SMARTER IRRIGATION FOR PROFIT 2

Tongala Dairy Optimisation Site

TECHNICAL REPORT

SITE BACKGROUND

Dairy Optimisation Site Coordinator: Natalie Eckert

Owner: Andy Tyler

Location: Goulburn Murray Irrigation District, Murray Dairy Region, Northern Victoria

Herd size: 900 cows on a milking platform of 450ha

Irrigation site and set-up: Lasered gravity-fed surface-irrigated 14.5ha paddock with Padman Stops. Double-cropped with summer maize (Pioneer 1467) and a winter vetch with a small amount of wheat or canola to improve canopy airflow and minimise fungal disease. An enclosed feed pad allows the farm to operate a predominantly cut and carry system.

Water supply: Automated water delivery with meters installed for every farm (delivery point).

The focus was the summer maize cropping period. In late 2019, seasonal water allocation was low and the temporary price was high. Dairy farmers needed to maximise production from each megalitre (ML) to make a return on investment. The next two seasons, Seasons Two and Three of SIP2, required less irrigation over the maize cropping period.

The maize sowing to harvest periods for each season were:

Season One: 130 days (5 December 2019 – 11 April 2020)

Season Two: 145 days (3 December 2020 – 27 April 2021)

Season Three: 131 days (11 November 2021 – 21 March 2022)

Site questions

- What volume of water is required for maximum yield of maize followed by an annual crop under surface irrigation?
- What are the management strategies to maximise water efficiency and minimise yield loss for maize and a winter cereal crop?
- What are the critical points for maize in a surface-irrigated system? How does the operator ensure applications of water meet these critical points?
- What are the irrigation management tools available and applicable to the Goulburn Murray dairy region?

Key messages

- Soil moisture monitoring technology assists dairy farmers in the Goulburn Murray Irrigation District to schedule the frequency of irrigation events to better match crop development stages.
- Maintaining soil moisture within the readily available water (RAW) zone at each crop development stage is a key determinant of yield at harvest.

Australian Government
Department of Agriculture, Fisheries and Forestry

Dairy Australia

This project was supported by funding from the Australian Government Department of Agriculture, Fisheries and Forestry as part of its Rural R&D for Profit program.

- Technology platforms need to be easily accessible via a smart phone, be uncomplicated and with minimal incidence of 'glitches'. Disengagement by time-poor farmers will limit irrigation technology extension and adoption. Services in support of the purchase, installation, maintenance, interface, understanding and data interpretation are limited in the region.
- Goulburn Murray dairy farmers are operating in a volatile water market (>$600/ML in 2019–20 to <$50/ML in 2021–22), so irrigation efficiency is a topic of importance. When rainfall is more plentiful and water pricing is reasonable, extension in irrigation management may be most effective when embedded in broader and aligned farm management topics such as nutrients (including nitrogen), soils and pasture/cropping selection.

Technologies and strategies used

- Three 80cm EnviroPro® capacitance probes with Wildeye® loggers/telemetry were installed in June 2020 in one bay of the paddock (1: Top, 2: Middle and 3: Bottom).
- A rain-gauge was installed.
- The tools most used and valued by Andy Tyler were:
  - Soil moisture monitoring using the EnviroPro®/Wildeye® equipment
  - *AgVic Weekly Irrigation Requirement Reports:* Seven-day historic and forecasted evapotranspiration (ETo) and rainfall data, with irrigation scheduling advice based on a basic water balance for surface and spray irrigation.
- IrriPasture was trialled in Season Three when maize was included as a crop type for the tool, with the site coordinator supporting Andy Tyler in irrigation inputs, use and interpretation:
  - **Pros:** Simple to use under most conditions and beneficial for identifying when irrigation applications were below estimated maize water use, using the ETc graph.
  - **Cons:** Unable to account for periods of saturation post irrigation (generally two days) and after significant rainfall. The tool commences draw-down on the next calendar day but often the soil is saturated for longer than this. The application amount can be unrealistic in a less-controlled system such as surface irrigation. For example, applications of <50mm of water may be recommended but are not realistic because the water would be required to run more quickly, resulting in reduced infiltration to depth and more frequent applications.
- Limited ability to vary the water applied with surface irrigation and typical applications are approximately 50mm, but it is possible to change the interval (frequency) between irrigations. By Season Three, soil moisture monitoring data were being used for irrigation scheduling, particularly before forecast heat or rain events.
- Bringing an irrigation event forward (prior to forecasted higher ETo events) or delaying (prior to forecasted rainfall events) can greatly affect yield outcomes.

