Irrigation Design Planning

Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

TAS FARM INNOVATION HUB

UNIVERSITY of TASMANIA
TIA
Tasmanian Institute of Agriculture

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This program received funding from the Australian Government's Future Drought Fund.

The Irrigation Planning Process

1. Review your farm natural resources
2. Financials (return on investment)
3. Making it work? (skills and capability)
4. Irrigation design steps
5. Existing irrigation systems (the same principals apply)
6. Reviewing irrigation quotations (ask the right questions)

*Good irrigation system design is achieving the right balance between **economics, agronomics and the environment**.*

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Natural Resources

1. Access to water (allocations and where?)
2. Where to irrigate?
3. Land capability
    - Determine potential short term and long-term sustainable crop rotations
    - Soil limitations – soil type, depth, RAW, slope, frost risk, water infiltration rate
    - Use soil maps – simple soil reconnaissance survey to EM
5. Consider and plan drainage
6. Water budget – how much water do you have v/s need?
7. Get help! - use an agronomist, soil scientist etc.

Financials

1. Know your potential crop rotations and returns
2. Compile development budget – include incidentals such as fencing, drainage & pivot crossings
3. Know the operational costs – **labour, energy & maintenance**
4. Look at the sensitivity – Will it still make $ if inputs or output costs change
5. Get help if required
6. Ensure you can make $ before proceeding

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Making it work?

Skills and capability

- Do you have the necessary skills to make this work?
- Can you learn the skills to make this profitable?
- Often the required skills are missing
- Poorly established and managed irrigation systems pose significant risks
- Just adding water doesn’t always = more profitability

First Who, Then What…

“Those who build great organisations make sure they have the right people on the bus and the right people in the key seats before they figure out where to drive the bus” Good to Great – Jim Collins.

Irrigation Design Steps

1. Determine system capacity required

– this gives us the design flow rate

– which in turn allows us to size the pipes, pumps and all other equipment.

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What is System Capacity?

The system capacity is the maximum possible rate at which the machine can apply water to the irrigated area.

Expressed in mm/day

NOT the depth applied per pass (mm)

$$\textbf{System Capacity} = \frac{\boldsymbol{Daily\ pump\ flow\ rate\ \left(\frac{ML}{day}\right)}}{\boldsymbol{Area\ Irrigated\ (ha)}}\ \text{x}\ \mathbf{100} = \text{mm/day}$$

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System Capacity – under or over?

- Irrigation systems should be able to meet maximum crop water demand – System Capacity
- We can draw down into soil moisture reserves
- Underdone on System Capacity = *plant stress at key times = reduced yields & quality*
- Overdone on system capacity = *overcapitalise & increased application related issues - off target application, wheel tracking etc.*
- Consider what you are irrigating – Crops vs Pasture

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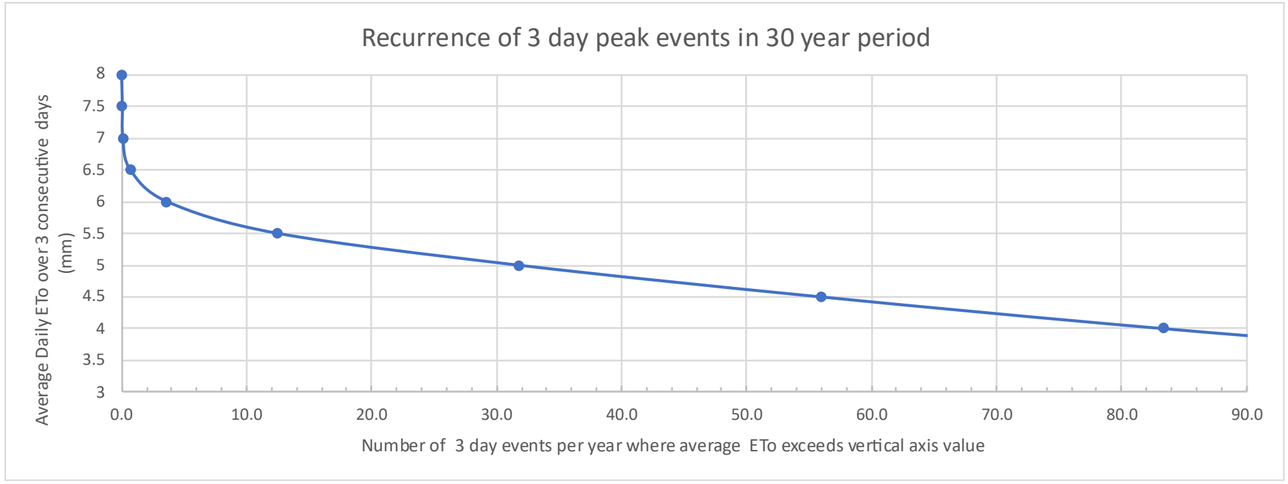
A metric-based approach to system capacity

