SMARTER IRRIGATION FOR PROFIT 2

Coraki Dairy Optimisation Site

TECHNICAL REPORT

SITE BACKGROUND

Dairy Optimisation Site Coordinator: Ross Warren

Owners: Brian and Lizzy Chappell

Location: Ruthven in the Northern Rivers region of NSW

Climate: Subtropical

Herd size: Jersey herd of 400–470 cows, all-year-round milking

Irrigation site and set-up: Paddock 19 (1.42ha) and Paddock 20 (1.41ha) irrigated by a three-year-old solid-set irrigation system with a 21.5 x 25m grid layout and NaanDanJain sprinklers

Water supply: Pump from Richmond River, fitted with a flow-meter at the beginning of the mainline

Irrigation season: July–December, annual ryegrass

Record flooding affected the site in early 2022, with all irrigation infrastructure lost

Site questions

- Will scheduling irrigation in response to soil moisture and water balance information improve water and energy efficiencies compared to the region's standard application rates?
- Will scheduling irrigation in response to soil moisture and water balance information enable annual ryegrass to reach its yield potential?
- Compared to a travelling irrigator, does a solid-set system deliver improved production and input efficiencies? If so, what is the potential payback period for transitioning to a solid-set system?

- Will the practices and outcomes reported from the optimisation site be regularly observed and, in turn, prompt changes in management practices by Northern Rivers' irrigators, particularly the strategy of maintaining soil moisture in the readily available water (RAW) zone?

Key messages

- Regular assessment of the SWAN Systems Weatherwise seven-day forecasts, soil moisture monitoring and growth rate measurements enabled improved irrigation efficiency and pasture production across the 55ha irrigated platform. The farm's usual practice of very small applications (approx. 2.5mm) often did not meet daily evapotranspiration (ETo) losses or penetrate to rooting depth, so applications were increased to up to 11.5mm in the latter part of the seasons.
- Improved understanding of the interaction between the pasture rooting depth, soil characteristics, moisture losses and irrigation management is critical in responding appropriately to site data throughout the season.

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.

- Use of irrigation scheduling technologies improved gross production water use efficiency by 43%, reduced energy use by 13.7% and improved pasture production.
- The SIP2 project has identified the importance of a fit-for-purpose irrigation system and the appropriate technology to assist with management of the system. The project has highlighted the many issues that influence the performance of an irrigation system, pasture yield and overall farm efficiency.

Technologies and strategies used

- Three 40cm EnviroPro® capacitance probes with Wildeye® loggers/telemetry were installed in soils with small variations in characteristics (1: North, 2: Middle, 3: South) along the shared fence line of paddocks 19 and 20.
- One 80cm EnviroPro® capacitance probe with Wildeye® loggers/telemetry was installed under the travelling irrigator on a satellite site of annual ryegrass on the property of Lee and Jo Behrens in Season Two.
- A rain-gauge installed at the Middle probe.
- The tools most used and valued by Brian Chappell were:
  - Soil moisture monitoring using the EnviroPro®/ Wildeye® equipment
  - SWAN Systems Weatherwise forecasts.
- Using the data and with support from the coordinator to make amended irrigation decisions, applications were increased in both seasons from 2.85mm for seedlings to up to 11.5mm when rooting depth was 30cm. The increased soil moisture at depth was reflected in the Wildeye® graphs obtained later in the season.
- IrriPasture was used across the two seasons, primarily by the site coordinator:
  - **Pros:** simple to use under most conditions and good records of rainfall, ETo and irrigation between seasons. A good alternative to soil moisture monitors, but with some cautions.
  - **Cons:** input data are required and less confidence in data compared to soil moisture monitoring data.

Findings

Table 1 shows the pasture production, water and energy metrics for Season One and Two at Coraki. Figures 1 and 2 (top) show the measured pasture growth, the modelled pasture growth and the growth rate as measured by Pasture.io. Figures 1 and 2 (bottom) show the soil moisture profile in relation to the field capacity and refill points for the same time period as the pasture measurements.

Table 1 Seasonal metrics results

Production	Season One	Season Two
Growth rate (kgDM/ha/day)	95.00	110.88
GPWUI (tDM/ML) rainfall and irrigation	2.31	3.30
Energy per irrigated ML (kWh/ML)	322.67	283.75
Energy per tonne DM (kWh/tDM)	73.11	51.37
Energy used per ML irrigation per m head (kWh/ML/m head)	3.45	3.03
Costs	**Season One**	**Season Two**
Water costs per tonne DM ($/tDM)	0	0
Energy costs per tonne DM ($/tDM)	$20.50	$14.40
Energy costs per ML water ($/ML)	$90.48	$79.56
Energy costs per ML irrigation per m head ($/ML/m head)	$0.97	$0.85
Total cost per tDM ($/tDM)	$20.50	$14.40
Total cost per hectare ($/ha)	$366.13	$218.80