Findings

Analysis of the yield and water data collected over the three seasons is detailed in Table 1. Figures 2 and 3 show the soil moisture status at the Middle soil probe for Seasons Two and Three respectively.

Table 1 Seasonal metrics results

Production	Season One	Season Two	Season Three
Modelled yield* (tDM/ha)	28.90	28.90	30.10
Growing days	130	145	131
Yield (tDM/ha)	21.20	22.17	21.00
Total irrigation applied (ML)	110.6	116.7	127.5
GPWUI (tDM/ML) rainfall and Irrigation	2.22	2.40	2.08
Costs	**Season One**	**Season Two**	**Season Three**
Water costs per tonne DM ($/tDM)	$138.52	$58.81	$46.06
Total cost per hectare ($/ha)	$2,936.62	$1,303.82	$967.25

*Modelled silage yield determined using the Agricultural Production Systems sIMulator (APSIM v7.10) under different irrigation strategies for a range of sowing dates in Tongala using 41 years (1981–2021) of climate data. (Dr James Hill, Dr Matthew Tom Harrison, Dr Ke Liu, Tasmanian Institute of Agriculture.)

Figure 1 Season Two Middle probe summed soil moisture

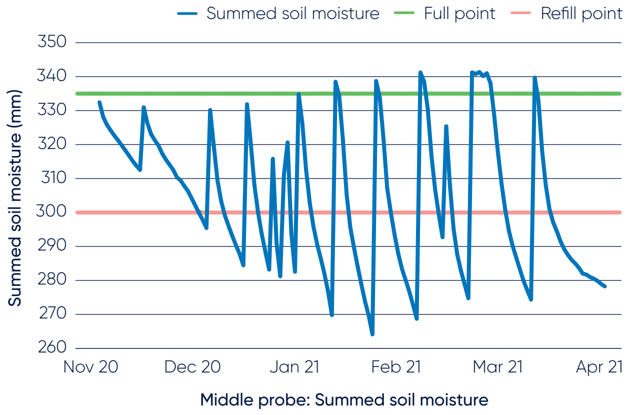
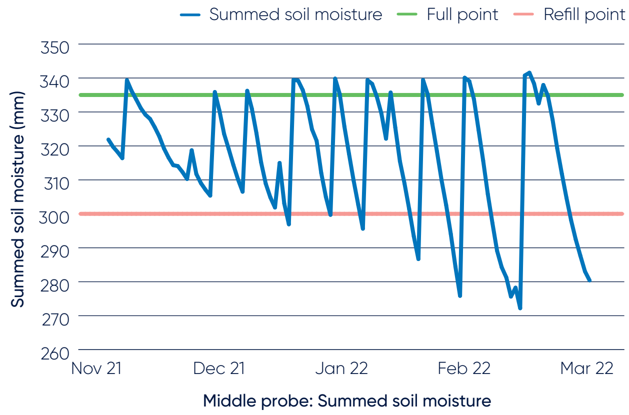