- Derived from peak 3 consecutive day ETo averages
- The likely re occurrence of the 3-day average ETo in a season
- Exceedance for Longford
- Average daily ETo for Jan = 4.9mm



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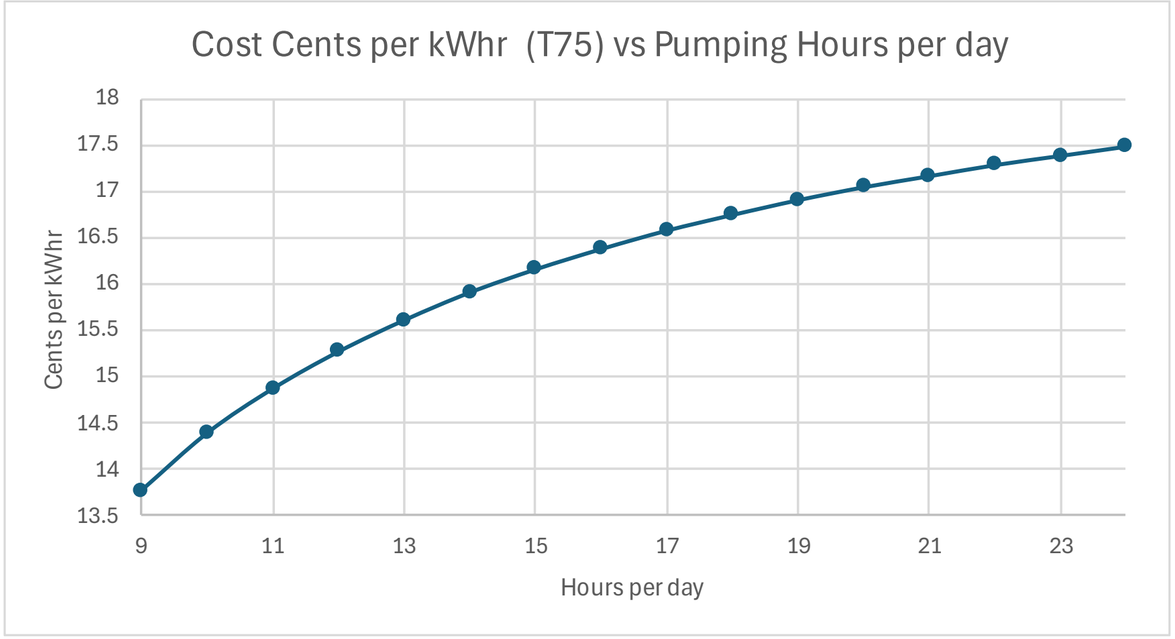
DON’T LET POWER RULE YOU

- Don’t get caught up trying to just use off-peak power
- Pumping cost should never be put before the crop



