Irrigating when water is limited: Research findings

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Irrigated Crop Production Update
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Outline

- Project Rationale
- Objectives
- Crop Water Use
  - How we measured crop water use
  - Total crop water use findings
- Yield
  - How we measured crop yield
  - Crop yield as a response to irrigation
- What's next?
- Acknowledgements

Project Rationale

- Irrigated crops provide nearly 20% of the annual crop production in Alberta on 5% of province's cultivated land, creating a stable and reliable production base
- As water scarcity becomes an increasing issue in southern Alberta, competing demands for water are rising and irrigation water restrictions have been occasionally imposed
- We want to help producers have a strategy for irrigation management in times of water shortage/scarcity

Project Rationale

- Previous water use studies done in 1950's & 1960's under gravity irrigation
- Irrigation recommendations are dated:
  - Crop breeding has increased yield potential
  - Improved water use and management with pivots
  - Seeding earlier and at higher rates
  - Improved weed management options
  - Better disease control: seed treatments & foliar
  - More efficient fertilizers such as ESN
  - Better agronomic management techniques

Project Rationale

- Have typically managed irrigation in top meter but studies have shown that 70%-80% of crop water use typically takes place in the surface half meter
- As pivots have replaced gravity irrigation and wheel moves, it has become possible for producers to accurately target irrigation amounts and a more specific depth range

To address these issues, and more, a research project with Five Experiments was initiated in 2006 by Alberta Agriculture staff, titled:

"Optimizing water use, nitrogen use and agronomic management of irrigated grain and oilseed crops"

- Ross discussed the nitrogen use and agronomic management components yesterday
- Today I will discuss the Water Use Efficiency component of the project

Water Use Efficiency Study

Objective: to determine the water use efficiency for a representative variety of an irrigated grain (soft white spring wheat) and an oilseed (canola) crop

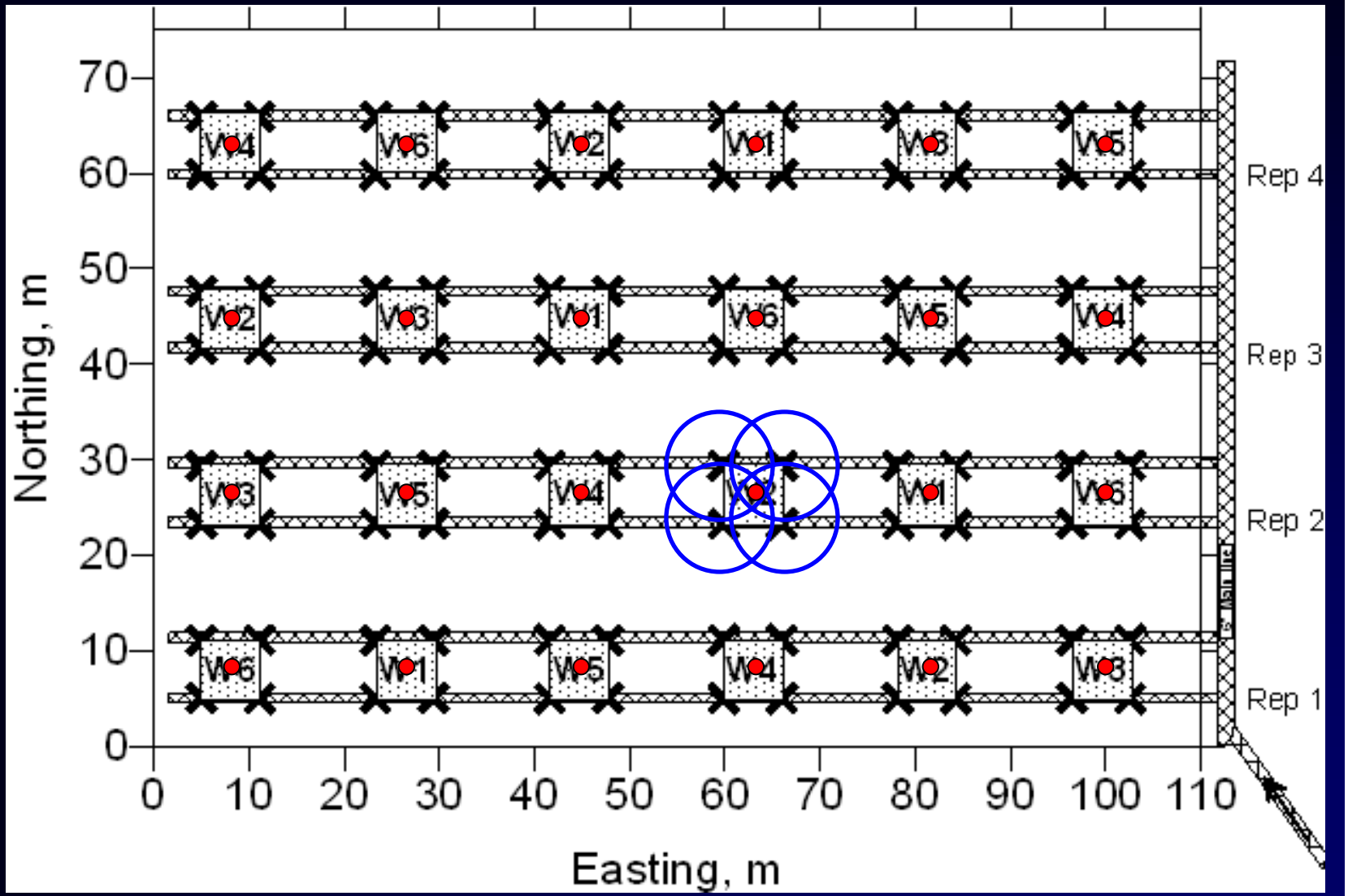
- Focused on two crops to find creative ways to use less irrigation water, while still maintaining optimal crop yield and quality
- Most efficient use of irrigation water and energy and for decision-making during times of shortage/scarcity

