Economic Impacts of Irrigation Scheduling Decisions

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Irrigation Insight

- Collaborative research programme- including NIWA, DairyNZ, Fonterra, AgResearch, LIC and IrrigationNZ.
- Focus on developing knowledge, tools and confidence in better managing irrigation, precisely applying the water needed—where, when and how much.
- Aims to use improved weather forecast, drainage and economic impact estimations to inform on-farm water management on irrigated dairy farms, ideally at a marginal level.

Hydro-Economic model

- A model which estimates the environmental and economic impacts of various irrigation scheduling practices.
- This presentation includes altering the application depth and frequency, and test the direct and indirect economic benefits and costs in a basic scenario.
- Future iterations:
    - Vary soil type
    - Include weather forecasts
    - Include nutrient losses
    - More complex scheduling decisions

Hydrology

- The hydrological model calculates changes in root zone soil moisture each day using a water balance approach accounting for rainfall, irrigation, evapotranspiration and drainage.
- Uses 18 seasons, results are an average over these seasons.

Economics

- Economic impacts
  - Direct costs
    - Pumping ($\$/m^3$)
    - R&M ($/day)
    - Labour ($/day)
  - Indirect costs (changes in PGR)
    - Soil moisture
    - Wastage
    - Pugging

Indirect costs – impact on PGR

- Equation 1- soil moisture
  - $$F_{moisture} = \begin{cases} 0 & \text{if } PAW \leq WP \\ \frac{AET}{PET} & \text{if } WP < PAW \leq SP \\ \left(0.5 + 0.5\frac{Sat-PAW}{Sat-FC}\right) & \text{if } FC < PAW \leq Sat \\ 0 & \text{if } Sat < PAW \end{cases}$$
- Equation 2- wastage
  - $$F_{wastage} = \begin{cases} 1 & \text{if } PAW \leq SP \\ 1 - 0.16\frac{PAW-SP}{FC-SP} & \text{if } PAW > SP \end{cases}$$
- Equation 3- pugging
  - $$F_{pugging} = \left(1 - \frac{DaysPugging}{RotationLength} \times ImpactSeverity\right)$$

Scenario- Farm A

2 Guns: 45mm depth & 11 day return

3 Guns: 35mm depth & 9 day return

Just in time: Irrigate when soil storage reaches user set threshold

Always: Irrigate whenever water is available

Name	Irrigators	Irrigation approach	Frequency limitation logic
2-JM	2 Guns	Just in time	Minimum return interval
2-AM	2 Guns	Always	Minimum return interval
2-JR	2 Guns	Just in time	Rostered
2-AR	2 Guns	Always	Rostered
3-JM	3 Guns	Just in time	Minimum return interval
3-AM	3 Guns	Always	Minimum return interval
3-JR	3 Guns	Just in time	Rostered
3-AR	3 Guns	Always	Rostered

Minimum return interval: Cannot irrigate until a set number of days after the last irrigation