Figure 1 Season One

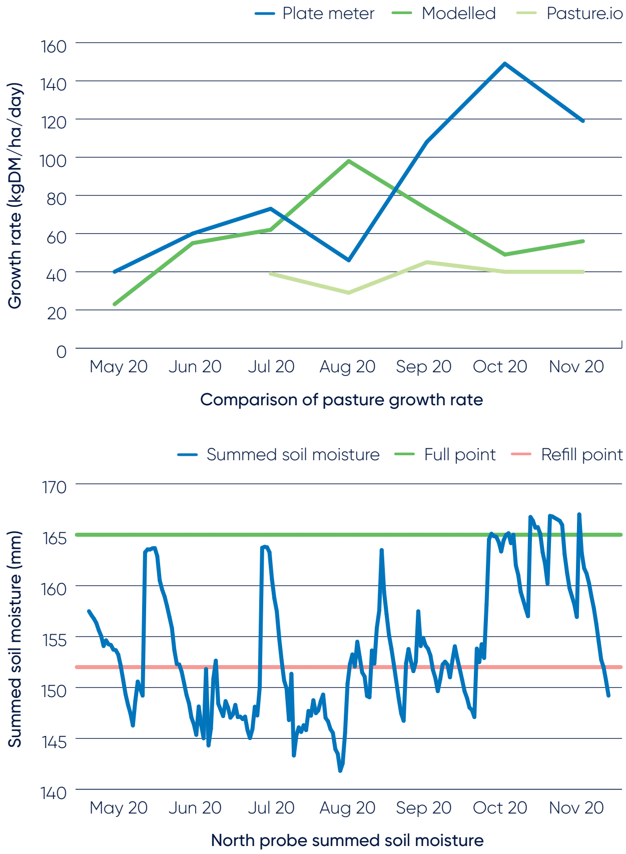
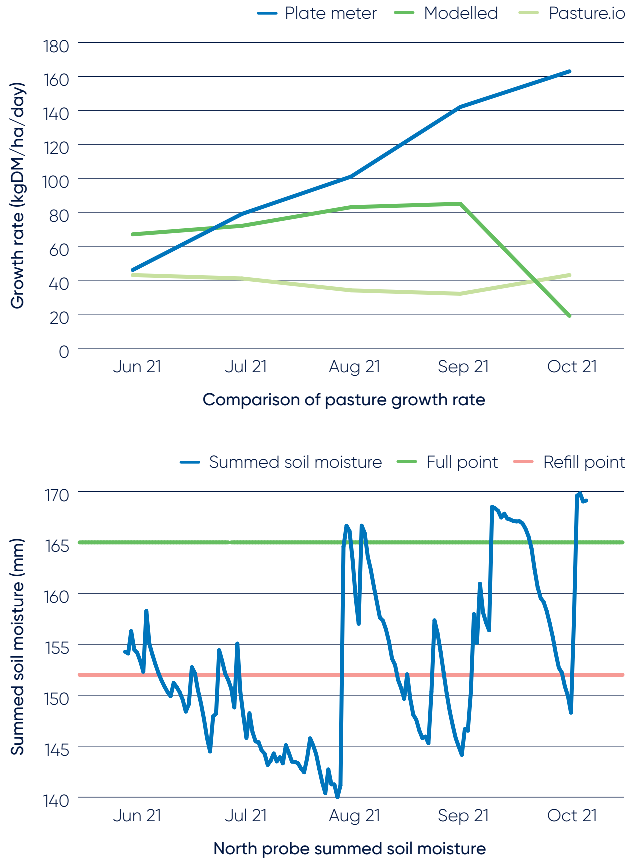


