SMARTER IRRIGATION FOR PROFIT 2

Mepunga East Dairy Optimisation Site

TECHNICAL REPORT

SITE BACKGROUND

Dairy Optimisation Site Coordinator: Graeme Ward

Owners: Stephen and Allira Smith

Location: 20km south-east of Warrnambool, WestVic Dairy Region, Victoria, Australia

Herd size: 650 Holstein Friesian cows, as well as young and dry stock

Irrigation site and set-up: two centre pivot irrigators, a 4-span (15ha) and a 7-span (45ha), run alternatively from the same dedicated irrigation bore, power supply and water meter; perennial ryegrass

Irrigation season: typically late October–early April

The site is particularly challenging because it has a wide range of soil textures and types across the irrigated area, so the different readily available water (RAW) zones as well as changes in topography have to be considered in the timing and rate of applications.

December–February was chosen as most relevant period to assess performance of the irrigation system with the grazing management strategies being used. The aim was to optimise water productivity.

Site questions

- What are the region-/district-specific metrics for irrigation productivity, efficiency and profitability of centre pivot-irrigated perennial ryegrass dairy pastures in south-west Victoria?
- Is it viable to install variable rate irrigation (VRI) technology to centre pivots in south-west Victoria?
- Can the accuracy and ease of irrigation scheduling be improved by using new or improved soil, water and pasture monitoring, in addition to new irrigation scheduling tools?

Key messages

- Maintaining soil moisture within the RAW zone by optimising soil–water–plant management is a high priority of irrigators in south-west Victoria to increase yield, water use and energy efficiencies.
- Maintaining and engineering of irrigation equipment delivers improved system performance efficiencies.
- VRI technology has potential benefits for centre pivot irrigation:
  - reduced water use
  - reduced electricity consumption
  - improved matching of irrigation applications to varying soil types and topography of the irrigated area (e.g. commence irrigating the dry sandy ridges before the wet flats early in the season and dry-off low lying flats earlier in the autumn)
  - avoiding applications to non-productive areas such as farm tracks and gateways
- Simplicity and ease of use of tools or apps/programs for irrigation scheduling/management is a major determinant of uptake, use and acceptance. The concept of maintaining soil moisture within the RAW zone (between refill and field capacity) zone was quickly grasped by farmers and the Wildeye® reporting platform enabled them to quickly review soil moisture status from a smartphone.

Australian Government
Department of Agriculture, Fisheries and Forestry

Dairy Australia

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Technologies and strategies used

- Four 40-cm EnviroPro® capacitance probes with Wildeye® loggers/telemetry installed, two under each irrigator of the site to reflect soil and topography variability with differing RAW: sandy clay loam of flats (RAW 22mm) to sand of the ridges (RAW 9mm), determined through EM38 soil survey conducted in 2019.
- Three rain-gauges installed: one dryland and one under each pivot.
- The tools most used and valued by Stephen Smith and reference group members were:
  - Soil moisture monitoring using the EnviroPro®/ Wildeye® equipment
  - SWAN Systems Weatherwise daily 7-day forecast evapotranspiration (ETo)/rainfall reports.
- IrriPasture was used during the 2021–22 irrigation season by the site coordinator:
  - **Pros:** beneficial for identifying when irrigation applications were below estimated pasture water use and when soil profile water levels were below refill point.
  - **Cons:** manually entering irrigations and overriding Bureau of Meteorology weather station rainfall that was not accurate for the site. The tool does not allow for more complex soil water dynamics such as the inward and outward cross-water flow variation associated with topography changes.

Strategically located soil moisture monitors in the major soil types enables monitoring of trends to inform the irrigation schedule to maintain RAW. The 7-day rainfall and ETo forecasts provide a guide to likely pasture water use, and hence irrigation requirements, for further precision applications.

- Seasonal conditions influenced the project's results. Season Three was a dry summer period (19% water applied was rainfall) compared to Season Two, which had a wet summer (52% water applied was rainfall), and Season 1 was relatively middle range (37% water applied was rainfall).
- Energy efficiency improved from 4.66 to 4.10 kWh/ ML/m head over the three seasons. Energy used per ML applied reduced, but was not reflected in cost savings: 13.74 kWh/ML were saved in Season Three compared to Season Two, but costs increased by $3.74/ML due to price rises.
- Energy was the most expensive variable cost in dry matter (DM) production, varying between $38 and $58/tDM depending on the demand for irrigation water.

