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Irrigation System Design & Planning

Delivering savings in labour, water & energy

11th June 2025, Longford, Tasmania

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Australian Government
Department of Agriculture, Fisheries and Forestry

Future Drought Fund

TAS FARM INNOVATION HUB

UNIVERSITY of TASMANIA TIA Tasmanian Institute of Agriculture

pinion ADVISORY

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

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Visualisation, Optimisation & Design

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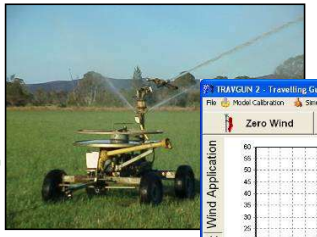
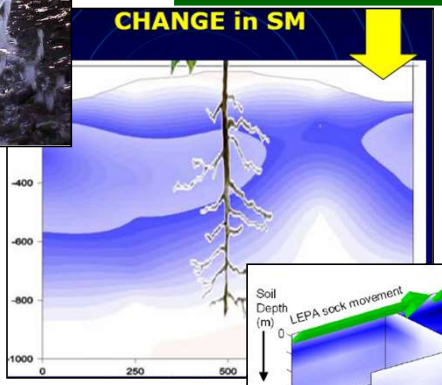
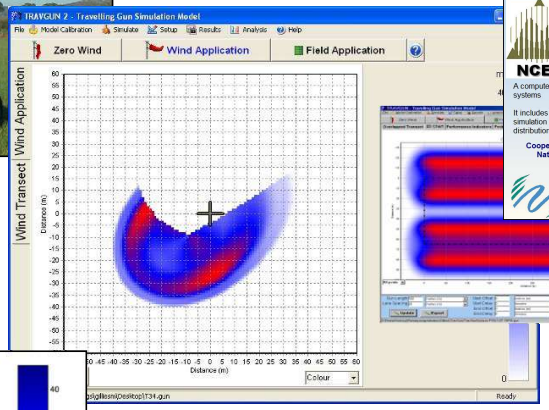
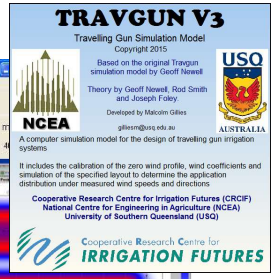
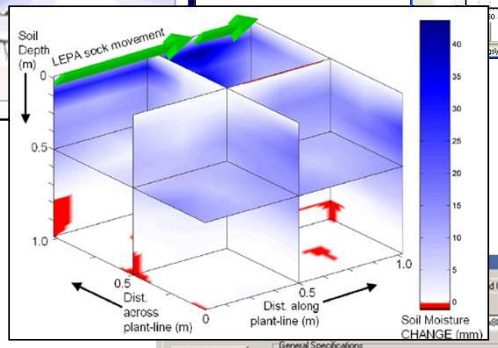
Infiltration



