



Fast watering

– does it “save” water?

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IN A NUTSHELL

- Fast watering will best suit soils suited to border check, paddocks with high water use that can't be explained by run-off losses, and frequently irrigated summer crops and pastures
- In rice layouts, decreasing drainage times will have a far greater effect on reducing deep drainage and improving irrigation efficiency than increasing supply flow rates

Fast watering is the term adopted for flood irrigating border check systems using a flow rate to bay size ratio of 10:1 or greater. Fast watering aims to shorten the time that water is ponded on the soil surface (ie the opportunity time) and so reduce the amount of water lost below the root zone.

Fast watering has the potential to improve irrigation efficiency and result in appreciable water savings when applied to light textured soils. However, it is not clear whether any production benefit would be gained from its adoption on these soil types.

Fast watering (increasing flow rates) may not significantly improve either irrigation efficiency or production on heavy textured clay soils in typical rice layouts. Irrigators with these layouts may find that improving drainage will have a far greater impact on irrigation efficiency and productivity.

Why consider fast watering?

Low water allocations in recent years have forced irrigators to find ways of increasing production per ML in order to maintain farm incomes. In addition, Federal Government water buy-back schemes require irrigators to relinquish a portion of their entitlement in return for capital grants to upgrade on-farm irrigation infrastructure. Increasing supply flow rates and reducing irrigation opportunity times may improve water productivity. This article describes preliminary investigations into the conditions under which fast watering might lead to a gain in water productivity.

Improving water productivity by

1. Decreasing deep drainage

Infiltration curves for three soil types typical to the Riverine Plain are shown in Figure 1. The curves show the extent of water savings that could potentially be achieved by reducing irrigation opportunity times. For instance, reducing opportunity times by 3 hours would result in 1.2 ML/ha, 0.45 ML/ha and 0.1 ML/ha less water being applied to the Merah loam (sandy sub-soil), the Birganbigil loam and the sodic Merah clay loam, respectively (Figure 1). Reducing opportunity times can therefore significantly increase irrigation efficiency on lighter textured soil types but will not be as significant on heavy textured and sodic soils.

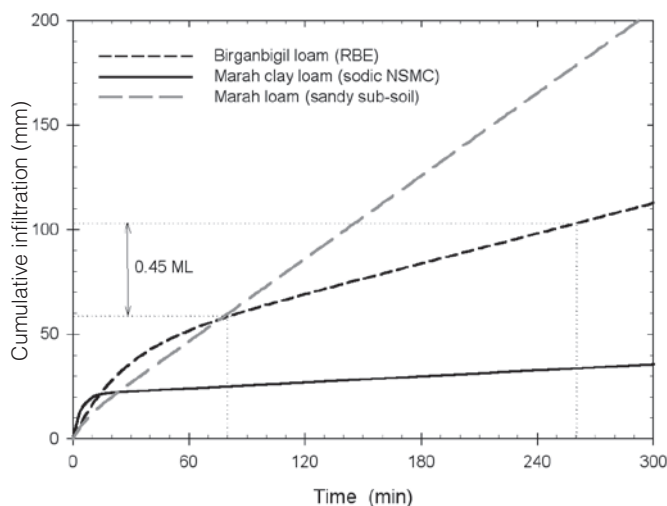


Figure 1. Infiltration curves of three typical Riverina soils obtained using ring infiltrometers



Figure 2. Irrigators at a field day at the Katamatite site of the fast watering demonstration held in the 2007-08 summer.



2. Reducing waterlogging & lifting yields

Previous research has shown that wheat yields decline by 70 kg/ha for every day water is ponded on the soil surface, and when high temperatures (>30°C) coincide with spring irrigation in slow draining layouts, yield losses of more than 1 t/ha are possible. For perennial pasture, ponding water for 12 and 24 hours reduced production by 17% and 14% respectively compared to ponding for only 4 hours.

The effects of waterlogging are worse in light soil, under high temperatures and with low soil nitrogen, and these effects increase with the duration of waterlogging. Anaerobic conditions have been shown to take 10 days to develop in duplex (a sand or loam soil over clay, eg red-brown earths) soils and 3 days to develop in heavy clay soils, once they become waterlogged.

It follows from this that:

1. there is a lower risk of waterlogging leading to yield loss in duplex soils
2. reducing the time that heavy clay soils are waterlogged to under 3 days may have significant production benefits.

Testing fast watering

Work conducted by NSW DPI staff in the Murray Valley over the past 12 months provides some insight into the benefits of fast watering as well as some of the pitfalls of fast watering in conventional rice layouts, ie lasered contours with 5 cm side fall and side-ditch (bankless channel) delivery.

