Performance Evaluation and Deep Drainage Risk Assessments for Surface Irrigation

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Relation to other work

This work is primarily focused on improving the whole farm water use efficiency of irrigated cropping in the Northern Murray Darling Basin. This particular component of the broader research program has been directed at the performance evaluation of surface irrigation practices and the development of monitoring tools and techniques to identify practices to improve in-field water use efficiency. These tools have been incorporated into the "Irrimate" product range which is currently being used by commercial consultants in NSW and southern Qld for performance evaluations, deep drainage risk assessments and optimisation of surface irrigation practices.

Main findings

Detailed performance evaluations of surface irrigation in the cotton industry have been undertaken for the last six years (eg. Dalton *et al*., 2001; Raine and Dalton, 2003). The performance of the surface irrigation is commonly highly variable both over space and time. The infiltrated volume and deep drainage risk associated with commercial surface irrigation practices is also variable. There is some evidence that infiltration functions may be broadly correlated to soil type (eg Figure 1). However, detailed evaluations of infiltration variation throughout the season and on similar soils in close proximity confirm that infiltration under commercial conditions is highly variable (Figure 2).

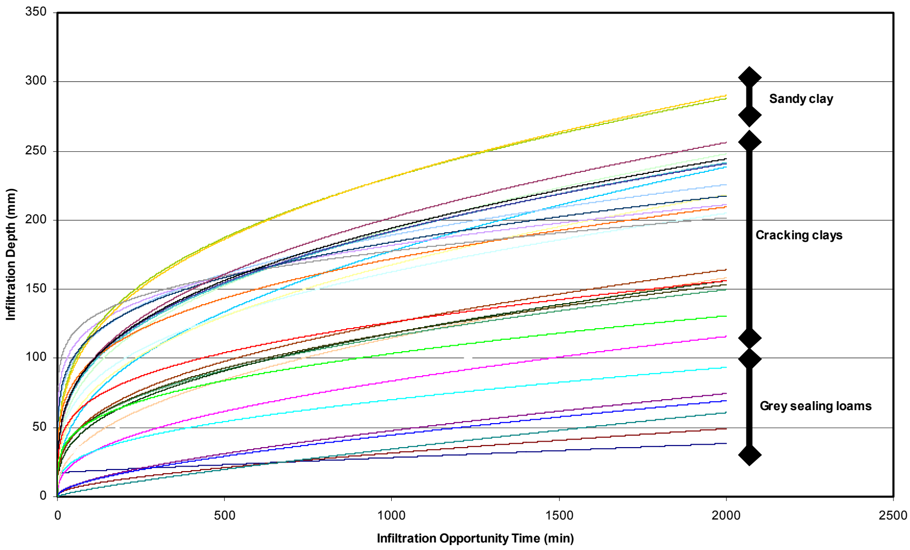

Figure 1. Relationship between soil texture and infiltration measured under surface irrigation
(Dalton, 2002)