Project Details

- **Two crops**
  - Cereal: Barley (2006) SWSW (2007-09)
  - Oilseed: Canola (LL 2006-07; RR 2008-09)
- **Two locations**
  - Lethbridge (CACDI) 2006-09
  - Bow Island (BISS) 2007-09
- **Six irrigation treatments (four replicates)**
  - **Dry:** Dryland
  - **Optimal:** Maintain 60-90% AW in the surface 0-40 cm
  - **75%:** Irrigate ¾ amount of Optimal
  - **50%:** Irrigate ½ amount of Optimal

  } Deficit
  - **75%+:** Irrigate ¾ amount + to 90% at critical stages
  - **50%+:** Irrigate ½ amount + to 90% at critical stages

Plot Layout Map

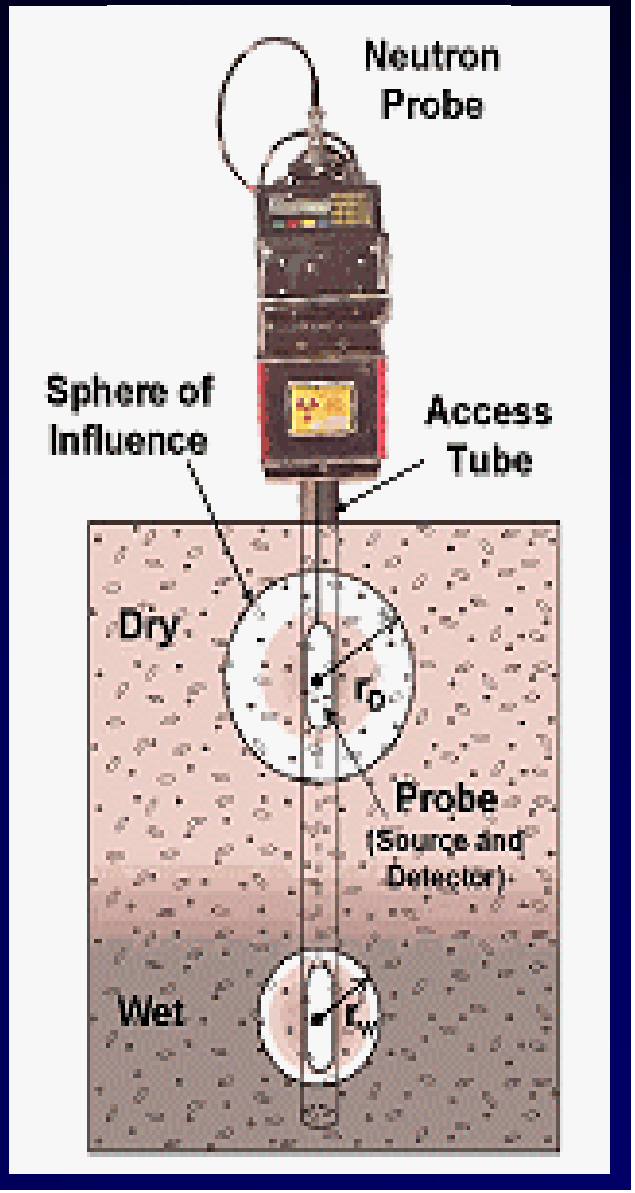


Insertion of soil moisture access tube


Soil moisture access tube in place

Monitoring Soil Water Content

- Campbell Scientific 503DR neutron probe
- probe contains a source of fast neutrons and a detector for slow neutrons
- inserted into soil (various depths) via access tubes
- emits fast neutrons, which are slowed and scattered by collisions with H atoms (H_2O)
- slow neutrons counted by detector: proportionate to amount of moisture in soil