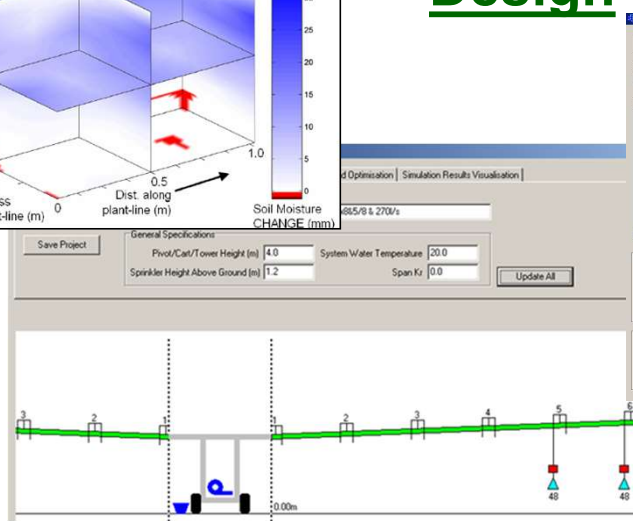


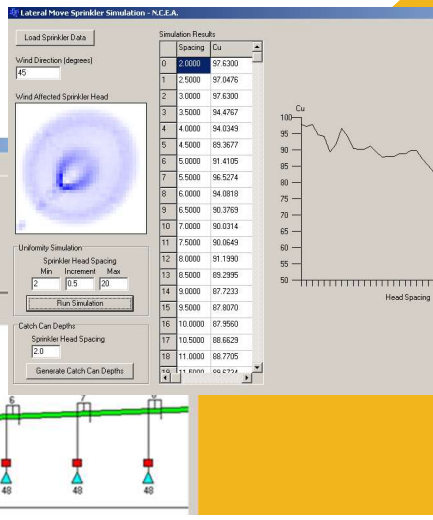


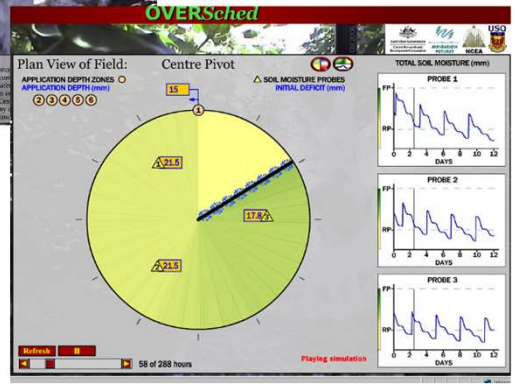




Design



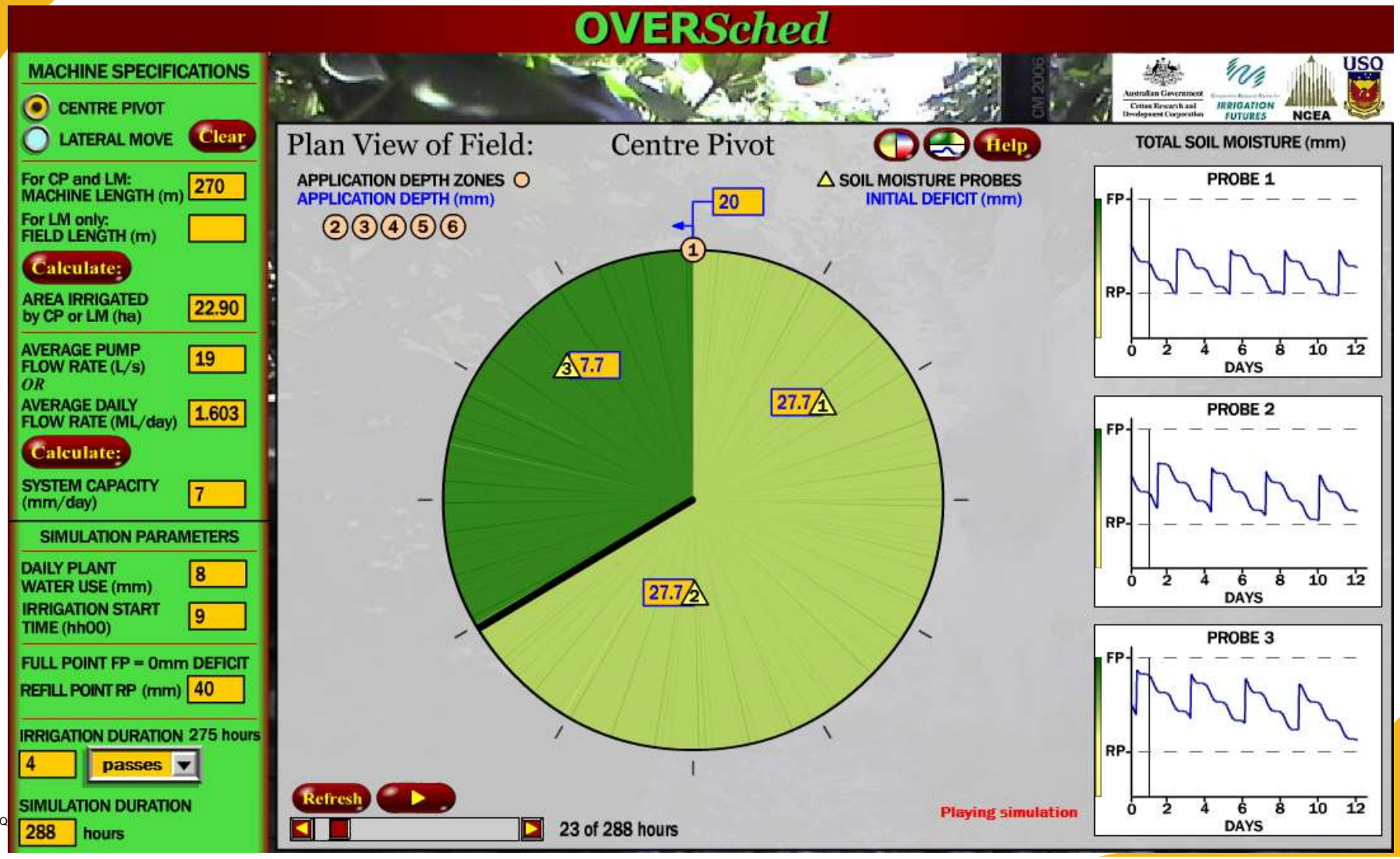




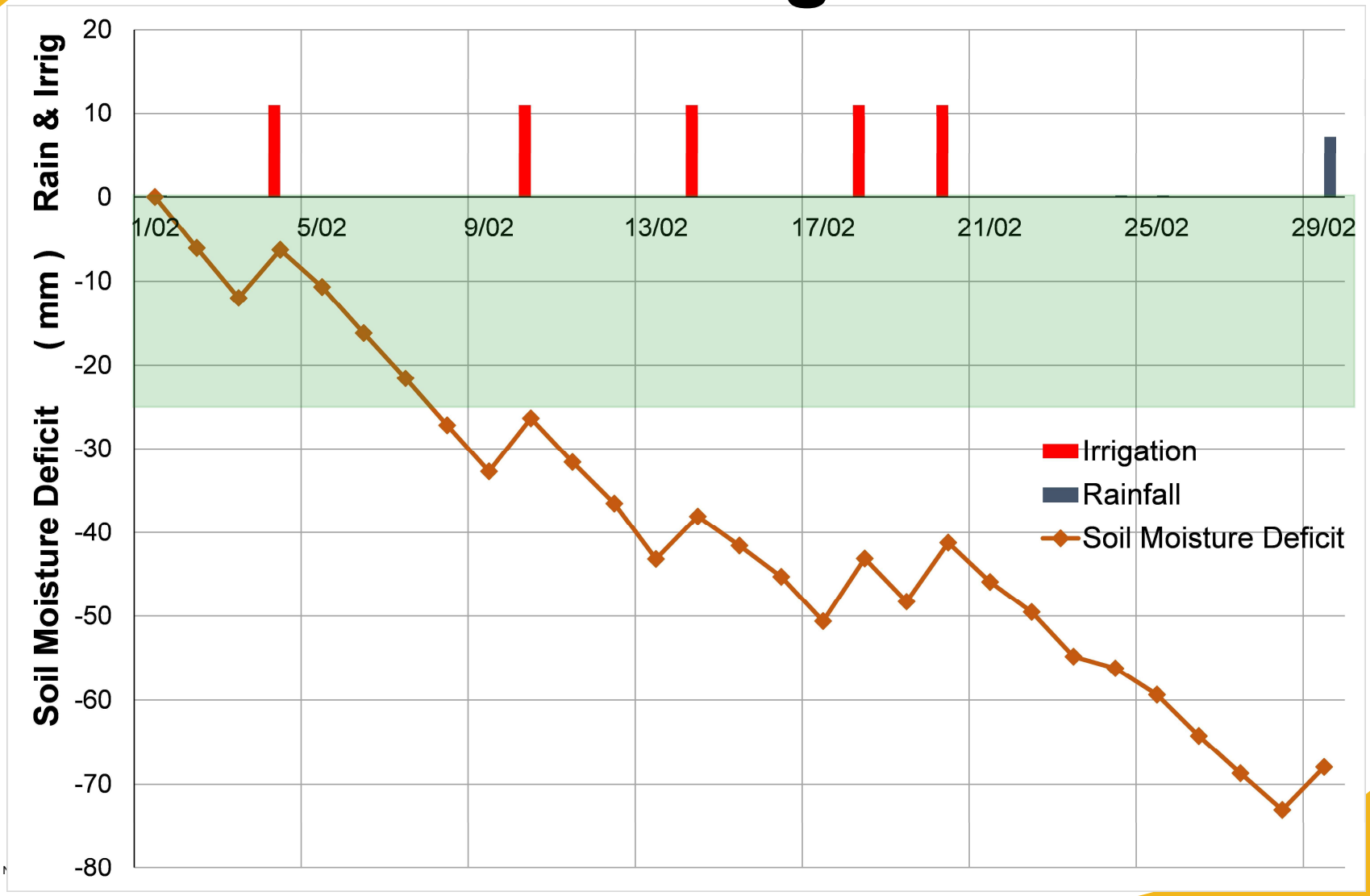
Management

CRICOS QLD00244B NSW 02225M TEQSA:PRF12081

CP management - OVER*Sched*



Precision Broad-acre Irrigation of Pasture??