1. Fast watering demonstrated at Katamatite

Gary and Lisa Flanigan run *Bryandra*, a 272 ha dairy farm, near Katamatite in northern Victoria. Murray-Goulburn irrigation water is supplemented by groundwater from a bore. Two hundred and twenty hectares of the property have been landformed and laser graded into border check.

In winter, the landformed area is used to grow annual ryegrass, which is cut short in spring to allow summer fodder crops to be direct drilled. None of this feed is grazed, as it is all harvested as green chop or made into silage. The pasture and cropping program is targeted to average 20 t/ha of dry matter per annum.

Low allocations have meant that Gary has had to rely on his bore, which can only deliver 2 ML/day. This has increased irrigation time per bay to 7 hours (up from 2 hours) and led to higher water use and more time spent irrigating. Demonstration results from Gippsland showed that it was possible to save water and reduce labour if high flow rates were used on light soil types. The loan of a 20 ML/day pump from John Padman of Padman Stops allowed the Flanigans to investigate fast watering.

The demonstration

Paired bays with similar pasture growth were selected in two millet paddocks for a demonstration. Site 1 was in the 24-Acre Paddock and Site 2 in Willow Paddock. Site 1, bay 3 (0.8 ha) and site 2, bay 5 (1.4 ha) were *fast watered*, with the pump run at full throttle to apply 20 ML/day. Site 1, bay 4 (0.8 ha) and Site 2, bay 6 (1.2 ha) were *slow watered* with the pump ticking over at 4 ML/day.

The volume of water put onto each bay was measured by a flow meter on the pump. The wet tonnage of millet cut from each bay was measured and moisture contents and dry weights were obtained. Areas irrigated and harvested were surveyed using a differentially corrected GPS. Soil water content to 1.2 m depth

Table 1. The volume of water applied to each bay and the difference between the "fast" and "slow" watered bays. Numbers in bold type show irrigations after 24 Jan when "fast" and "slow" treatments were applied.

Site	Watering date	Water applied (ML/ha)		
		Fast	Slow	Difference
24-acre Paddock	26-Nov-07	1.0	1.0	
	5-Jan-08	0.6	0.5	
	18-Feb-08	0.5	0.8	- 0.3
	5-Mar-08	? †	? †	- 0.6 †
Willow Paddock	30-Jan-08	1.0	1.0	
	19-Feb-08	0.4	1.0	- 0.6
	2-Mar-08	0.5	1.1	- 0.6

† the volume applied to each bay in this irrigation is not known as run off occurred. The difference between pumped amounts was estimated by Gary to be -0.6 ML/ha.

was monitored in each bay using capacitance probes and soil water potentials at 5 cm depth were obtained in each bay using Watermark™ sensors connected to loggers.

The millet was sown in December 2007 and, prior to sensor installation on 24 January 2008, each pair of bays received the same management. Watering rate treatments were applied after this date.

Results

The amount of water applied to each bay over summer is shown in Table 1 together with the differences between the watering regimes. It appears from these (non-replicated) results that a saving of up to 0.6 ML/ha per irrigation may be obtained on this soil type from faster watering. There was no clear treatment difference in the tonnage of millet cut from each pair of bays.

The capacitance probes showed the soil was wet to a greater depth and that the soil stayed wet for longer in the slow watered bays compared with the fast watered bays (Figure 4). It appears from the data that water passed beyond the root zone with both slow and fast watering, though the time during which this deep drainage occurred was shorter with fast watering. Further increasing flow rates could save more water but a change to sprinkler application may be more appropriate.



Figure 3. A 20 ML/day pump was used to generate 'fast' flows so that fast watering could be investigated at Bryandra, Katamatite.