How We Measured Crop Water Use

- Readings taken twice weekly in 20 cm increments to a depth of 120 cm
- Soil moisture in 0-40 cm depth in the Optimum treatment plots used to determine irrigation requirements
- Soil moisture changes at depth will be used to determine if any deep drainage occurred

Total Crop Water Use

Total = Soil Water Used (ΔS)

+ Precipitation

+ Irrigation

- Run Off

+ Run On

} Zero

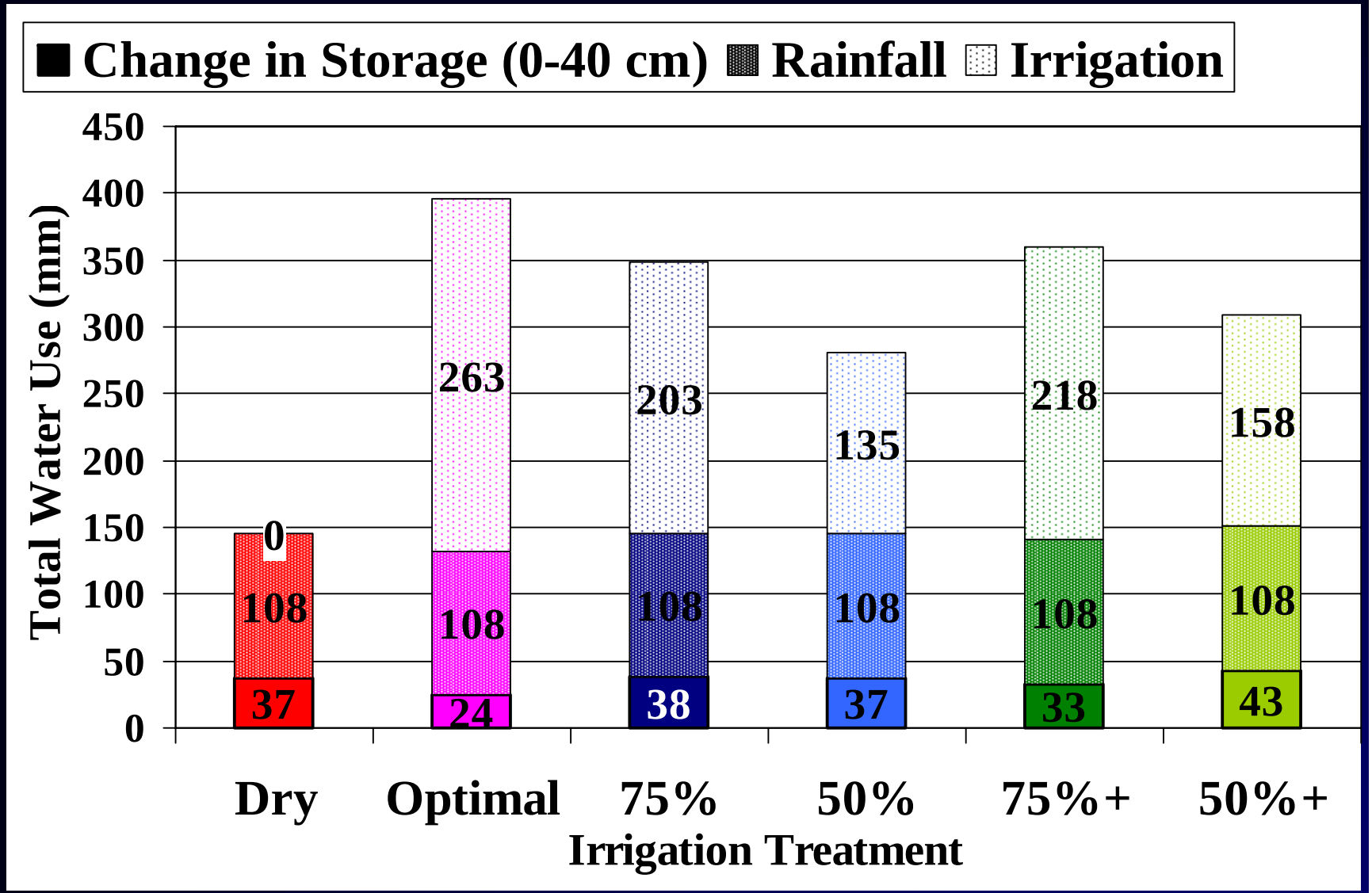
- Deep Drainage

+ Capillary Flow

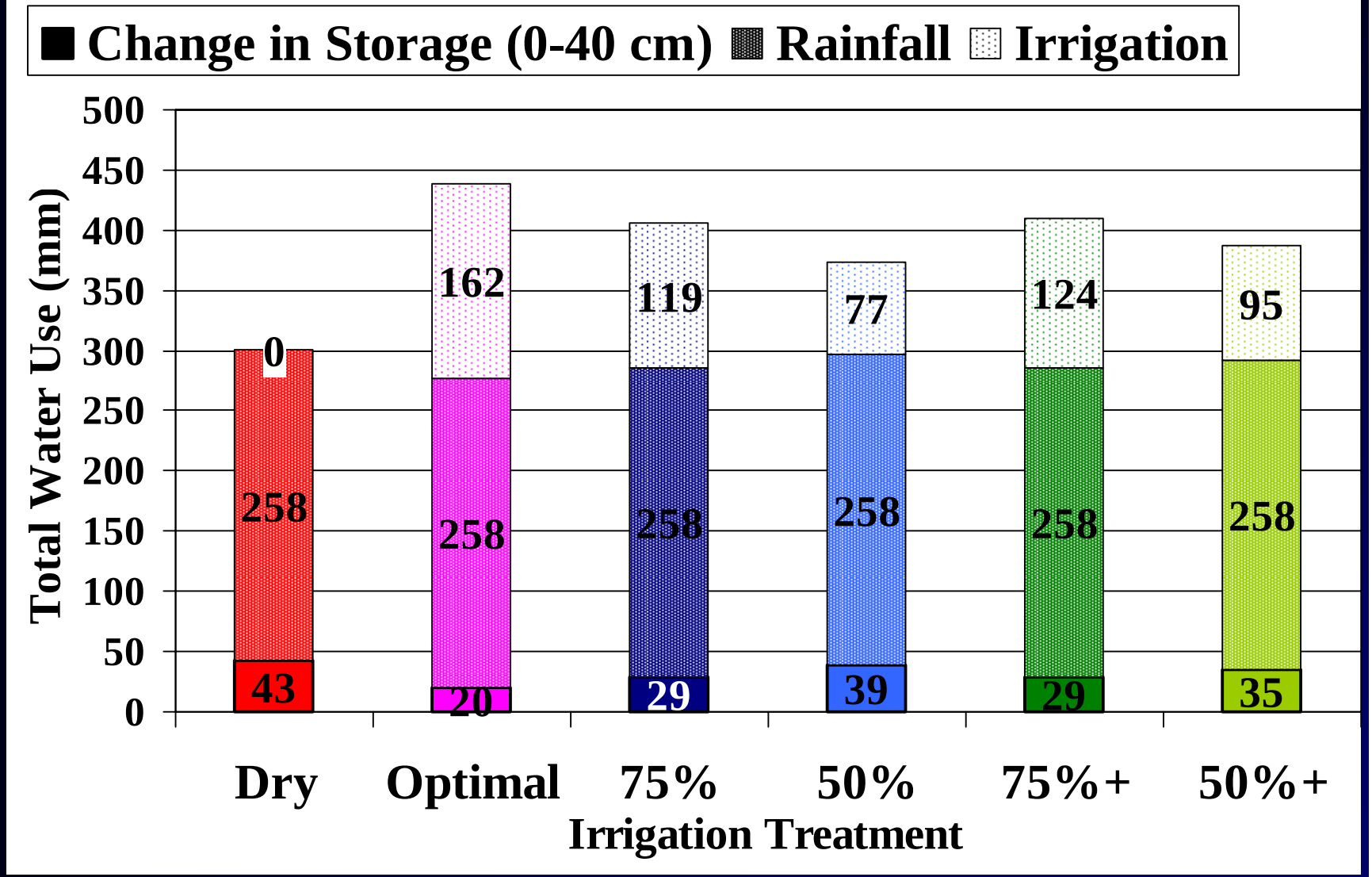
Lethbridge Climate 2006-2008

- **2006**
  - Record rainfalls in summer and fall of 2005 left high water tables that persisted throughout the 2006 growing season
  - April to July 2006 were slightly warmer than long-term average
  - June 2006 was wet, however, May, July and August were dry
- **2007**
  - July 2007 was hot
  - April was wet but June, July and August were very dry
- **2008**
  - temperatures were close to the long-term average
  - May, June and July were wet
- **2009**
  - temperatures were close to the long-term average
  - April to July slightly drier than the long-term average
  - August precipitation was nearly double the long-term average