Figure 2 Season Three Middle probe summed soil moisture



- Season Two had the highest crop yield and the best performing GPWUI of 2.4 tDM/ML. However, the growing period was two weeks longer. Although Seasons One and Three had almost identical growing days and yield, Season One was more water efficient, with a GPWUI of 2.22 versus 2.08 tDM/ML.
- Season One had the most expensive crop. The cost of water ranged from $350/ML in Season One to $75/ML in Season Three.
- Season Two had more plant stress, but in Season Three moisture levels were well controlled within the RAW zone, with adequate depth of application for the developing roots until ETo rates peaked in early to mid-February (Figs. 2 and 3).
  - Stress in February 2021 contributed to the effects on yield because it coincided with pollination. Irrigating a few days earlier would have minimised plant stress and contributed to improved yield.
  - Stress into March is less concerning because the crop needs to dry-down for harvest but enough moisture has to be maintained for green leaf retention. The final irrigation is affected by extraneous variables such as availability of contract harvesters and unexpected rain events.
- The commencement and end points shown in Figures 1 and 2 demonstrate the challenges faced by double-cropping irrigators.
  - Retaining soil moisture for the immediate crop to retain green leaf and maximise kernel fill.
  - Allowing for adequate draw-down of moisture for harvesters to access the paddocks.
  - Maintaining as much soil moisture as possible for the following crop, particularly in years of water scarcity and high prices.
- The critical points for maize in an irrigated system are determined by the developmental stages that affect yield. Using Figure 2 as the reference:
  - **Sowing (mid-November to late December):** Emergence is the critical growing stage, with irrigation needed to ensure all seeds emerge on the same day. Crops that are sown into ideal moisture are likely to experience warmer soil temperatures and hence emerge between one and ten days after sowing (O'Keefe, NSW DPI, 2009).
  - **Early vegetative growth (mid-December to mid-January):** Avoiding underwatering or overwatering during low, but increasing, crop water use. Soil moisture is maintained within the RAW zone, providing optimal growing conditions. Changing the irrigation frequency avoids waterlogging.
  - **Tasselling/silking (mid-January to late March):** Maintaining soil moisture within the RAW zone and at depth to develop rooting (up to 1m). Successful pollination ensures maize ears develop, often occurring near the end of January and coinciding with higher ETo rates. Irrigation is more frequent, with waterlogging occurring for up to two days afterwards, followed by strong drawdown of moisture. Towards the end of silking (early February) if soil moisture slips into stress, it can potentially negatively affect yield.
  - **Preharvest (late March to harvest):** Maintaining soil moisture to kernel-fill while considering harvesting conditions. Overwatering will lead to an excessively wet crop and delayed harvest because of access issue, resulting in poor-quality silage. Underwatering will cause early dry-down and subsequent poor kernel-fill. Irrigation could have been brought forward to meet the crop's requirements while also allowing adequate crop dry-down. The graph shows that the crop was still using significant moisture up until harvest. Although there were many factors influencing the decision to force the crop into stress, it is likely green leaf was lost and the rate of kernel-fill in the latter half of February and into March was slowed, which would negatively affect quality and yield respectively.

Reference group support

- There was no reference group support in Season One. Two Soil Moisture Monitoring Technology Coaching Groups were established in Seasons Two and Three. Members of these groups trialled soil moisture probes and telemetry over the two seasons. The extension activities of the optimisation site were specifically targeted at improving the knowledge and understanding of irrigation technologies and key principles (such as the concept of RAW) of the 30 farmers involved.
- The coaching group events included two initial workshops to support farmers in the installation and use of technology, two field days (one at the optimisation site and one at a neighbouring farm with a centre pivot) and two webinars on using soil moisture monitoring to make informed irrigation decisions. A presentation was also made to the Young Dairy Network. A total of 140 attendees participated in these events comprising two-thirds farmers and one-third local service providers.
- Group members indicated they were likely to invest in soil moisture monitoring equipment and believed trialling the technology prior to purchase was worthwhile.

A post-project survey of members revealed the following:

- **Reasons growers are not using soil probes include:**
  - Cost
  - IT literacy
  - Brands (what to purchase and where to get good advice)
  - Unaware of the benefit
  - Assumption that irrigation scheduling was correct
  - Understanding their use with new crop types
  - Confidence in interpreting the data.
- **Perceived benefits include:**
  - Confidence in correct irrigation timing
  - Reduced travel time (to out blocks that may/may not need watering)
  - Confirmation that current management practices were suitable
  - Reduction in overwatering
  - Increased accuracy with forecast rain events (that may/may not eventuate).
- **Perceived challenges include:**
  - Level of IT literacy
  - Understanding the probe interface
  - Incorrect installation
  - Lack of local ongoing support in technology use and interpretation.

90% of interviewed participants believed that involvement in the groups had improved their knowledge of soil moisture monitoring, which highlights the importance of providing new technology in a supported environment to improve adoption rates.

Reference

O'Keefe, Kieran (2009), *Maize Growth & Development,* NSW Department of Primary Industries

MORE INFORMATION

Cath Lescun, Dairy Australia
National Soils and Irrigation Lead
E: Cath.Lescun@dairyaustralia.com.au

dairyaustralia.com.au/smarterirrigationforprofit

smarterirrigation.com.au

Dairy Australia Limited ABN 60 105 227 987
E enquiries@dairyaustralia.com.au
T +61 3 9694 3777
F +61 3 9694 3701
dairyaustralia.com.au

3513.9 | Dec 2022