Dairy Directions — Analysing Farm Systems for the Future

Providing robust analysis of the impact of on-farm changes and innovation on the profitability of dairy farm systems

Sub-surface drip irrigation for grazed pasture production — does it pay?

Why sub-surface drip irrigation?

Reduced irrigation water availability and a range of environmental issues have increased the pressure on the dairy industry to use water more efficiently. While there is some scope for improving the efficiency of the common border-check irrigation, dairy farmers are also looking to alternative irrigation methods such as the micro-irrigation technology sub-surface drip irrigation (SSD).

SSD irrigation relies on the use of 'drip tape' installed below the soil surface. The tape is fitted with 'emitters' which release water at a constant flow rate under pressurised conditions. This technology delivers water directly to the plant root zone and allows dissolved fertilisers to be applied.

Is this new irrigation technology a good investment?

A partial budget analysis (over a 10-year period) was used to investigate whether the installation of SSD technology was a good investment on a case study farm. The farm was located in the Goulburn Irrigation system of northern Victoria.

The milking area was 99 ha made up of 67 ha of flood-irrigated perennial pasture and 32 ha of irrigated annual pasture. Of the perennial pasture, 25 ha was difficult to irrigate due to small and irregularly shaped bays. On this loam type soil, re-levelling and/or redevelopment would be required to improve irrigation efficiency. This area was used to investigate the economics of installing SSD technology.

Irrigation water applied on the perennial pasture was about 8.6 ML/ha per year. Estimated perennial pasture consumption by the herd was about 14 t DM/ha including the area identified as suitable for SSD.

Estimated start-up costs

The capital cost per hectare of installing SSD depends on 5 main variables:

- Type of tape (relating to thickness and diameter)
- Type of emitters (pressure or non pressure compensating)
- Emitter spacing
- Distance between tapes
- Access to electricity

In this analysis, a design using Python 250 tape (0.68mm thickness) with non pressure compensating emitters at 0.4 m spacing and a tape spacing of 1 m was used. It was assumed access to electricity cost $5,000. Installation of this system costs approximately $9,375/ha or around $237,000 for just over 25 ha (Table 1).

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Table 1. Capital cost of sub-surface drip installation (Costs provided by 'Water Dynamics' valid at June 2008).

SYSTEM COST	Total $	$/ha
In pump shed		
Pump and variable speed drive	5,060	200
Primary filter	10,254	406
Irrigation controller	3,000	119
Fertigation pump	4,000	158
Shed and slab	5,500	218
Suction line (to pump) & connections	5,200	206
Cabling and electrical work	3,100	123
Sub total (in pump shed)	**36,114**	**1,430**
In field		
Submains, other pipes and fittings	35,810	1,418
Valves (control, air release, flushing)	20,428	809
Secondary filtration (at each block)	2,175	86
Meters (for monitoring volume to each valve)	5,000	198
Drip tape with non PC emitters	83,325	3,300
Sub total (field)	**146,738**	**5,811**
Installation costs		
Tape laying (approx $371 per ha)	9,350	370
Trenching	10,800	428
Labour (240 hours)	18,000	713
Power connection (rough estimate)	5,000	198
Pasture establishment costs		
Deep rippling (16 hours)	2,750	109
Seed establishment costs	7,972	316
Sub total (installation costs)	**53,872**	**2,134**
TOTAL CAPITAL COSTS	**236,724**	**9,375**

The capital cost of this system is related to the number (and quality) of parts of the system. Using cheaper, thinner tape was rejected in this analysis as it is not recommended for grazing situations. Increasing the distance between tapes to 1.4 m would reduce the capital cost of installation by $1,000/ha, however, this spacing is untested under grazed perennial pasture. It is also likely to lead to reduced pasture production, impact on species composition and increase the time to apply a given amount of water, which would increase the operating cost (Table 2).

Table 2. Impact of tape spacing on operating costs.

Tape spacing (m)	Total capital cost ($/ha)	Hours required to apply 8 mm/ha	kWh required to apply 8 mm/ha	Cost (pumping) per 8 mm/ha irrigation ($)	Pumping cost ($) for season at 8.6 ML/ ha applied	Pumping cost ($) for season at 6.5 ML/ ha applied
0.6	11,575	9.2	138	9	985	752
1.0	9,375	15.4	231	26	2,474	1,889
1.4	8,431	21.5	323	42	4,208	3,212

The high capital cost associated with SSD requires significant ongoing cash savings/benefits for it to be a worthwhile investment. The investment was considered to be worthwhile if the nominal Internal Rate of Return (IRR) was greater than 15% over a 10 year period. The analysis explored changes in the amount and value of (i) additional pasture consumed, (ii) irrigation water saved and (iii) labour saved.

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How does it look if I increase my pasture production?