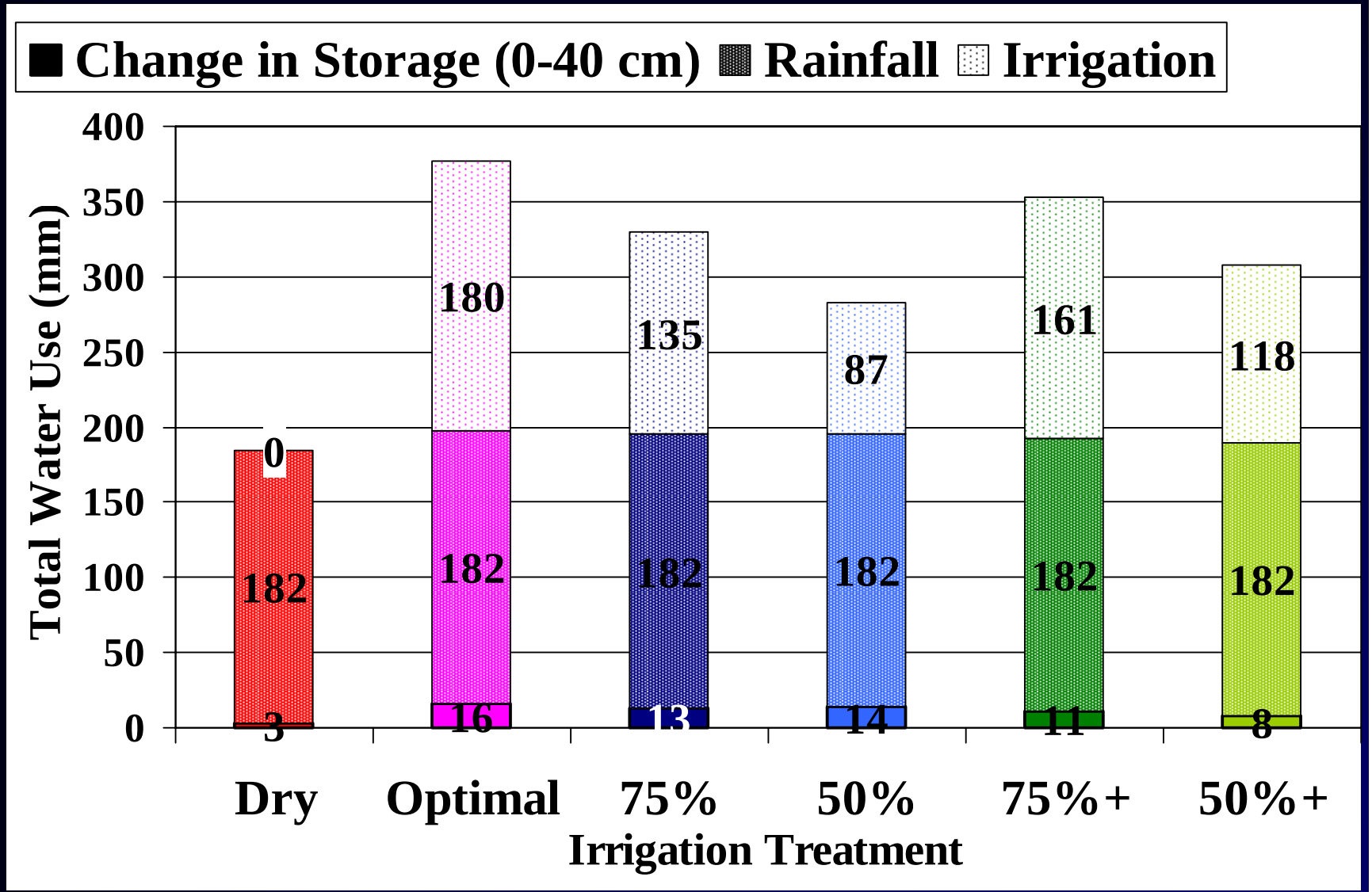
Lethbridge SWSW 2007 - Water Use



Lethbridge SWSW 2008 - Water Use



Lethbridge SWSW 2009 - Water Use



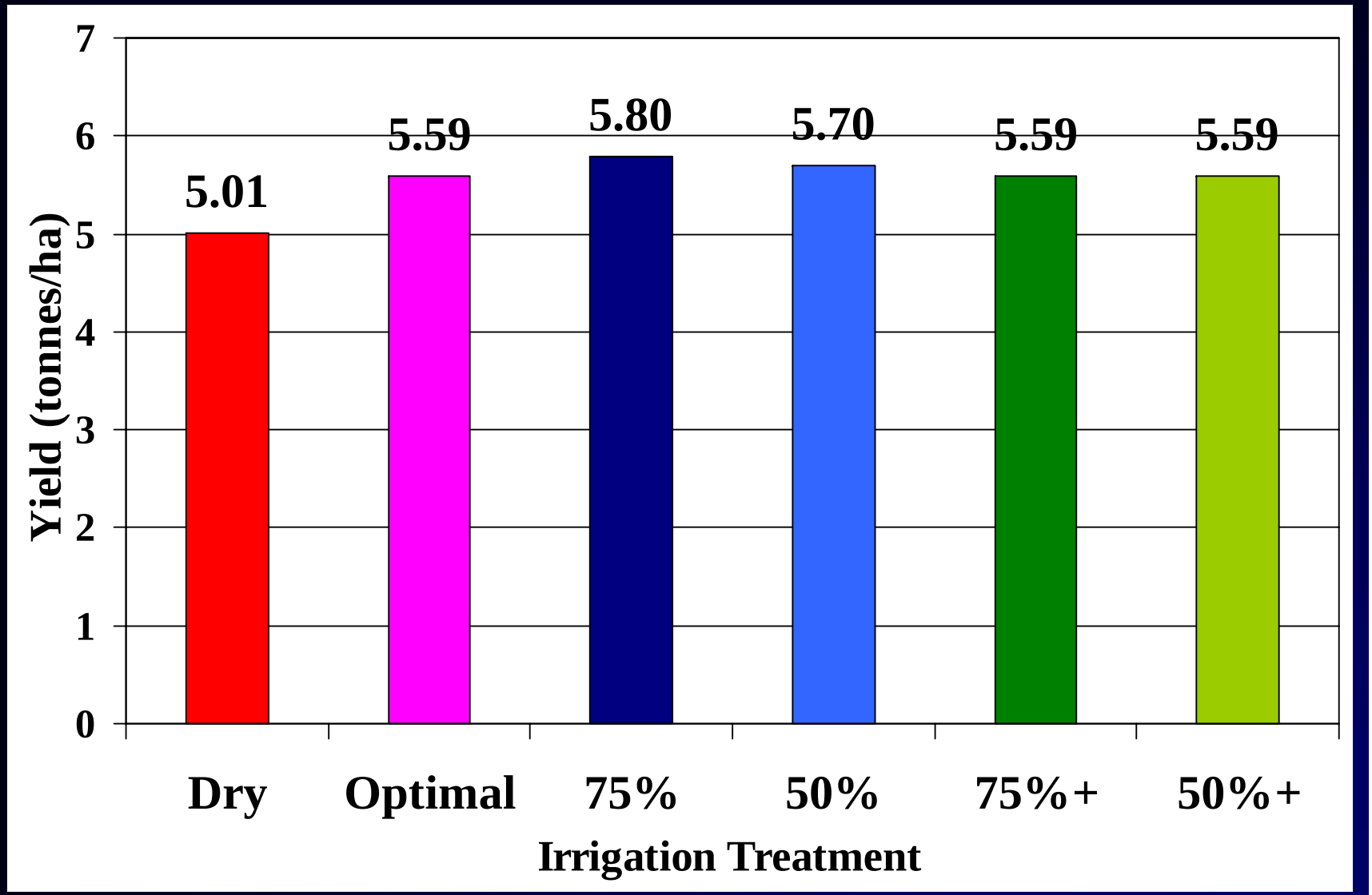
Water Use Summary

- SWSW 375-450 mm; Canola 270-380 mm
- Location and climate (temperature and rainfall) affected water use and irrigation requirements
- Stored soil water makes up only a small proportion of total irrigated crop water use
- Difference in amounts of water applied among our treatments were smaller, when less water applied to the optimum treatment