Roster: Irrigate on pre-set days

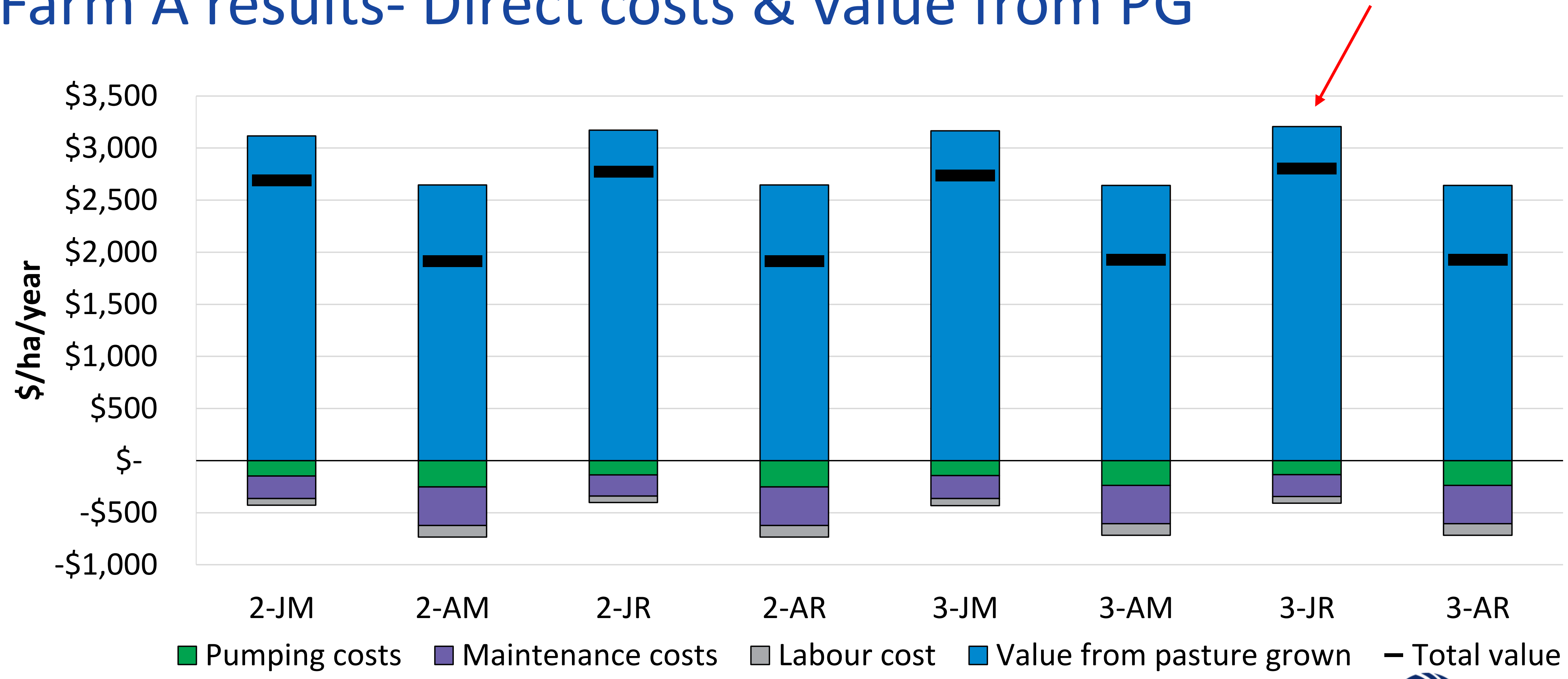
Farm A results

Name	Irrigation applied (m^3)	(mm)	Days of irrigation	Total drainage (irrigation season) (mm)
2-JM	437,325	368	90	20
2-AM	749,700	630	154	261
2-JR	410,550	345	84	18
2-AR	749,700	630	154	261
3-JM	425,756	358	92	18
3-AM	708,050	595	153	225
3-JR	402,617	338	87	12
3-AR	708,050	595	153	225

Farm A results

Name	Total direct costs $/ha/yr	Pasture grown Kg DM/ha/yr	Pasture value $/ha/yr	Total value (value of pasture minus direct costs) $/ha/yr
2-JM	$429	13,732	$3,116	$2,688
2-AM	$735	11,311	$2,646	$1,911
2-JR	$402	13,997	$3,172	$2,770#
2-AR	$735	11,311	$2,646	$1,911
3-JM	$431	13,960	$3,165	$2,733#
3-AM	$718	11,360	$2,642	$1,924
3-JR	$408	14,150	$3,207	$2,799
3-AR	$718	11,360	$2,642	$1,924