Findings

Table 1 Seasonal metrics results

Production*	Season One	Season Two	Season Three
Growth rate (kgDM/ha/day)	53.33	54.11	53.00
GPWUI (tDM/ML) rainfall and irrigation	1.34	1.00	1.01
Energy per irrigated ML (kWh/ML)	366.12	335.72	321.98
Energy per tonne DM (kWh/tDM)	216.51	214.12	292.66
Energy used per ML irrigation per m head (kWh/ML/m head)	4.66	4.28	4.10
Costs	**Season One**	**Season Two**	**Season Three**
Water costs per tonne DM ($/tDM)	$2.70	$2.91	$4.14
Energy costs per tonne DM ($/tDM)	$41.74	$38.22	$57.86
Energy costs per ML water ($/ML)	$70.59	$59.92	$63.66
Energy costs per ML irrigation per m head ($/ML/m head)	$0.90	$0.76	$0.81
Total cost per tDM ($/tDM)	$44.44	$41.13	$62.01
Total cost per hectare ($/ha)	$142.21	$200.28	$295.78

*January and February data used Season One, December–February data used Seasons Two and Three.

Figure 1 Season One

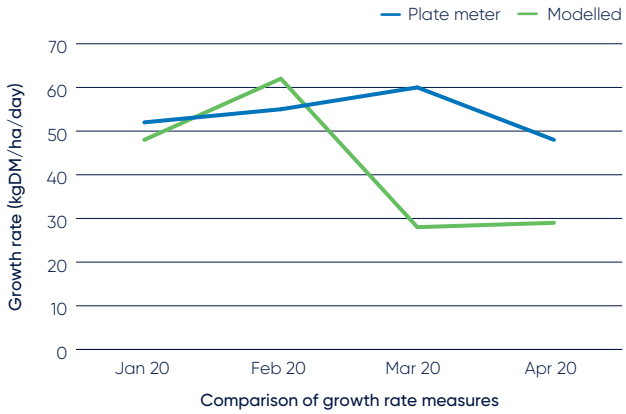
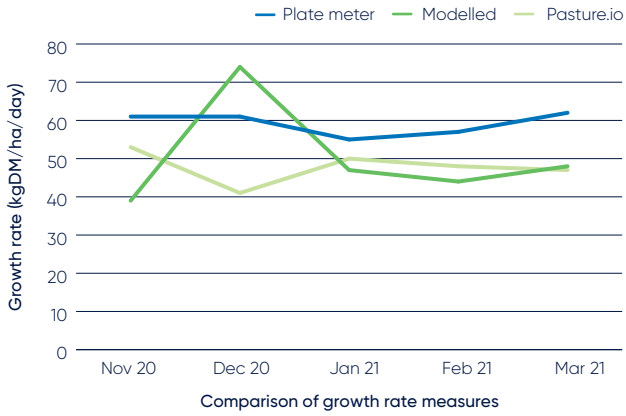


Figure 2 Season Two



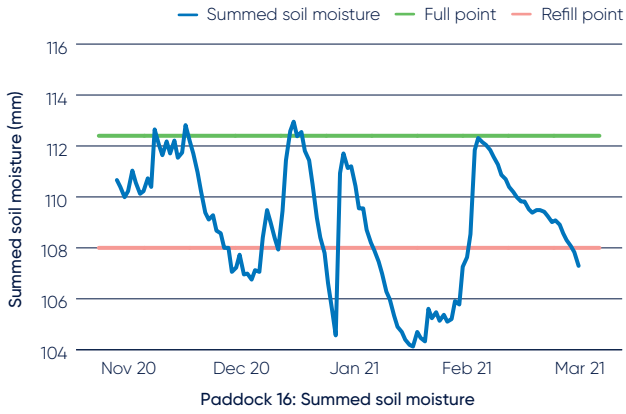
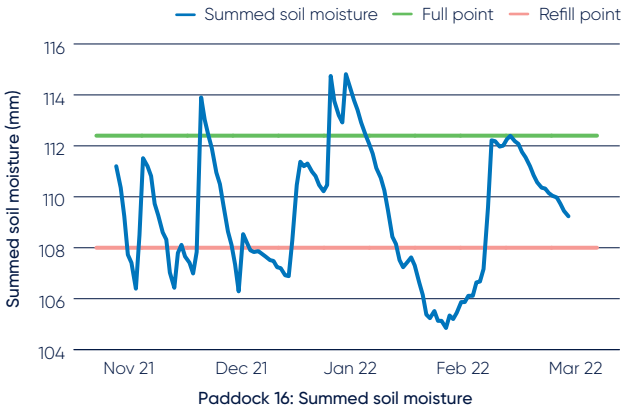