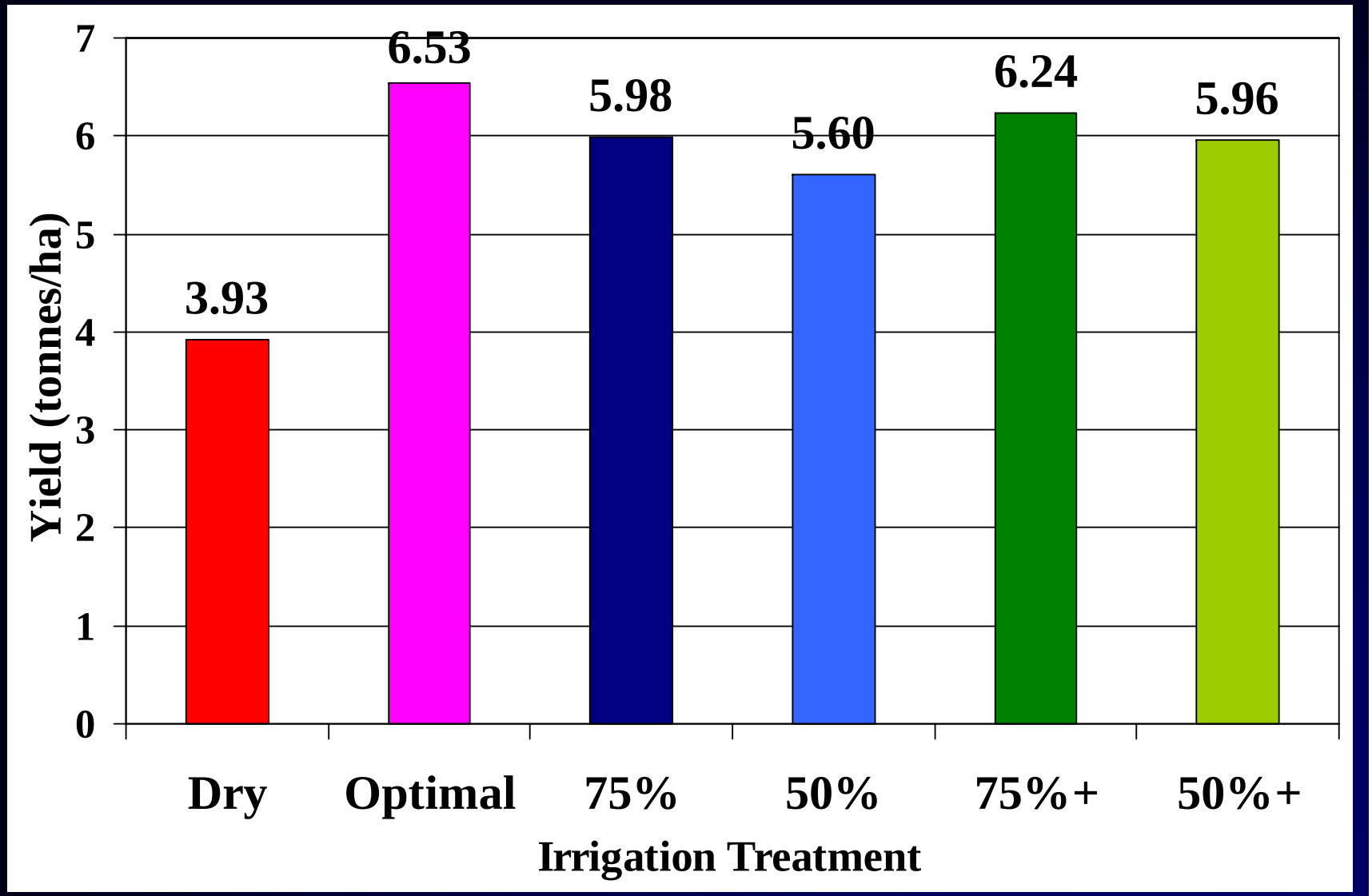
Crop Yield

- Each plot sampled at harvest using a Wintersteiger plot combine
- Two strips (1.5 m by 6 m) harvested
- Clean seed weights and moisture (yield), protein/oil content (quality)
- Sub-samples of wheat seeds sent for microbial analysis (*Fusarium* etc.)