Farm A results- Direct costs & value from PG



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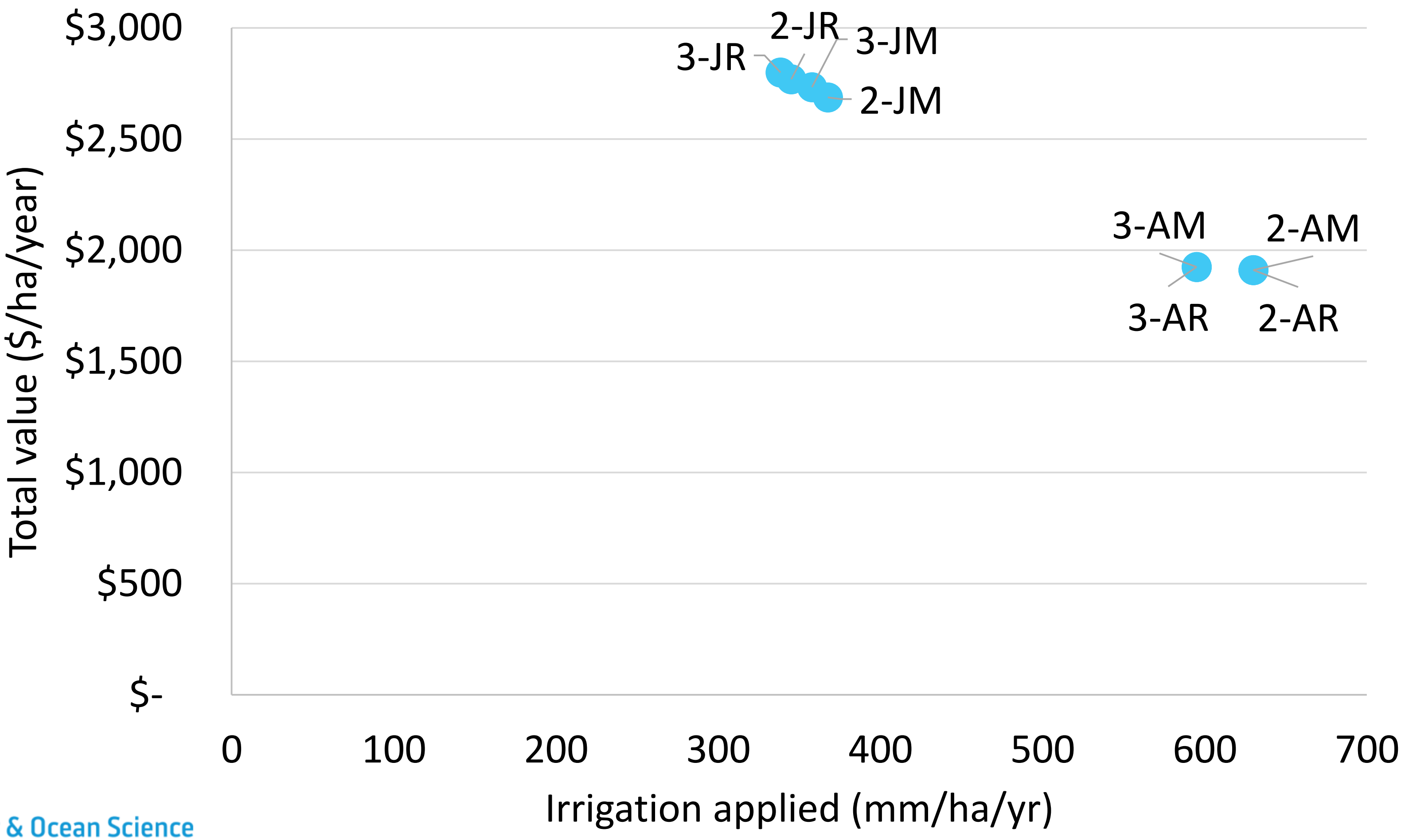
Farm A results- Water use and total value



Farm A conclusions

- Theoretical best option = purchase the new irrigation gun, reduce their irrigation application depth and return length, and utilise a just in time irrigation approach and a roster.
- However, there is not a significant difference between the top four options (scenarios 3-JR, 2-JR, 3-JM, 2-JM).
- The difference in roster and minimum return is generally driven by type of infrastructure on farm.
- So no significant economic benefit in purchasing additional irrigation infrastructure- in this case.
- Significant benefit in using a just in time approach relative to the always irrigation approach.
- The top four scenarios economically also had lower total drainage, indicating a positive environmental outcome as well.

Conclusions

- Farm A shows that there is a significant positive economic and environmental benefit from using soil storage based scheduling rather than a rostering system.
- However, there is no significant difference between reducing irrigation application depth by 10mm and rotation length by 2 days.
- While these results aren't ground breaking, they tested the model, proving its validity and mean we can continue further development.
- This research provides an important first step in understanding the economic impact of marginal irrigation scheduling decisions.

Thank you

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- NIWA,
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