https://irripasture.com

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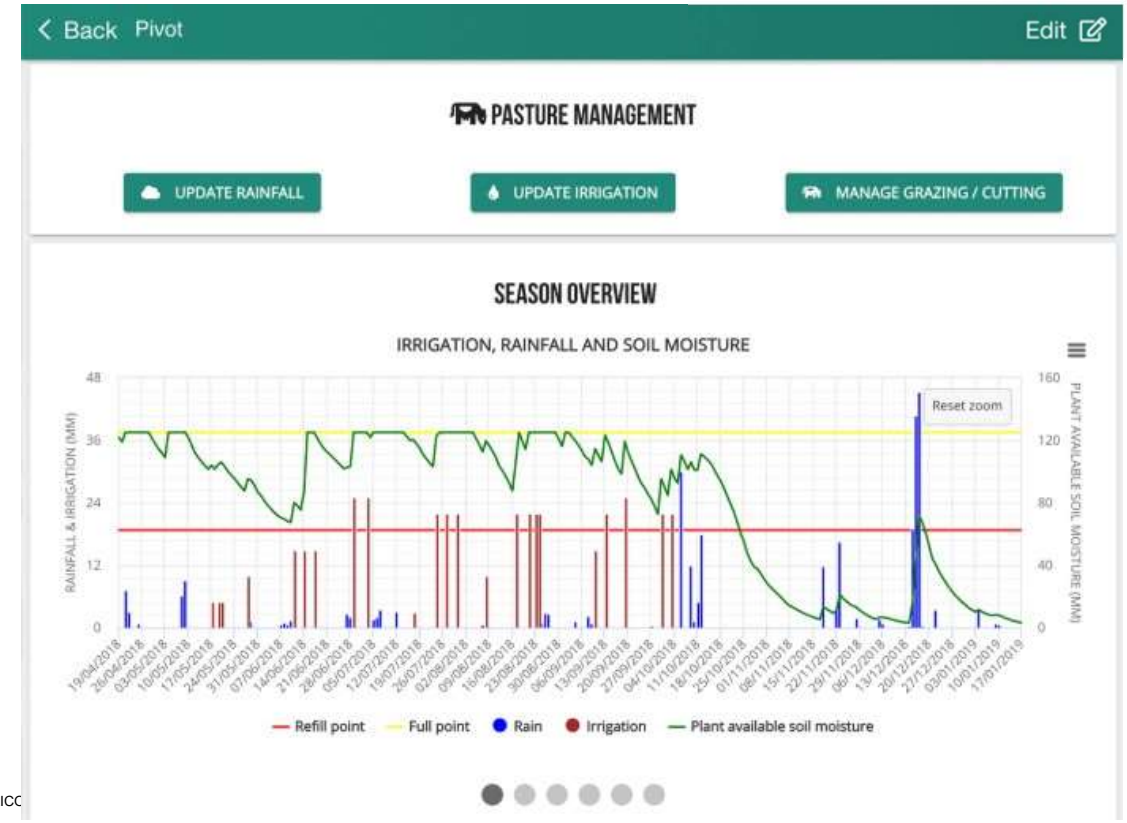
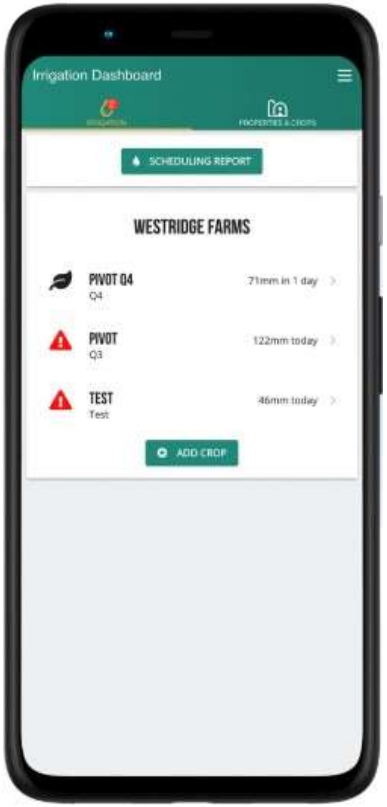




Performance Measures for Sprinkler Systems

- System Capacity (mm/day)
- Uniformity
- Application Efficiency

System Capacity

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

Expressed in mm/day

IT IS NOT the depth applied per pass (mm)

$$\text{System Capacity} = \frac{\text{Daily pump flow rate (L/day)}}{\text{Field irrigated area (m}^2\text{)}}$$

System Capacity

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

Expressed in mm/day

IT IS NOT the depth applied per pass (mm)

$$System\ Capacity = \frac{100 \times\ Pump\ discharge\ (ML\ /day)}{Irrigated\ area\ (\ ha\ )}$$

System Capacity

Managed system capacity is the real maximum rate at which growers operate the machine to apply water to the irrigated field area