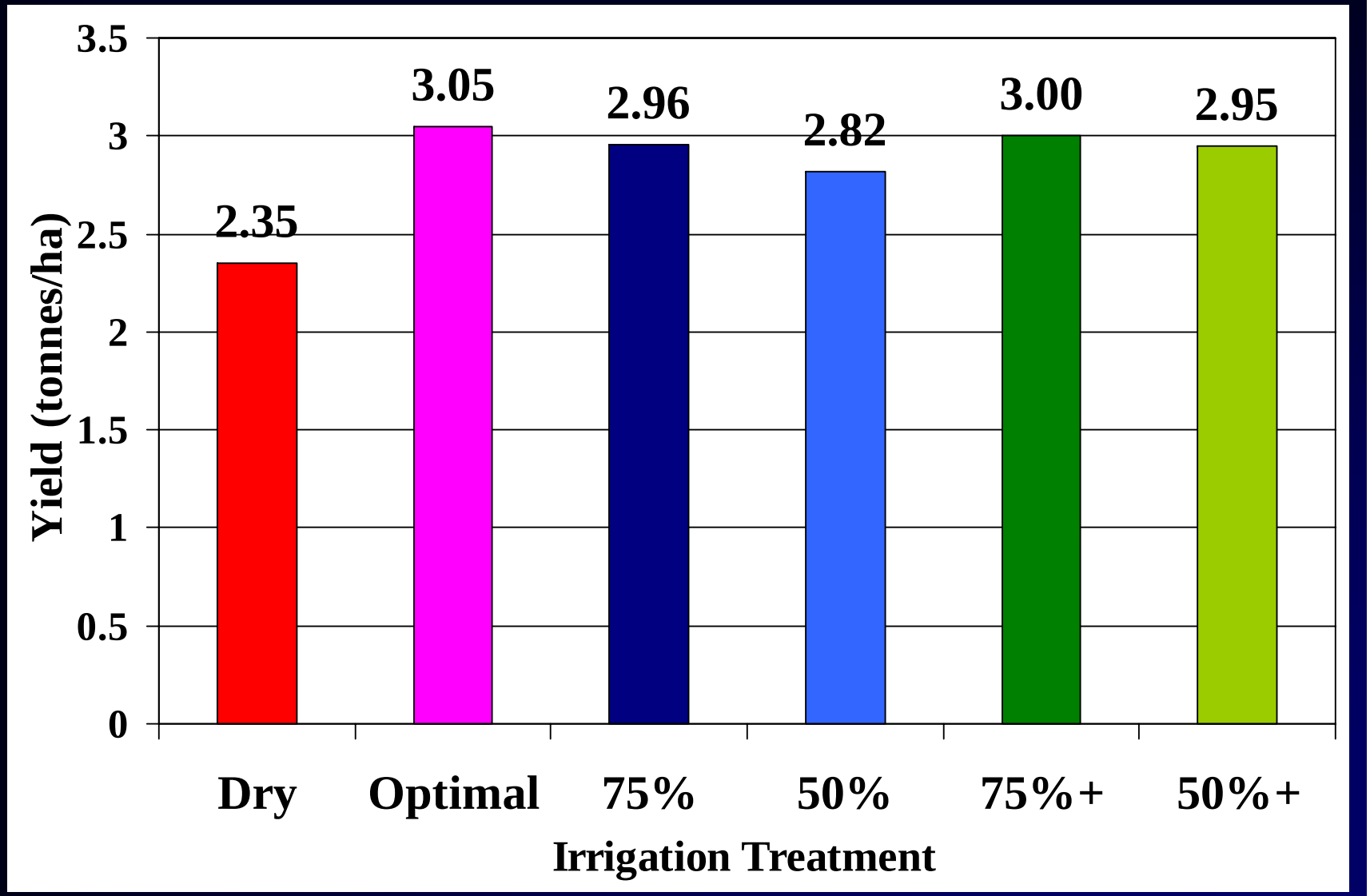
Lethbridge Barley 2006 –Yield



SWSW 2007-2009 – Average Yield



Canola 2006-2009 – Average Yield



Crop Yield Summary

- Optimal irrigation strategy (60-90% AW in the 0-40 cm range) gave the best yields
- Both insufficient and excess irrigation can decrease the potential crop yield
- Varieties can respond differently to irrigation rates
- Management strategies (agronomy, fertility, pest control) can influence the response to irrigation

The Next Step…
Water Use Efficiency (WUE)

- Water productivity
- Amount of “crop per drop”
- Crop output per unit of water use

$$\text{WUE} = \frac{\text{Crop Yield}}{\text{Total Water Use}} = \text{kg/(ha•mm)}$$

Other Applications

- Looking at irrigation effects on crop quality and disease
- Total crop water use of 11 cereal and oilseed crops
- Quantifying deep drainage
- Understanding daily water use
- Refining crop curves for the AIMM (Alberta Irrigation Management Model)

Thanks to project sponsors:

- Alberta Agriculture and Rural Development
  - Irrigation & Farm Water Division
  - Agriculture Research Division
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- Agrium
- Alberta Reduced Tillage Linkages