Figure 3 Season Three



- Average pasture DM growth rates across the irrigation seasons were consistent in the range of 50–60 kgDM/ha/day (Table 1). Average growth rates were maintained around 53.5 kg DM/ha/day in both the wet Season Two and very dry Season Three, largely due to improved irrigation practices in November–December and increased system performance that more adequately maintained RAW (summed soil moisture graph, Figure 3).
- Water cost is relatively low at $2.70–$4.20 /t DM. Farms that have purchased or leased water licences privately, subsequent to the initial licences being issued, will be experiencing higher water costs.
- An outcome of the SIP2 project is installation of a VRI system on the 7-span centre pivot irrigator based on analysis* that indicated a 3-year payback.
- Modelled yield showed greater fluctuation than either the actual measured pasture growth rates or Pasture.io (Figs 1, 2). The optimisation site exceeded the annual modelled yield in both Season Two and Season Three. The Pasture.io measurement was lower than the actual measured, by up to 30% in December of Season Two and January of Season Three.

*Water and pumping costs, and value of additional pasture consumed, used SIP2 site results. Estimates of likely water savings and additional pasture consumed were from earlier Tasmanian VRI studies on sites with similar variable topography.

Irrigation system evaluation

Table 2 Comparison of irrigation system evaluation metrics

Evaluation year		System capacity (mm/day)	Co-efficient of uniformity (%)	Distribution uniformity (%)	Application V panel (%)	Pump efficiency (%)	Energy use (kWh/ML/m)	Average application rate (mm/h)	Centre pressure (%)	End pressure (%)
2020	4-span	7	81	69	-38	60	5.2	85	+83	+168
	7-span	7	84	70	-2.5	63	4.9	83	+13	-11
2022	4-span	7	94	86	-22	88	3.4	81	+4	+26
	7-span	7	94	94	+3	65	4.6	87	+11	-40

The first irrigation system evaluation was conducted in late February of 2020 (Season One) and identified poor calibration of the 4-span control panel (under-applying by 38%), variable DU, resulting in a 'fair' rating (DU >90% is excellent), excessive operating pressure (using excessive energy) of the 4-span pivot due to the fact that the pump performance is designed for a larger system and build-up of iron deposits in sprinklers and pipework.

Implementing the recommended changes resulted in improvements in energy efficiency in Seasons Two and Three (Table 1) and more accurate precision rates of irrigation applied (Table 2, 4-span pivot) as well as more uniform irrigation distribution (Table 2, 7-span pivot) assessed in the second evaluation of April 2022 (Season Three).

The current system capacity prevents application of sufficient water to maintain adequate soil moisture levels during prolonged high daily ETo. As such, paddocks and rotations need to be carefully managed at times of peak water use to allow the irrigator to operate at least 16 hours/day. Recommended additional installation of a variable speed drive control pump to match the changing flow rates between the 7-span and 4-span will further address the remaining energy inefficiencies (Table 2, 2022, 7-span).

Reference group support

- The site was supported by an engaged and active reference group of farmers and service providers who investigated ideas and options across the region at 14 meetings (av. 12 attendees), 3 field days (84 attendees) and 2 webinars (63 attendees).
- A total of 56 *Weekly Irrigation Requirement Reports* were prepared and emailed to the reference group members by the coordinator through Seasons Two and Three, designed for group members to browse on their smartphones. The reports included:
  - SWAN Systems Weatherwise 7-day forecasts for ETo/rainfall at the optimisation site
  - ETo and rainfall data for previous 7 days recorded at the Warrnambool Airport Bureau of Meteorology All Weather Station and rainfall at the optimisation site
  - commentary on the information and its relevance for irrigation requirements and management
  - short item on relevant weather- or irrigation-related issue (e.g. seasonal climate outlooks)
  - upcoming events for the group.

Support group members also reported forwarding emails to their own farmer networks on a weekly basis.

- Two quarterly breakfast workshops of Agriculture Victoria's *Nutrient Advisor Discussion Group* were dedicated to the Mepunga East SIP2 site, updating and extending findings to 46 local service providers.
- Communication outputs of 6 WestVic Dairy News articles, 1 radio interview, 1 recorded video and social media posts extended the activities and findings of the site to over 9,000 people.

MORE INFORMATION

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