Figure 2 Season Two



- Changes in irrigation management improved water and power efficiencies.
  - In Season One (2020), 60% of water applied was irrigation compared to Season Two (2021), when 52% of water applied was irrigation.
  - 13.7% reduction in energy use from 322.67 to 283.75 kWh/ML.
  - Gross production water use index (GPWUI) improved by 43% from 2.31 tDM/ML to 3.30 tDM/ML.
  - Economic benefit of $6.10/t DM from Season One to Season Two through management of both the irrigation applications and the moisture within the soil profile.
- Maximum growth rates occurred when soil moisture was least limited (Figs 1 and 2). The average growth rate increased by 15.8% from 95kg DM/ha/day in Season One to 110kg DM/ha/day in Season Two. Both years significantly exceeded the modelled potential average growth rates of 59.42 and 65.20kg DM/ha/day respectively. Pasture.io did not demonstrate any relationships with either modelled or measured outcomes; however, grazing events were mainly entered into the platform after the three-day recommended window.
- In Season Two, irrigation start-up was late and applications were not adequate (Fig. 2). Pasture was stressed for moisture in late September 2021, although production still peaked shortly afterwards at 170kg DM/ha/day for this period. Unless there is spring rainfall, the soil profile dries more rapidly than irrigation can replenish (Figs 1 and 2).
- Good pasture production results were achieved: Season One, 15.19 tDM/ha and Season Two, 17.86 tDM/ha. In comparison, *Benvenutti, 2019 Gatton Research Dairy*, recorded a ryegrass yield of 16.841 t DM/ha (cut experiment) on a site using soil moisture probes for irrigation decisions. Using soil moisture monitoring and SWAN Systems forecasts to strategically manage irrigation resulted in a significant yield increase at the site.
- Pasture yield was 32% higher in 2021 than at the satellite site with the travelling irrigator (13.5 tDM/ha), which can be attributed, in part, to greater precision in applications according to plant requirements.
- The Wildeye® graphs demonstrate the difference between a travelling irrigator and automated solid-set system. The travelling irrigator could not be moved quickly enough around the platform before the soil started to dry during spring. Precision application of irrigation is more difficult, with more water applied in a single event than with the solid-set system, and there is less ability to plan irrigation events around predicted rainfall.
- In Season Two, the solid-set system on the optimisation site recorded 3.03 kWh/ML/m head (improved from 3.45 kWh/ML/m head in Season One), a 15% improvement in efficiency and a reduction in costs. Energy data were not collected at the satellite site, but the Dairy Fodder Water for Profit project in Queensland reported that energy use is higher for hard-hose irrigators than with solid-set systems. Data from 81 evaluations of travelling irrigators indicated a median kWh/ML/m head of 4.65.

Irrigation system evaluation

Table 2 Reported irrigation system evaluation metrics

Evaluation year	Flow rate (%)	Co-efficient of uniformity (%)	Distribution uniformity (%)	Application V panel (%)	Pump efficiency (%)	Energy use (kWh/ML/m head)	Average application rate (AAR) (mm/h)	End pressure (%)
2020	+8.5	48	39	+8.5	73	4.4	5.7	-16

- Labour efficiency is also improved with an automated solid-set system. A travelling irrigator takes approximately one hour to move every day of irrigation, whereas the solid-set requires negligible labour. There is less maintenance with the solid-set system. The high-pressure irrigation operation of the travelling irrigator places more strain on the components.
- Conditions were extremely windy when the evaluation was undertaken in June 2020, so the CU and DU findings are not representative of actual performance.
- With an AAR of 5.7mm/h, and a RAW at the North probe of 24mm, the soil moisture should lift from refill to field capacity (RAW) in approximately 4.5 hours.
- Sprinkler emitters were checked for specification and wear and tear in the nozzles. Operating pressure varied across the grid and all sites were below optimal. Hydrant control valves were checked and maintained. These small maintenance activities achieved increased operating energy efficiency from 3.4 KWh/ML/m head in Season 1 to 3.03 KWh/ML/m head in Season 2 (Table 1).
- Major flooding from the Richmond River in early 2022 inundated the entire farm and all irrigation infrastructure was lost, preventing a second system evaluation.

Reference group support

- This site did not have a continuous reference group to support activities. There was active participation in start-up decisions, with farmer representatives of the Far North Coast Dairy Industry Group Inc., Subtropical Dairy Programme Ltd - Far North Coast NSW Regional Group and Norco Cooperative Ltd field officers attending workshops in January and March 2020 and having input for farm selection, site questions, technologies used and communications/extension methods.
- NSW COVID-19 restrictions had a marked effect on participation in learning activities throughout 2020 and 2021.
- Record flooding affected the site in early 2022.
- A total of 44 *Weekly Irrigation Requirement Reports* were prepared by the site coordinator over the two irrigation seasons and published in the subtropical weekly eNewsletter with circulation to 500 farmers and service providers each week. The reports included:
  - Swan Systems Weatherwise seven-day forecasts for ETo/rainfall at the optimisation site.

  - ETo and rainfall data for the previous seven days as recorded at the Lismore Airport BoM AWS and rainfall at the optimisation site.
  - North probe Wildeye® summed moisture graphs.
  - Commentary on the information and its relevance for irrigation requirements and management.
  - Commentary on Brian's decision making to achieve optimal results.
  - A short item on a relevant weather- or irrigation-related issue (e.g. seasonal climate outlooks).
- The March 2021 field day at the site was one of the most successful across all sites. Of the 31 people attending, 18 were local farmers. Participants rated an average of 9.25/10 for the quality of the event's content and gave a rating from 6.1 to 8.2/10 for improved knowledge and understanding across three key irrigation strategy areas after attending the event.
- Norco received project results and milestones. SIP2 learnings assisted their field staff to better guide recommendations across their supplier base. Providing the Subtropical Dairy Extension Officer with project outcomes enhanced the distribution of information to farmers and service providers.

MORE INFORMATION

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3513.9 | Jan 2023