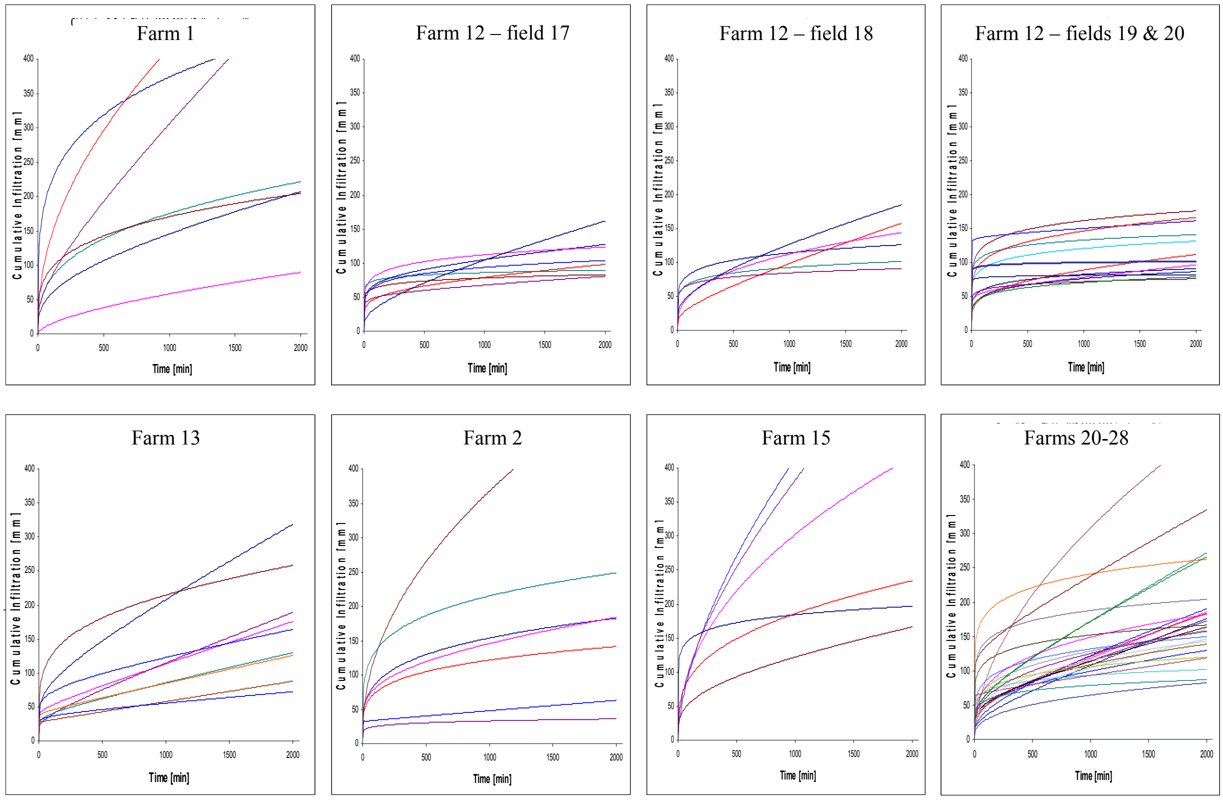

Figure 2. Infiltration variation measured under commercial surface irrigation practices

The potential to use "rule of thumb" management practices to improve the performance of surface irrigation in the cotton industry was assessed using data obtained from 78 irrigation events. In general, the application efficiency of irrigation events using traditional management practices (ie typical siphon sizes and tailwater allowed to run) as measured were found to have low application efficiencies and result in substantial deep drainage (Table 1). However, there was a wide variation in performance and deep drainage risk associated with individual events (Figure 3).

In general, reducing the period of irrigation to match the advance period was found to significantly increase application efficiencies and reduce deep drainage but also to reduce the requirement efficiency. However, while the average performance was increased, the application of this simple management change would still result in more than half of the irrigation events having an application efficiency of less than 75% and a deep drainage risk in excess of 25 mm per irrigation (Figure 4). Similarly, the introduction of this management change has the potential to significantly reduce the requirement efficiency of the irrigation which would subsequently require a change in scheduling practices to ensure that the crop stress remained unaltered. Hence, while the current move to encourage the adoption of "doubling siphons and pulling them early" generally has some merit, the effect on individual irrigators and specific events will not be the same and in 50% of cases, will not be sufficient to meet industry targets for efficiency or deep drainage minimisation.

Table 1. Effect on management practice on surface irrigation performance and deep drainage risk

	Average Application Efficiency (%)	Average Requirement Efficiency (%)	Average Deep Drainage (mm per irrigation)
Farmer management	48.2	93.6	42.5
Cut off time = advance time	72.0	88.7	25.8
Flow rate 6 l/s and cut off = 90% of advance time	73.6	82.3	16.0