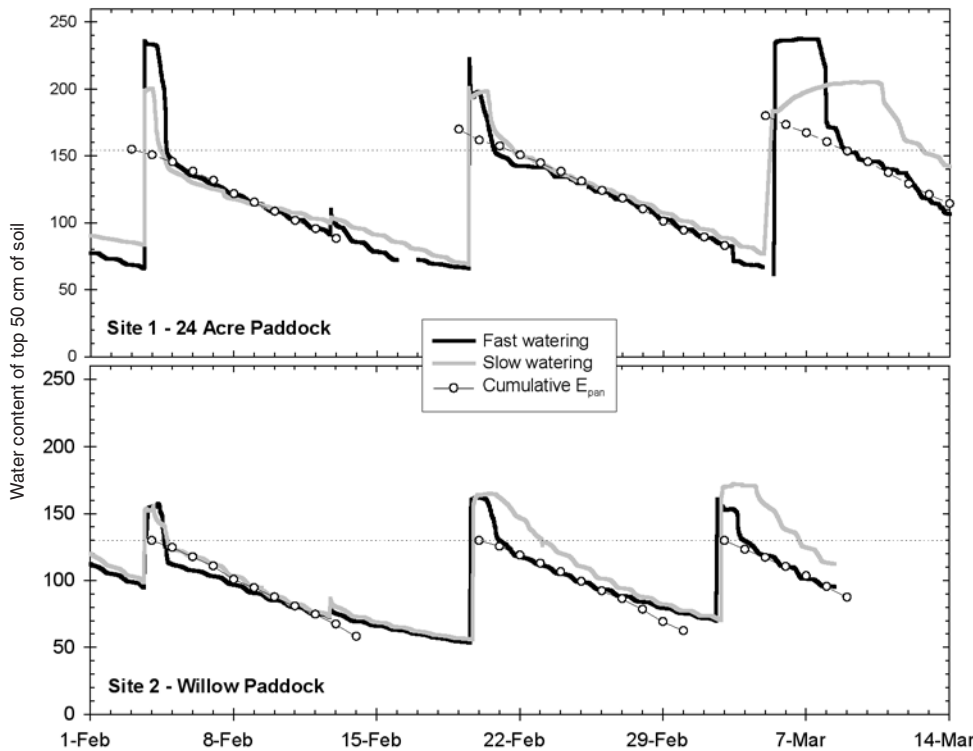


Figure 4. (left) Changes in profile water content (0–50 cm) in the fast and slow watered bays at the demonstration sites on Bryandra, showing the response to 36 mm of rain (3 February) and to the “treatment” irrigations (18 February and 2–5 March). Cumulative daily pan evaporation (Cumulative E_{pan}) is shown for comparison with plant water use and the horizontal dotted line shows the estimated “Full Point” for each soil.

Figure 5. (below) Results of EM38 survey of the two paddocks used in the fast watering demonstration at Bryandra.

Discussion

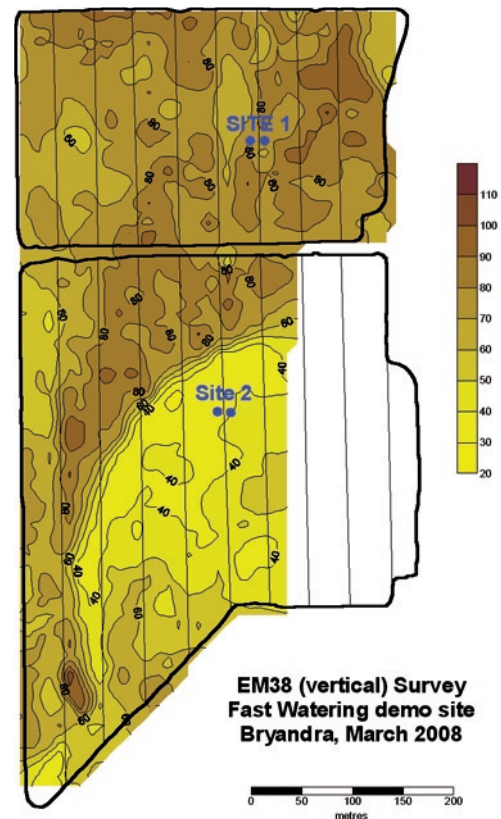
The clay content of a soil can be predicted by surveying with an EM38 to estimate the apparent electrical conductivity (EC_a). EC_a readings >150 mS/m indicate slowly permeable, high clay content soils suitable for growing rice, whilst low EM readings (<50 mS/m) indicate coarser textured, permeable soils.

The millet paddocks at Bryandra were surveyed in March 2008. The results (Figure 5) show that the soil in the 24-Acre Paddock (Site 1) had an average EC_a of 80 mS/m, indicating this area is heavier in texture than the soil in the south-eastern half of the Willow Paddock (Site 2) which had an average EC_a of 40 mS/m. In general, the survey suggests infiltration rates in both paddocks will be reasonably high and possibly very high in much of the Willow Paddock. This is reflected in the results shown above (Table 1 and Figure 4)

The soil water potential data shows that the soil stayed waterlogged for approximately 24 hours longer in the slow watered bays than in the fast watered bays (ie roughly 3 days compared with 2 days before the surface soil began to drain). In addition, the data indicated that the surface soil in the slow watered bays was saturated following irrigation whereas the surface soil in the fast watered bays was at field capacity and was therefore less likely to become anaerobic.