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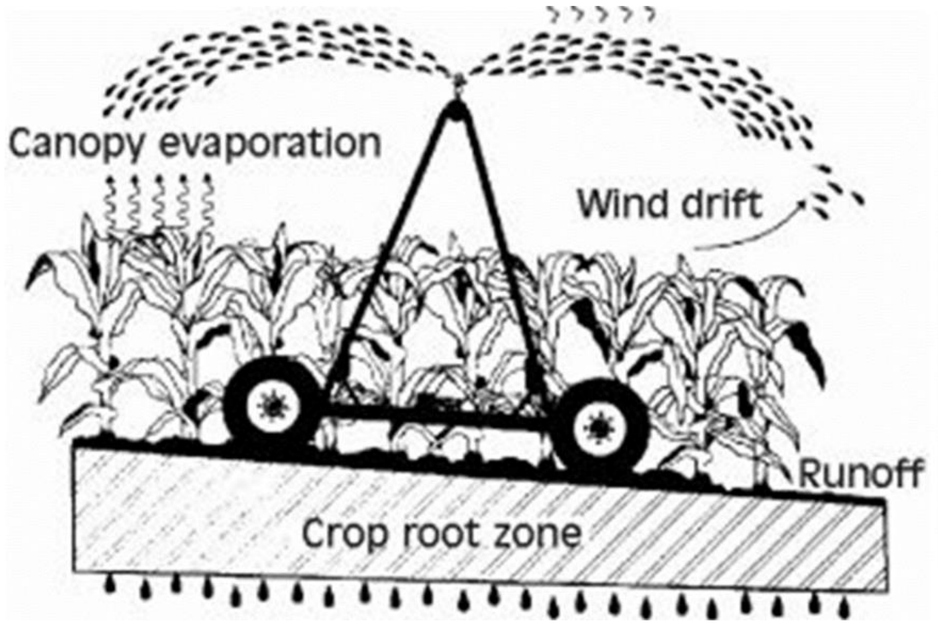
Managed System Capacity

Takes into consideration

1. Peak Crop Water Requirement (mm/day)
2. Application Efficiency (*the proportion of total water applied that the crop can use)*
3. Available operating hours of the system (Pump Utilisation Ratio).



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What is Average Application Rate (AAR)?

- ***"Average Application Rate (AAR)*** *is the rate of water application over the wetted area. It is an average value assuming uniformity within the wetted area*" (Nelson Handy Pocket Guide).

- Pivot average application rates increase with the higher flow demands required at the outer portion of a center pivot.
- AAR should be compared to the soil infiltration rate. If AAR at in the outer spans is **significantly** higher than the soil infiltration rate, runoff will occur.
- Investigate options to reduce this (System Capacity, Pivot Length, Wetted Diameter)

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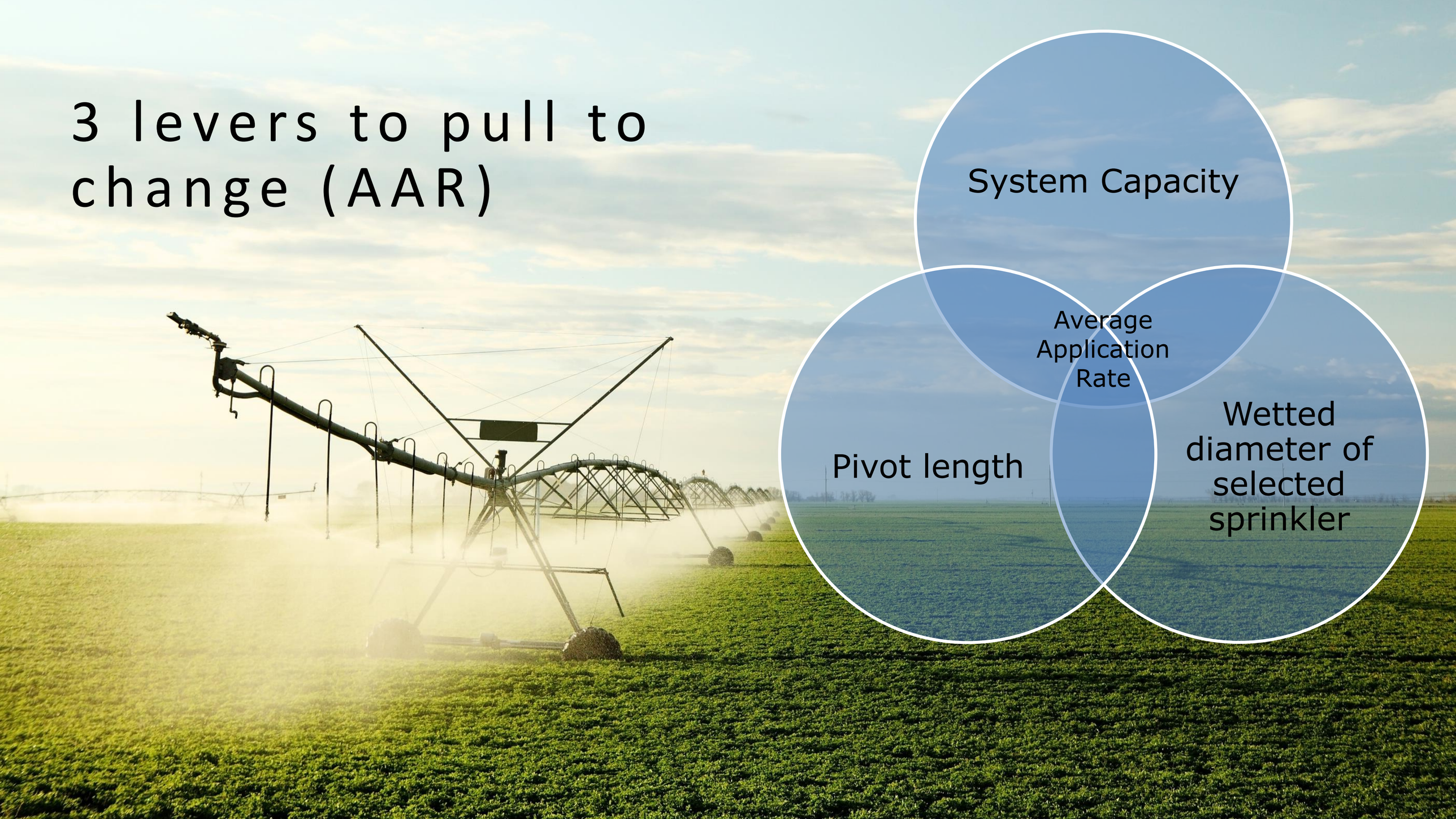
Implications of exceeding Infiltration Rates

