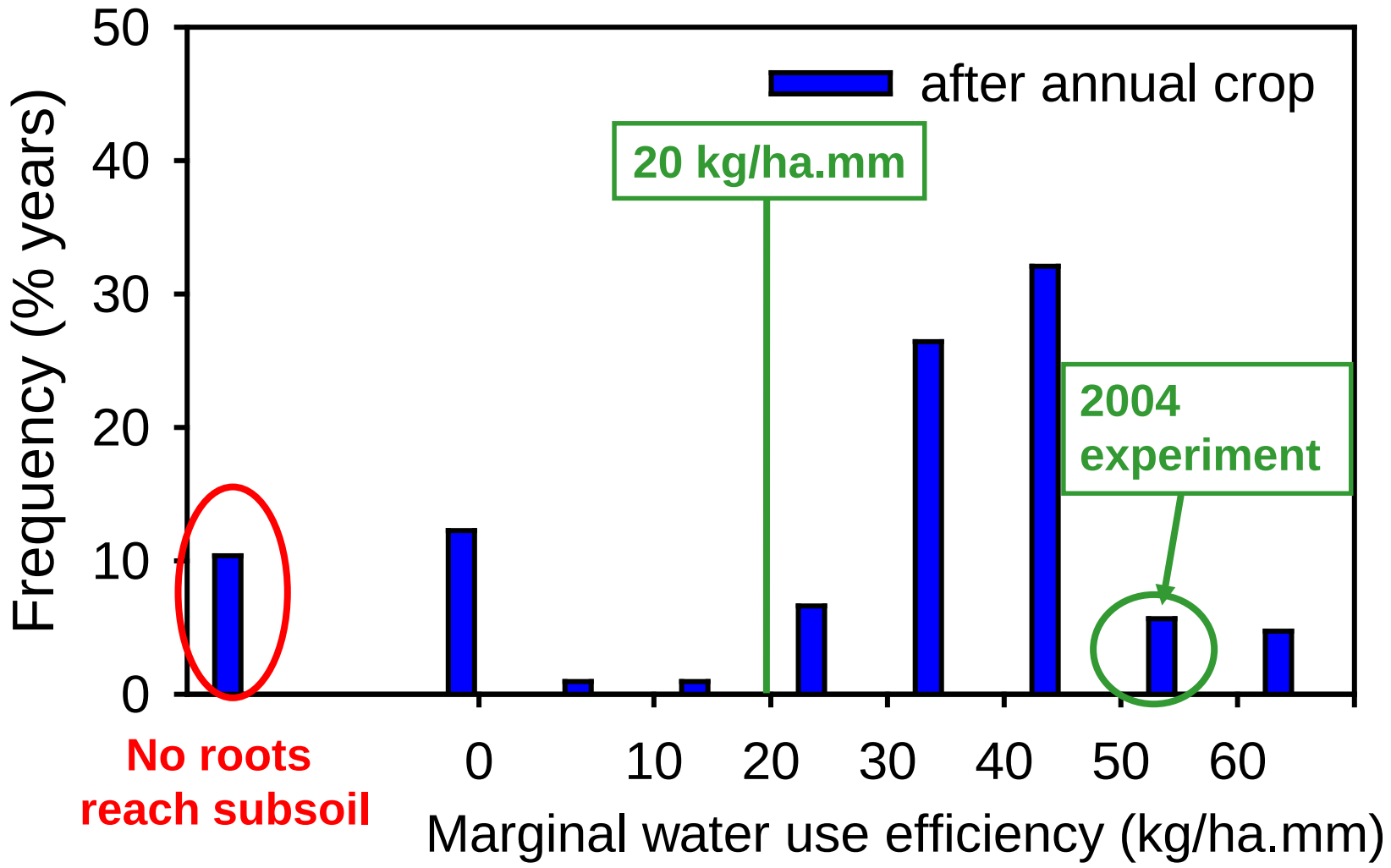
Yield benefit from subsoil water



Effect of site

Site	Annual rainfall (mm)	% years roots don't reach subsoil		Average yield benefit (t/ha)	
		After annual crop	After lucerne	After annual crop	After lucerne
Cootamundra	624	5	33	0.6	0.3
Bethungra	509	10	70	0.6	0.2
Ardlethan	484	21	78	0.4	0.1

Marginal water use efficiency of subsoil water



Conclusions

- **Weed control has more impact on fallow soil water storage than stubble treatment.**
- **Stored water at sowing is determined by the magnitude and frequency of rainfall events, timing of weed germination and control, and water left after the previous crop.**
- **Yield benefit from extra water stored at sowing depends on in-crop rainfall.**
- **Subsoil water is used efficiently *(when there)* and management which increases soil moisture storage may enhance its capture.**

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Thank You

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Summer rainfall storage efficiency