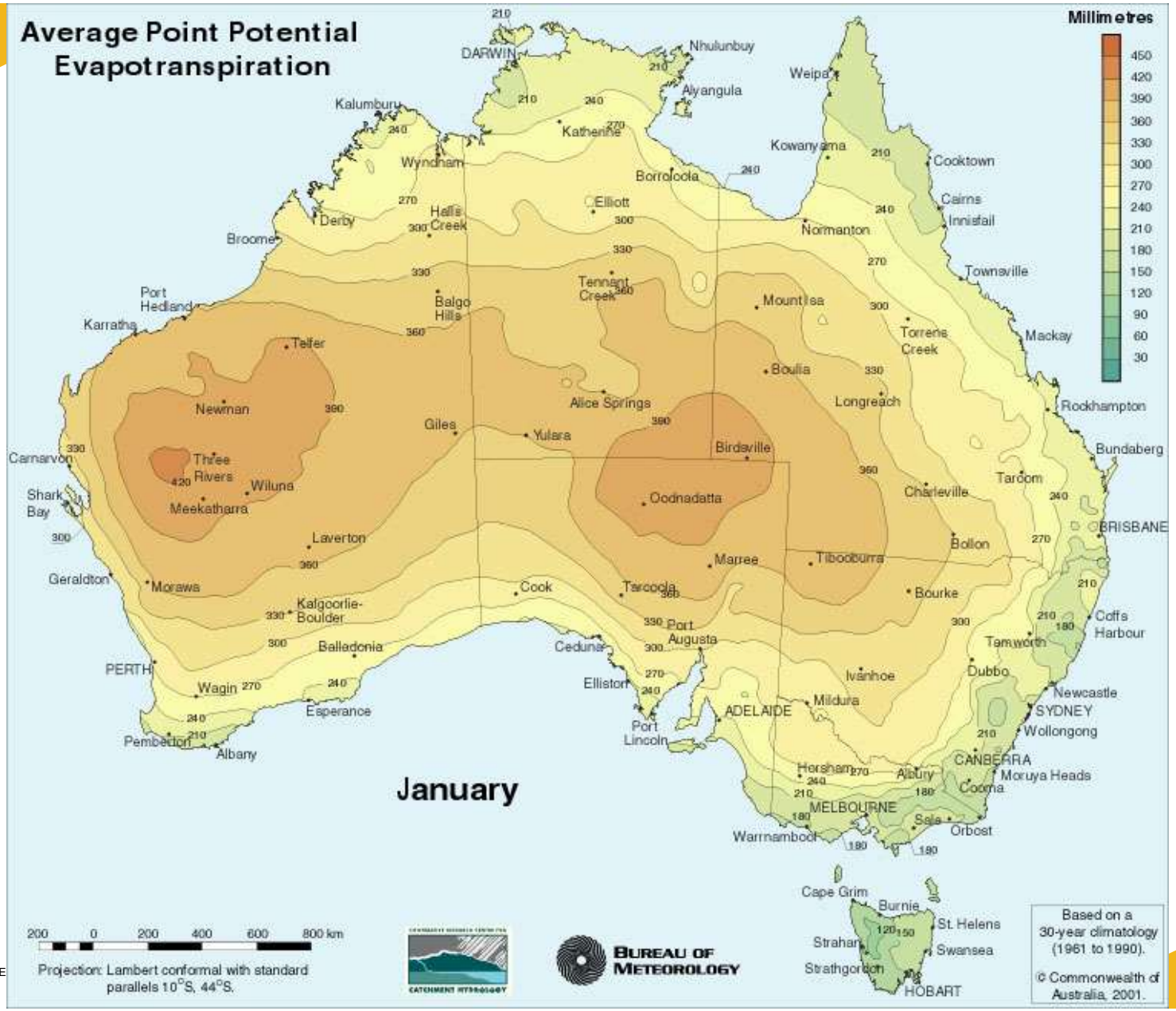
Expressed in millimetres per day

DESIGNERS must ensure system capacity producers use, is adequate

$$System\ Capacity = \frac{Pump\ Discharge\ (L\ /Day)}{Irrigated\ area\ (m^2) \times PUR \times AE}$$

where PUR is Pump Utilisation Ratio (e.g. pump 12 hrs off per wk, PUR = 0.93)

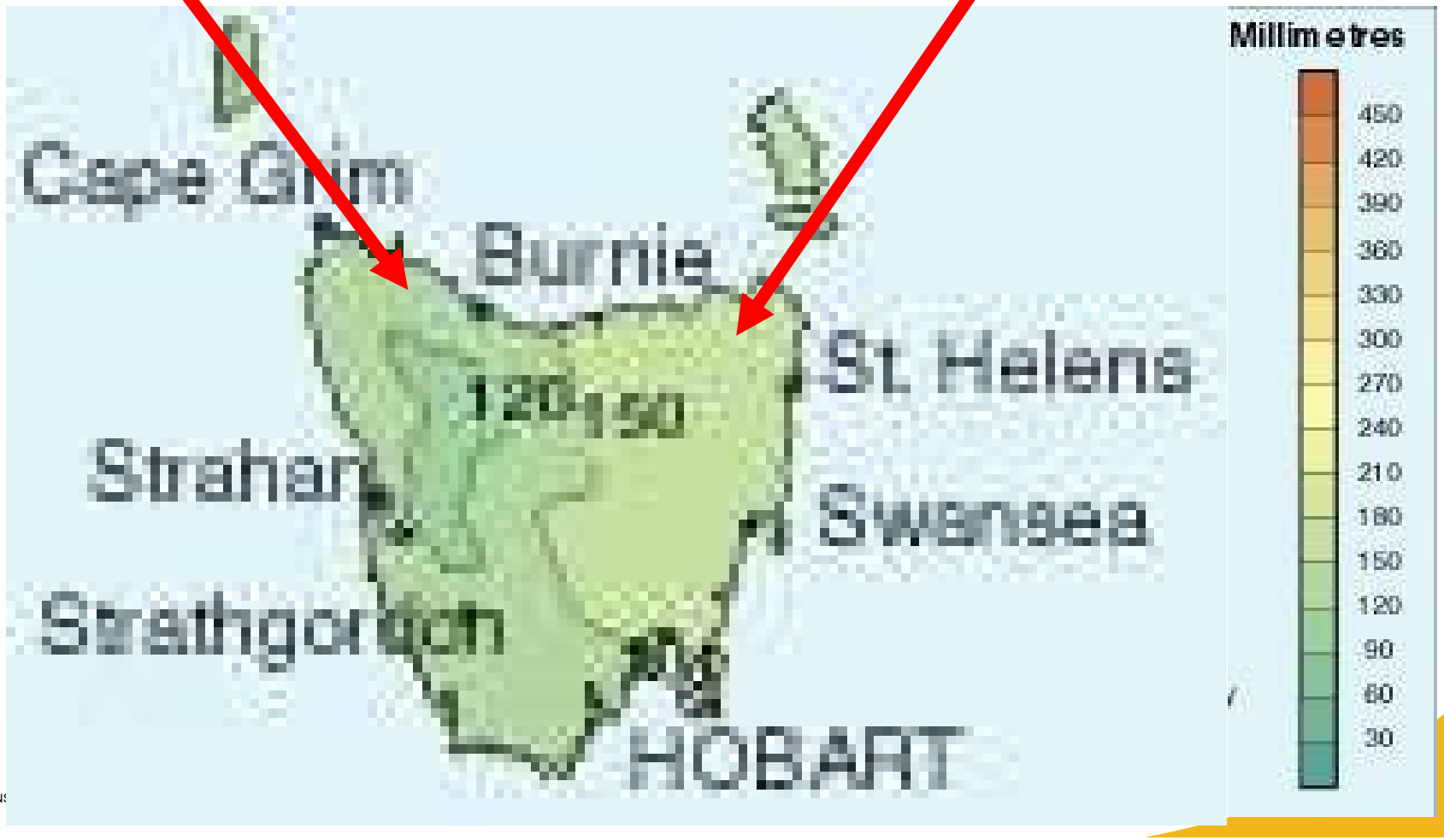
AE, Application Efficiency = 0.95 for well-managed modern pivot sprinklers