2. Water on-water off times at Jerilderie

A number of irrigation evaluations have been conducted over the last 12 months as part of a Murray LWMP/CRC IF funded project to improve the performance of contour layouts in southern NSW. One such evaluation was conducted at the McCaughey Memorial Institute, Old Coree, Jerilderie during flushing of drill sown rice in November 2007. The layout examined could be considered current rice industry ‘standard practice’, ie side-ditch delivery to 3.8 ha lasered contour bays (110 m by 350 m) on a 1:2000 slope. There was a road between every second bay (to aid access for experimental work), so side-ditch delivery to each bay alternated between 380 mm diameter pipes and 980 mm wide Murray Irrigation Limited rice stops.



Water pumped from the Billabong Creek was delivered to bays at approximately 15 ML/day. This is NOT fast watering but does meet the current best practice design recommendation for contour layouts (ie bay size (in ha) is no more than a quarter of the supply flow rate in ML). Flow meters and depth loggers were installed in the top six bays of one block to monitor the progress of water during the second “flush” irrigation on 27 November 2007. In addition to these instruments, six Watermark™ sensors



connected to a logger were installed in the bottom corner of Bay 2 near the outlet in order to monitor the duration of waterlogging in the surface soil. The results of this monitoring are shown in Figure 6, together with the depth of water over each sensor.

It can be seen from Figure 6 that it took 6 hours to fill the bay. Despite some initial drainage from the bay when the slide was pulled, water levels did not fall appreciably until 17 hours later. This coincided with the start of irrigation in Bay 5, clearly showing that water was backing up in Bays 3 and 4 and restricting drainage from bay 2. Figure 6 also clearly shows that it then took a further 27 hours for water to drain from the bottom corner of the bay and the surface soil remained waterlogged for another 54 hours (2¼ days). In total, the surface soil at the monitored site was waterlogged for 98 hours (4 days) following a 6 hour irrigation event.

The length of time the soil remained saturated after water had drained off the bay appears typical of the heavy clay rice soils included in this study and it would undoubtedly have affected the productivity of non-rice crops, as previously stated. Although the impact on this crop was not quantified, slow drainage and waterlogging can affect rice production by delaying sowing and harvest and through reduced and patchy establishment in drill sown crops. Recent research has shown that moving to raised beds has reduced the incidence and severity of waterlogging in these situations.

Water may have been backing up because of the low slope in the block or because the 380 mm diameter pipes were a restriction on supply/drainage rates. This example very clearly illustrates the deficiency of side-ditch layouts on flat slopes where the structures through which water is supplied to each bay are also used to drain the upstream bay. Structures need to be large to pass both inflows to the bay being irrigated and

outflows from the bay being drained, but increasing the size of structures (and the flow rate) may not improve drainage if the slope is too flat and water backs up.

In order to improve the irrigation efficiency of this layout, and reduce the production risks to non-rice crops caused by excessive waterlogging, attention should be focussed on improving drainage and reducing the duration of waterlogging.

Increasing flow rates will have comparatively little effect if issues associated with the size of structures and the slope are not also addressed (eg halving the time to fill the bay would reduce the time the soil was saturated by only 3%).

The drainage rate in this layout depends on both the size of the structures and the paddock slope. Whilst it is suspected that slow drainage off Bay 2 was caused by undersized pipes, the fact that drainage did not occur until Bay 5 was irrigated also suggests that water is backing up. If the restriction on outflow could be overcome (eg larger structures and/or separate supply and drainage), then drainage times could potentially be decreased by 17 hours. If the infiltration rate of this soil is similar to the sodic Marah clay loam in Figure 1, then this could equate to a saving of 0.5 ML/ha (actual savings would be less because water drains from the high side of the bay earlier).

The production benefits of such a reduction in the duration of waterlogging are being investigated.

Factors to consider for fast watering

- Bay size should be designed to match supply flow rate and soil intake rate.
- In border check and rice layouts where bays are supplied and drained individually, fast watering can decrease opportunity times (and save water), **but it is slope that predominantly affects drainage times.**