Substantial increases in pasture consumption by the herd were required to justify the investment in SSD. If this was the only benefit, pasture consumption needed to increase by 4 t DM/ha with a value of around $400/t DM, for the investment to be attractive. If the pasture consumption increased by 4 t DM/ha, but was not valued as highly, returns do not appear to justify the high capital cost and risk of installing this new technology (Table 3).

Table 3. Impact of additional pasture grown and value of pasture on internal rate of return (%).

Extra pasture (t DM/ha)	1.4	2.8	4.0	4.0
Value of extra pasture ($/t DM)	400	400	200	400
Yrs to break even (before interest)	>10	8	>10	5
Internal rate of return (IRR)	-3.8%	8.7%	1.8%	18.4%

Pasture consumption gains of 4 t DM/ha are unlikely. A research trial found that SSD produced about 1 t DM/ha more pasture (18.4 v. 17.4 t DM/ha), using 2 ML/ha less water (9.6 v. 11.3 ML/ha) than border-check irrigation (Wood and Finger 2006). These results were obtained under experimental conditions and may not be achievable on a commercial farm.

What if it means I use less irrigation water?

A water saving of 2 ML/ha was insufficient to make the investment worthwhile when the saved water was valued at $350/ML (opportunity cost or Transferable Water Entitlement value). This indicates that if water savings were the only benefit of SSD, it is unlikely to be an attractive investment (Table 4).

Table 4. Impact of water saved and value of water saved on internal rate of return (%).

Water saved (ML/ha/yr)	2	2	2
Water price ($/ML)	150	250	350
Yrs to break even (before interest)	>10	>10	>10
Internal rate of return (IRR)	-10.2%	-4.7%	0.1%

What if I get more pasture from less water and what if water and feed get dearer?

To warrant investment in SSD, an extra 2.8 t DM/ha of pasture would need to be consumed using 2 ML/ha less water. These improvements would need to be coupled with relatively high water ($350/ML) and fodder prices ($400/t DM) to make the investment attractive.

A combination of high water and fodder prices makes investing in SSD appear more attractive (Table 5). However, in the event of high water and fodder prices, whole farm profitability is questionable, unless there is a significant and sustained increase in milk price above the long-term average. In summary, if water and feed are expensive enough to make SSD an attractive alternative to irrigating perennial pastures, then dairying is unlikely to be profitable.

Table 5. Impact of different amounts and value of pasture consumed and different amounts and value of water saved on internal rate of return (%).

Extra pasture grown (t DM/ha)	1.4	2.8	2.8	4.0
Value of extra pasture ($/t DM)	200	200	400	400
Water saved (ML/ha/yr)	1	1	2	2
Water price ($/ML)	150	350	350	350
Yrs to break even (before interest)	>10	9	5	4
Internal rate of return (IRR)	-6.9%	4.5%	23.2%	33.1%

Does it save labour?

On the case study farm, about 176 hours of labour could be saved annually with the introduction of SSD compared with a border-check system. When the labour savings were valued at $50/hr they made some contribution to the economic performance of a SSD system, but not enough to justify the investment if the extra pasture consumption and water savings were not achieved.

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How much difference does saving money on the initial cost make?

The capital cost of installing a SSD system can vary markedly depending on the type of tape, tape spacing, type of emitters and emitter spacing, as well as other factors, such as distance from an appropriate electricity and water source.

A range of capital costs were analysed from $6,450 to $11, 450/ha. As the capital cost increased, higher expected pasture consumption benefits and water savings were required for the SSD system to be economically viable. Even at a set up cost of $6,450/ha, the analysis showed that a substantial increase in pasture consumption (greater than 2.8 t DM/ha) and/or water savings (2 ML/ha/yr) improvements were required to get a reasonable return from the investment.

Final thoughts

SSD technology under grazing appears to be a relatively high risk investment, given the uncertainty about the production gains and water savings that could be achieved, and the durability of the system. For the SSD irrigation system to be economically attractive, the capital cost would need to decline, or the pasture consumption response would need to be greater. This may be possible where the initial pasture consumption is low.

High water and fodder prices can make investing in SSD appear more attractive, but dairying is unlikely to be profitable in this case without exceptionally high milk prices.

The analysis suggests that installation of SSD under grazed perennial pasture in a dairy system would be an unwise investment in all but the most generous efficiency gains. Such improvements in efficiency appear to be optimistic with perennial pasture at this stage. Other crops may have a greater potential for improvement in yield with SSD irrigation technology.

Alternatively, there may be situations, such as a 'greenfield' site, where investment in irrigation development is necessary, that the installation of SSD irrigation could have a comparable economic performance to the installation of border-check or spray irrigation.

References

Wood, M.L. and Finger, L. (2006). Influence of irrigation method on water use and production of perennial pastures in northern Victoria. Australian Journal of Experimental Agriculture, **46**, 1605—1614

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