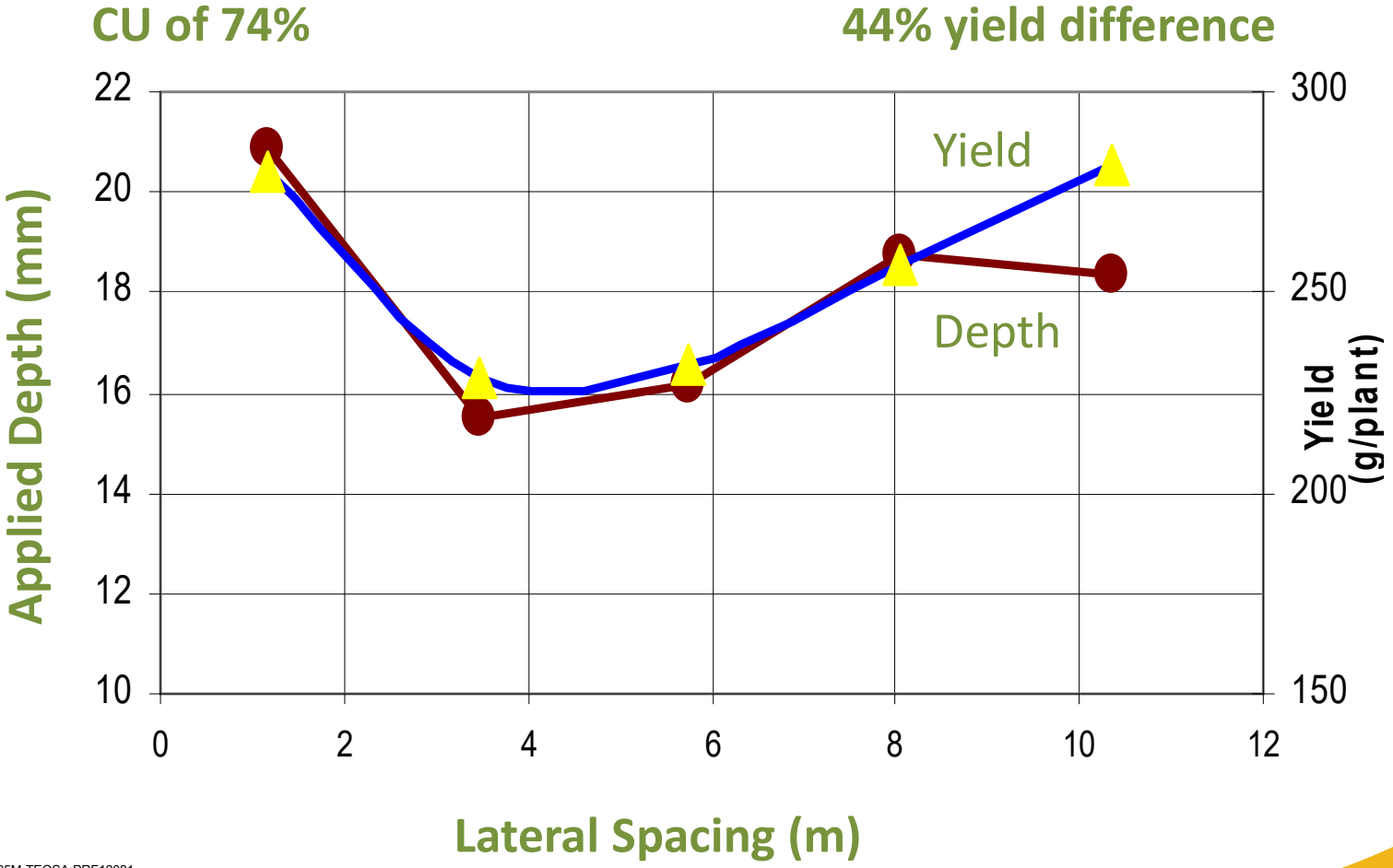
System Capacity Recommendations

6.5 to 7.0 mm/day

7.5 to 8.0 mm/day



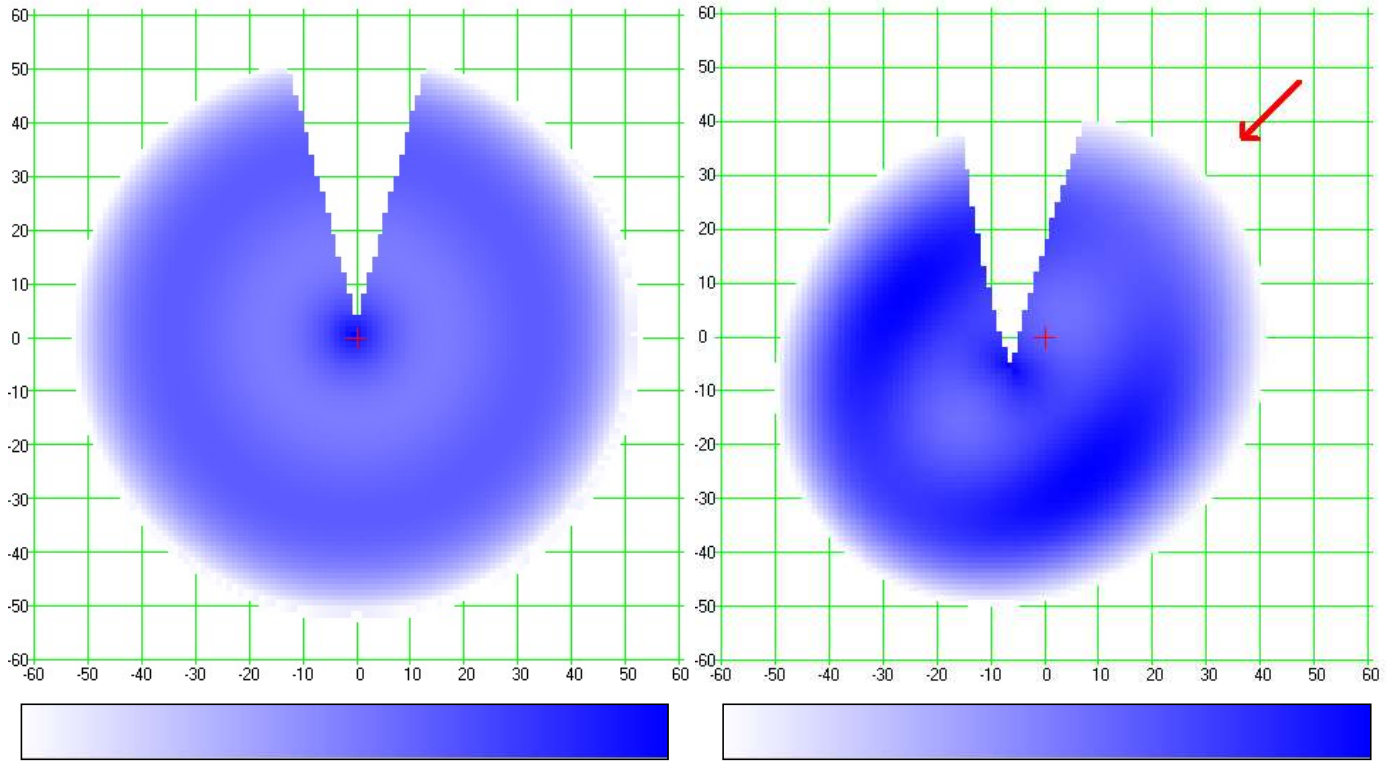
Uniformity and Yield Variation



Spray Pattern Distribution in Wind for Travelling Guns

Sector Angle 330°

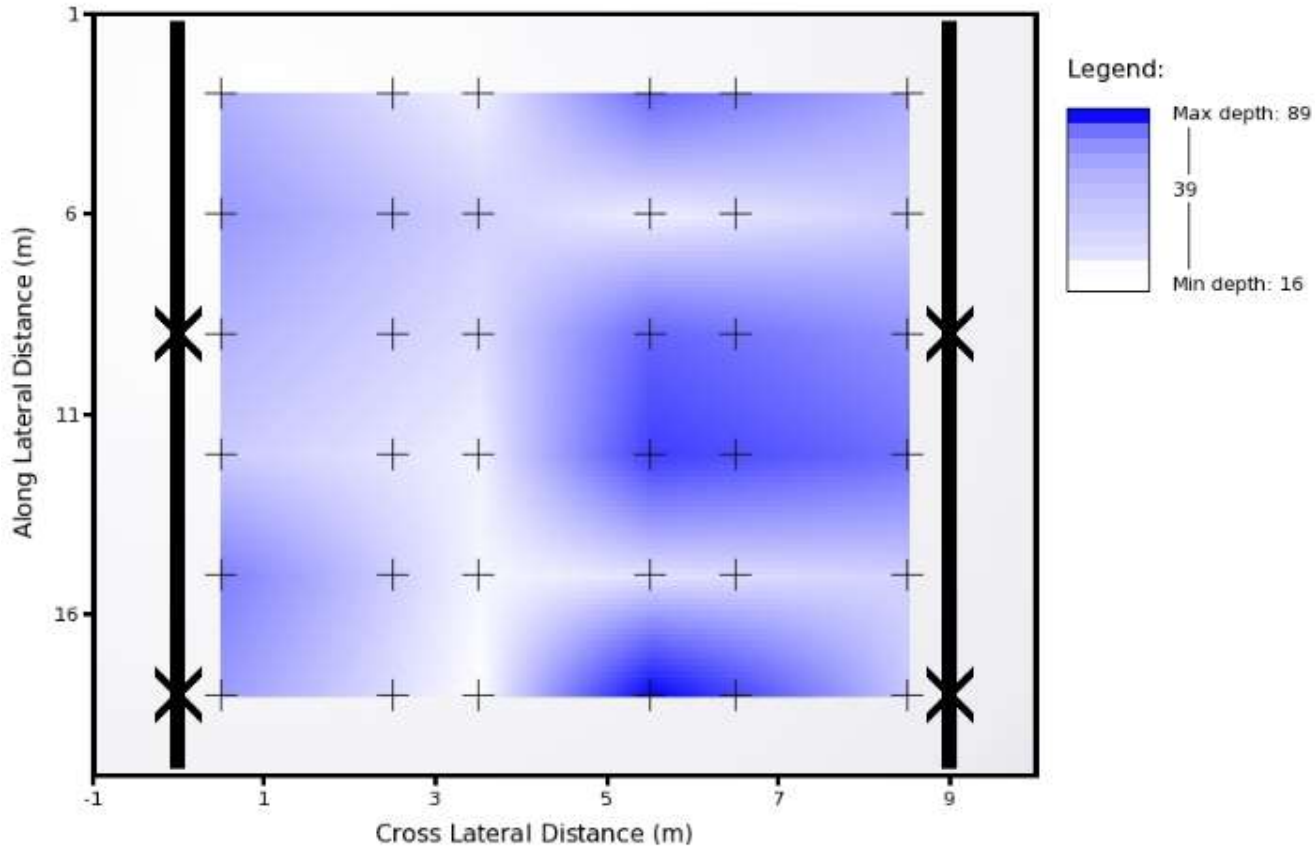
Wind Speed 10 km/h



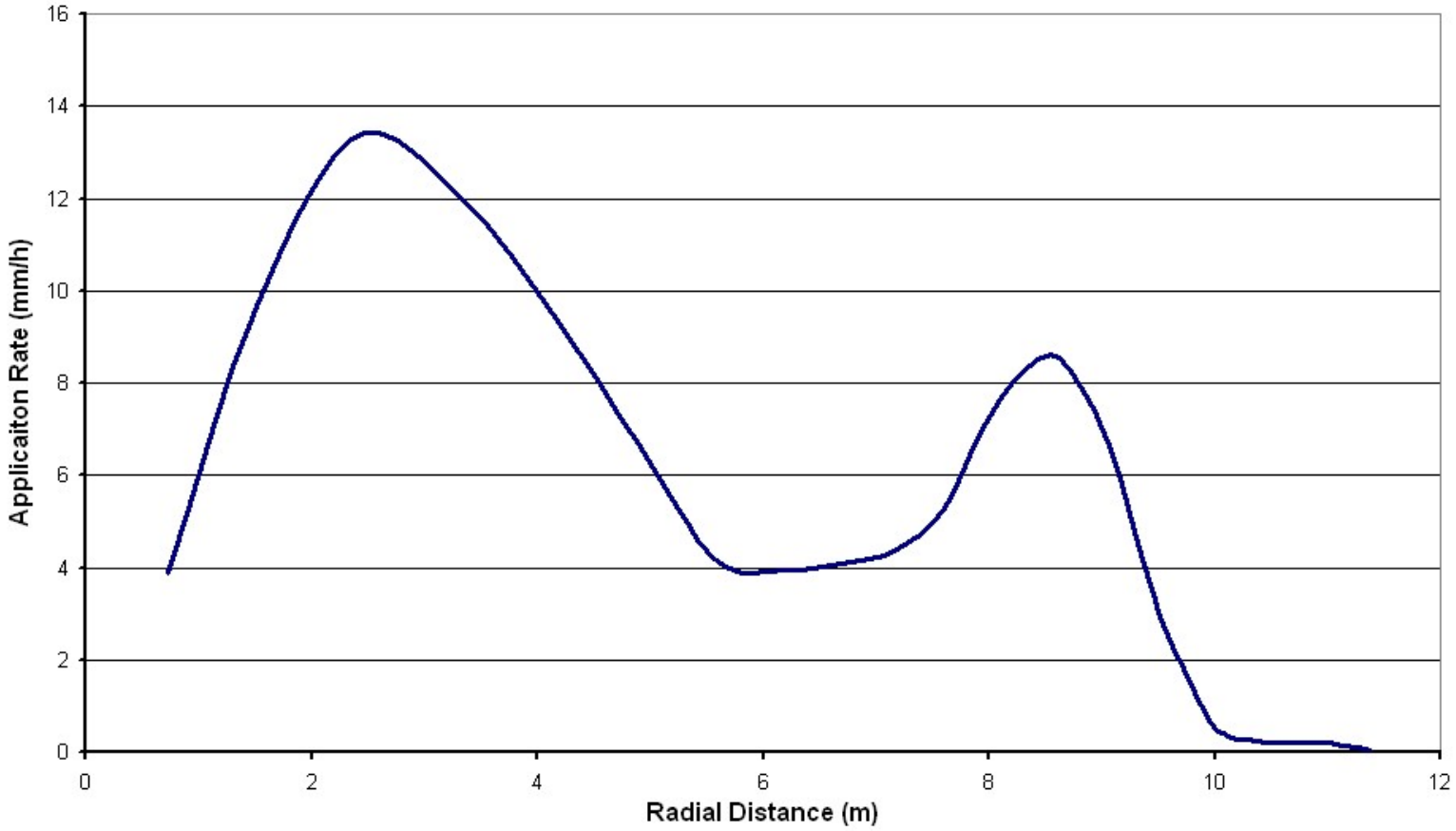
0 mm/h 10.9 mm/h 0 mm/h 12.0 mm/h