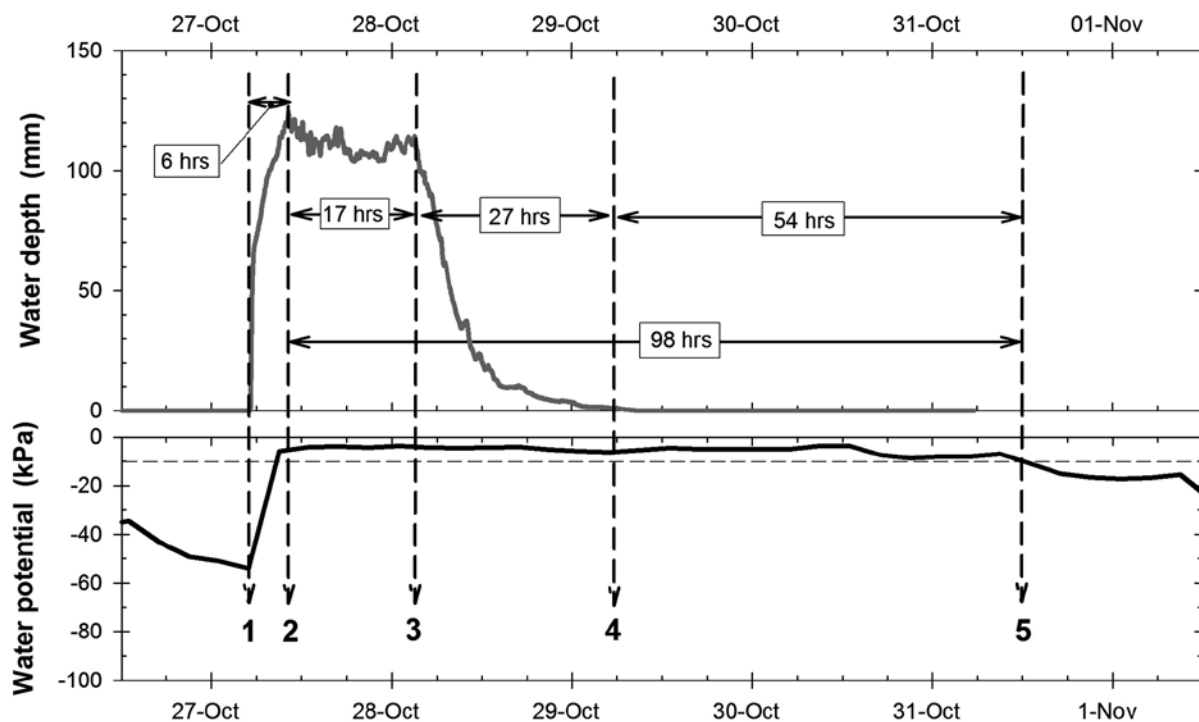



Figure 6. Graph showing the depth of water ponded (top) on the second bay of a lasered contour, side-ditch delivery flood irrigation layout during an irrigation event (second flushing for rice establishment) and the change in water potential of the top 5 cm of the soil (bottom) associated with this irrigation. The numbers indicate: (1) the start of irrigation; (2) slide pulled to commence drainage of bay; (3) start of irrigation in Bay 5; (4) surface water all gone; (5) water potential < -10 kPa (theoretically air entry). Each reading is the mean of 6.



- In rice layouts with side-ditch delivery, flow rates into and out of the bay are predominantly determined by structure size and the fall between bays. Modifying these two factors to decrease drainage times may have a far greater impact on irrigation efficiency and productivity than increasing supply flow rates.
- An EM survey is a cost effective way of determining soil variability and efficiently locating sample points for assessing infiltration rates when planning any change (Note: soils with similar EC_a can have different infiltration rates, eg self mulching and non-self mulching heavy clays).
- No flood system will be as water efficient as spray irrigation on very light textured soils.
- There is no point in upgrading irrigation technology without also lifting the level of management. Production should be increased to pay for the upgrade. An increase in inputs this should be factored in.
- Be prepared to upgrade your irrigation infrastructure
 - ◆ channels, structures and drains must be capable of conveying design flow rates
 - ◆ consider some form of automation to keep labour manageable
 - ◆ drainage recycling and re-use will need to be installed; site any storage appropriately to avoid deep drainage losses.
- Be prepared to pay more to deliver water to your paddocks if you need to pump. Factor in rising energy costs and compare the costs of electricity and diesel.
- You can not manage what you don't measure
 - ◆ monitor your paddock water use
 - ◆ install soil moisture monitoring equipment
- Fast watering will best suit the following:
 - ◆ soils suited to border check (eg soils intermediate between heavy clays and sands)
 - ◆ paddocks which have high water use that can't be explained by run-off losses (these may have excessive deep drainage. An EM survey and soil assessment should be done)
 - ◆ frequently irrigated crops and pastures.
- If irrigating with groundwater, be sure to monitor water and soil salinity and sodicity. A leaching fraction needs to be maintained to ensure salts do not build up in the soil profile.


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