- Soil damage
- Run-off
- Erosion
- Loss of fertilisers
- Excessive waterlogging of the root zone in low-lying areas
- Yield Penalties

3 levers to pull to change (AAR)



Average Application Rate (AAR)

Options for increased wetting footprint:

- Select a sprinkler type with a larger throw diameter (wetted radius)
- Considered higher pressure?
- Over truss rod clips
- Boom backs/Spreader bars

- Calculate the average application rate at the end of a 620m pivot.

- System flow is $277m3$/hr
- Pivot area is 120.76ha.

$$\mathrm{I}\,\alpha = \frac{277x620}{120x1.59x20}$$

$$\mathrm{I}\,\alpha = 44.7mm\ per\ hour$$

- Reduce wetted diameter from 20m to 10m.

$$\mathrm{I}\,\alpha = \frac{277x620}{120.76x1.59x10}$$

$$\mathrm{I}\,\alpha = 89.44mm\ per\ hour$$

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Irrigation Design Steps

2. Consider system types available / suitability

   - Labour
   - Energy usage
   - Water use efficiency
   - Land use efficiency

3. General layouts – traveller runs / pivot circles

4. Investigate application technology – sprinklers and pressure

Irrigation Design Steps

5. Development staging
6. Grouping of irrigators based on pump head
7. Pipe routes & sizing (energy efficiency)
5. Pump station design
6. Energy efficiency of the system – pipeline, pump & motor efficiency
7. System controls & monitoring

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Existing Irrigation Systems

- The same principals apply for new or existing systems
  - Measure to manage?
  - Labour and energy costs?
  - Has the machine been audited? (measure pressure and flow rates, catch can test)
  - Check sprinklers
  - Panel calibration
  - Asset or liability?
  - Overhaul or upgrade?

- *“There is no such thing as standing still; you either move forward or regress.”* — Bohdi Sanders

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Reviewing Irrigation Quotations (ask the right questions)

- What is the System capacity
- Sprinkler package Average Application Rates
- Number of sprinklers
- Expected annual operating costs? (Labour and Energy e.g. Pumping Cost $/ML)
- Is the specified machine operating within manufactures slope limits?
- Design Pressure at Pump and Irrigator
- Pipe sizes
- Pump & Motor Efficiency at duty
- Sprinkler type & pressure
- Use of part circles for dry wheel tracks
- Does it all add up?

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Take Home Messages

1. Get the fundamentals right

    - Resource base
    - Financials
    - Source the right skills *(e.g. get the right people on the bus in the key seats).*

2. Get the System Capacity right

3. Don’t get fixated on the equipment

4. Concentrate on ensuring the agronomic outcome is achieved

Good irrigation system design is achieving the right balance between ***economics, agronomics and the environment****.*

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THANK YOU,
ANY QUESTIONS?

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