IPART

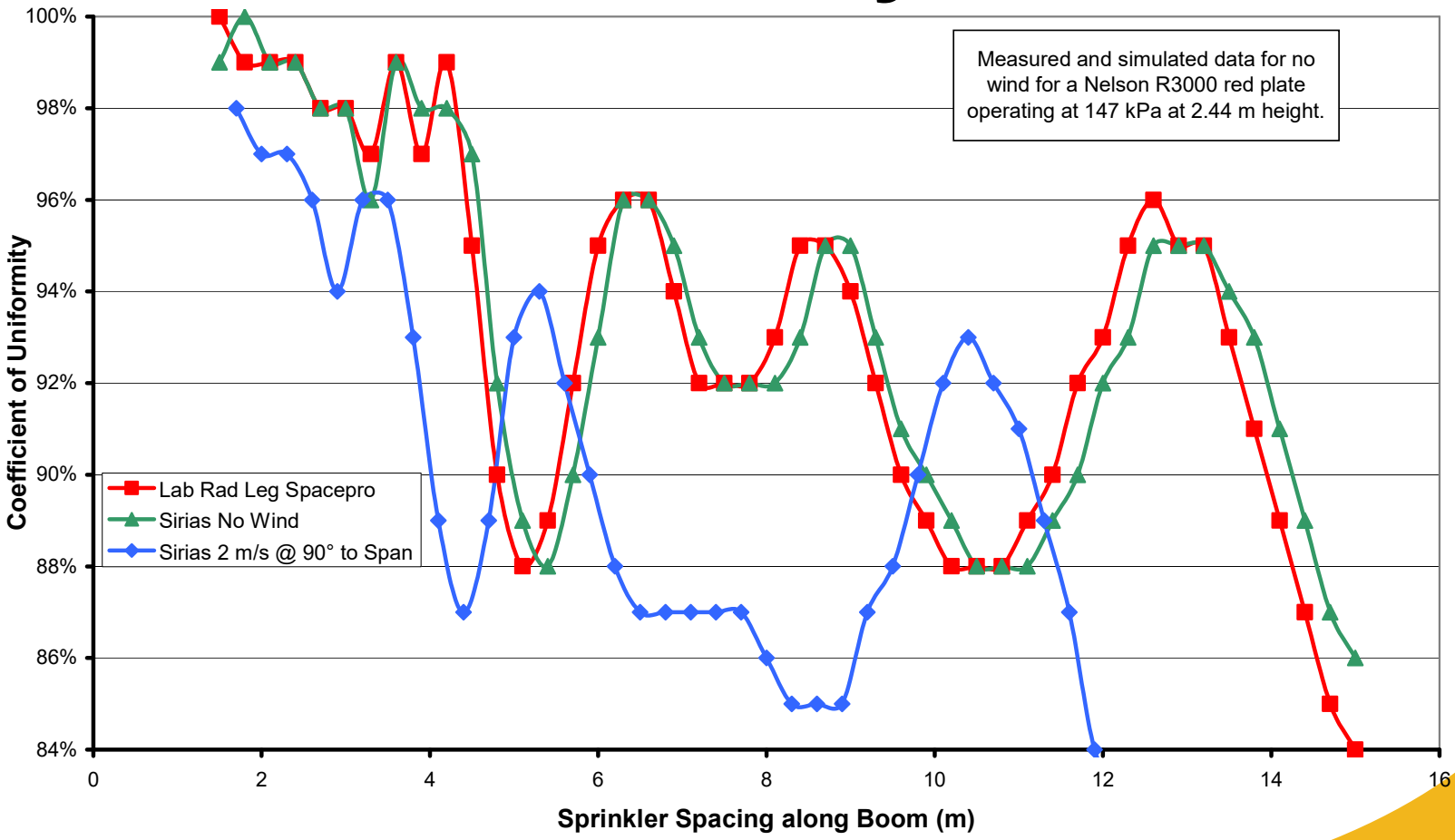
Irrigation Performance Audit and Reporting Tool



Application Rate over Radial Distance for CP&LM sprinkler



Measured & Simulated Uniformity



Sprinkler Irrigation Performance Measure – Application Rate

- Applied depth over the irrigation period - mm/day or week – System Capacity depends upon pump capacity and duty