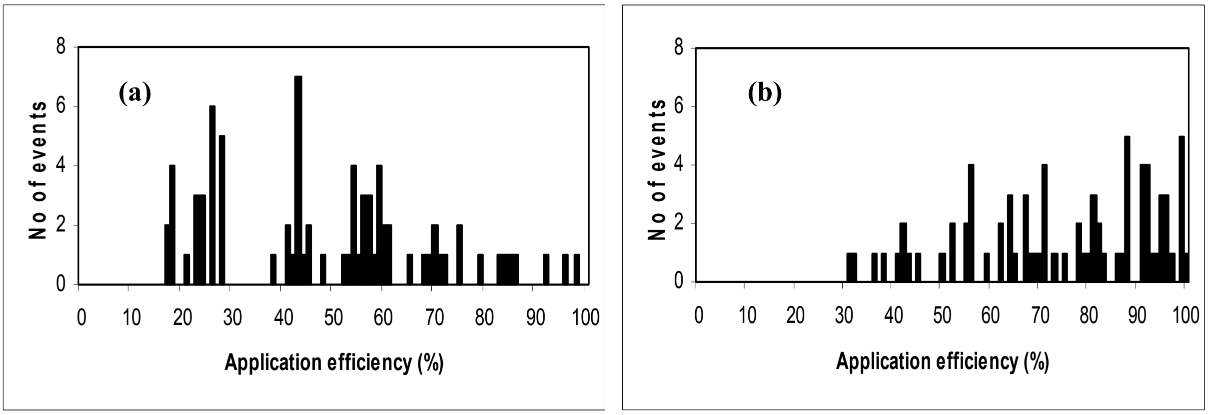

Figure 3. Variation in the application efficiency of surface irrigation under (a) traditional management practices and (b) where the irrigation water is applied at 6 l/s and is stopped when the advancing front reaches 90% of the field length.

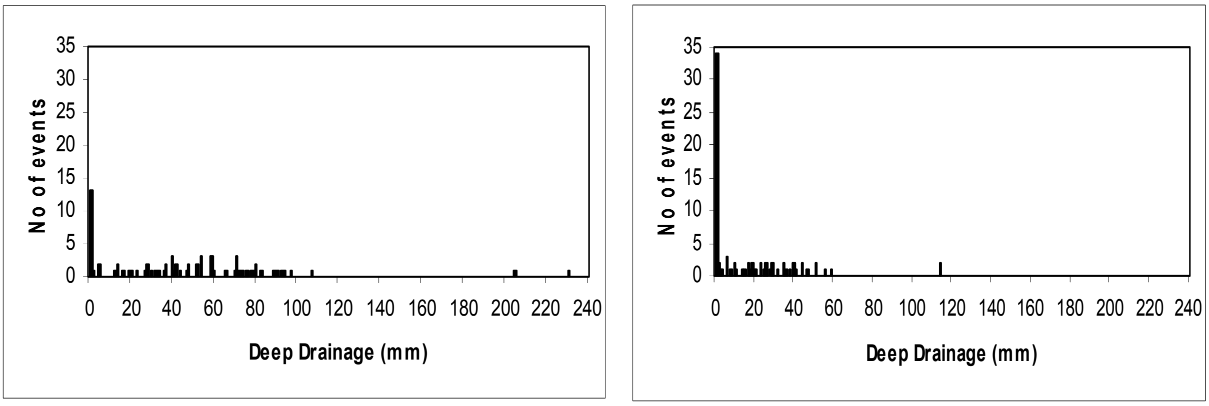

Figure 4. Variation in the deep drainage risk of surface irrigation under (a) traditional management practices and (b) where the irrigation water is applied at 6 l/s and is stopped when the advancing front reaches 90% of the field length.

Uncertainty

The main uncertainty in the development of deep drainage risk measures from surface irrigation performance evaluations is in the measurement of the soil moisture deficit. Deficits are rarely measured under commercial practices and where it is measured, the instrumentation is rarely calibrated to provide an accurate volumetric measure. There is also a discrepancy between the scale at which the infiltration characteristic is measured (furrow scale) and the point scale measurements of the soil moisture deficit. There is also some uncertainty associated with modelling the effect of management changes on surface irrigation performance as the infiltration characteristic varies slightly according to the flow rate adopted. Calibration of infiltration changes with flow rate changes is possible in the model where additional field measurements are undertaken.

Way forward

Commercial consulting services are currently available for the evaluation of irrigation performance and deep drainage risk. The utilisation of these services will enable growers to identify current levels of surface irrigation performance and deep drainage risk. This data will provide growers with a quantitative basis for the development of investment options that target poorer performing fields (eg. change management practices, field design characteristics, application system, or retire the field) and make informed decisions on long term deep drainage risks.

References

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