- Instantaneous Application rate in mm/hr to be compared with Soil Infiltration Rate
- Average Application Rate for irrigation event in mm/hr

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Sprinklers for Centre Pivots

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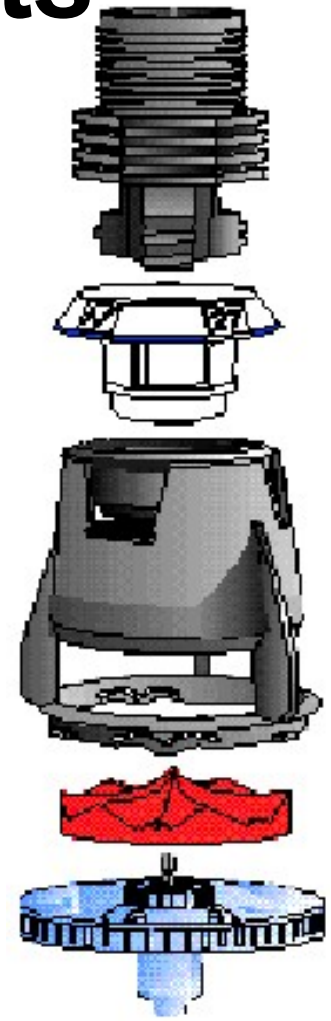

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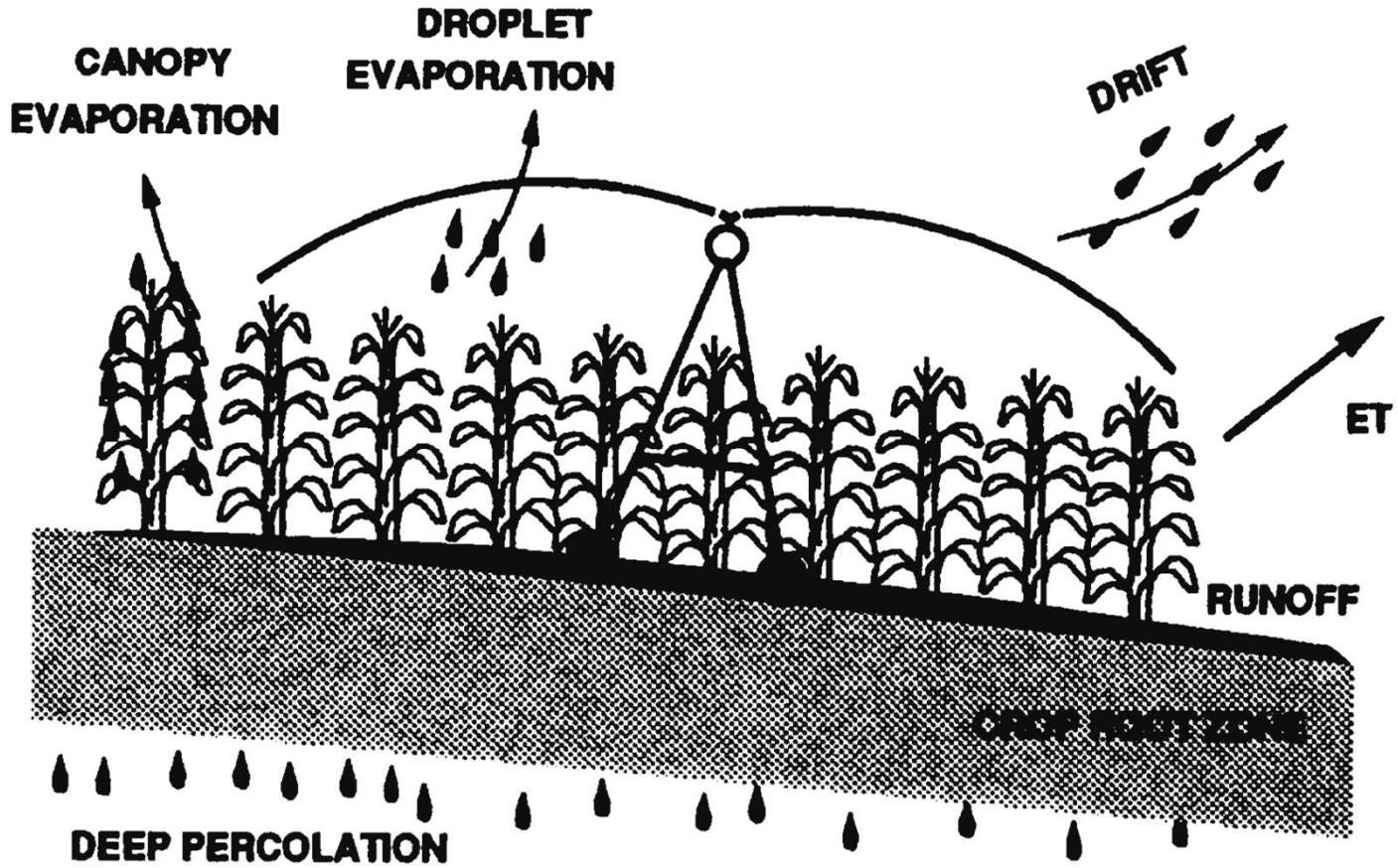

Sprinkler Losses vs LEPA

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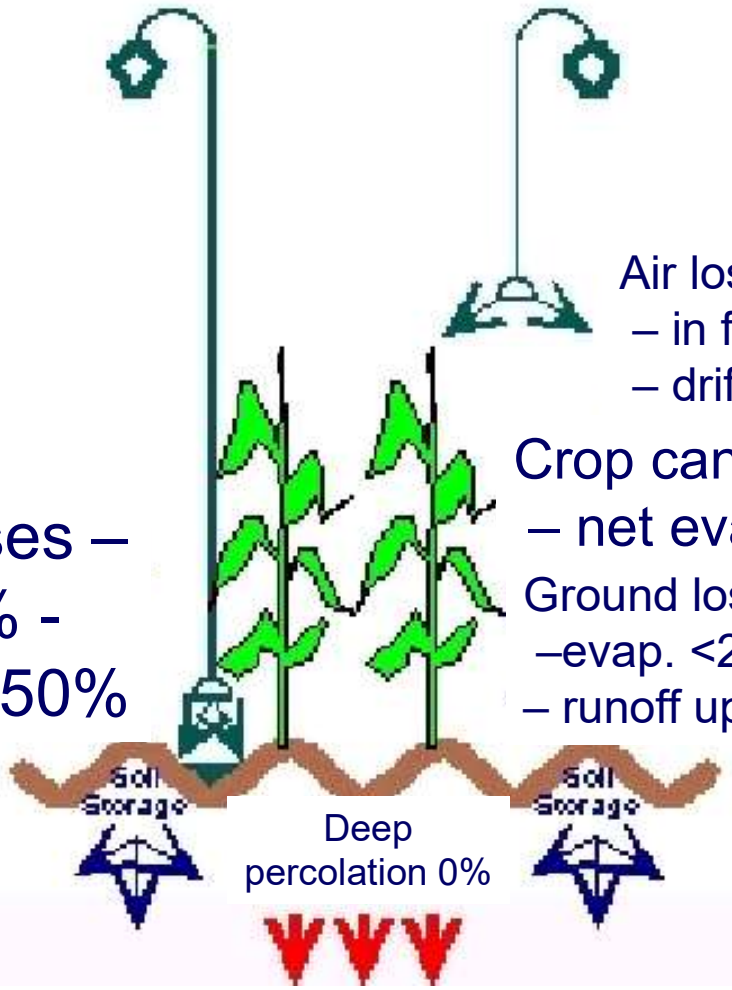

Air losses
– in flight ~<0.2%
– drift up to 1%

Crop canopy losses
– net evap. up to 8%

Ground losses
–evap. <2%
– runoff up to 15%

Ground losses – ponded ~1% - runoff up to 50%

Irrigation Energy Costs

- Moving water is all about using energy (kW.h)
- Every ML of water per ha is a 1000 tonne/ha
- Increasing energy costs force improved conversion of the energy you buy (kW.h)
  - Electricity(kWh) to pump 1 ML =$(2.725 \times TDH) \div (Eff._{Pump} \times Eff._{Drive} \times Eff._{Motor})$
- Moving toward lower pump TDH

  = lower energy costs
- Don’t burn your profit to irrigate better

Energy use of Centre Pivot

- Example : CP of 400 metres length with 450 metre length of 150 NB PVC pipe Class 6 to a pump 2.5 m lower than pad at centre of machine, with vacuum gauge reading of 5 m :
- A 6 mm per day sprinkler package will have a flow of 34.9 L/s and a pump TDH = 37.3 m head
- A 8 mm per day sprinkler package will have a flow of 46.5 L/s and a pump TDH = 47 m head
- Comparison with 42 mm applied for the week, which is 21.1 ML pumped for the week.

Energy use of Centre Pivot

- For same 400 m long machine
- Calc'd with Aurora Business Flat-rate Contract: all week at 27.7c/kW.h, plus daily rate of $1.48/day
- The 6 mm per day sprinkler package will run all week (168 hrs) & have pumping costs of $605/wk, which is $29 per ML pumped
- The 8 mm/day pack runs 33 hrs of peak, and 30hrs shoulder rate, and would have pumping costs of $760/wk, which is $36 per ML pumped

Energy use of Centre Pivot

- For same 400 m long machine
- Calc'd with Aurora Business Time-of-Use: Peak 7am to 10pm weekdays 29.95c/kW.h, shoulder at 21.65 c/kW.h, Off-peak 12.66c/kW.h, +$1.36/day
- The 6 mm per day sprinkler package will run all week (168 hrs) & have pumping costs of $482/wk, which is $22.84 per ML pumped
- The 8 mm/day pack runs 33 hrs of peak, and 30hrs shoulder rate, and would have pumping costs of $533/wk, which is $25.26 per ML pumped

Improving Irrigation Performance

- Measures of irrigation performance – application efficiency and uniformity
- Def'n : Irrigation Uniformity – evenness of irrigation depth across field
- Def'n : Application efficiency – proportion of the water you pump that you are able to put into the root zone for crop water use
- **Measure something – start somehow, anyway**
- Automation systems now can help you monitor and control
- These simple things can deliver large industry wide improvement in irrigation performance

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