



IRRIGATION RESEARCH & EXTENSION COMMITTEE

2007



FOR IRRIGATION CROPPERS

Aerobic and alternate wet-and-dry (awd) rice systems ... can we increase water use efficiency?

Paper prepared by

LEIGH VIAL

Email: leroy2@iinet.net.au

IREC

C/- CSIRO Land and Water, Griffith
Private mail bag 3 Griffith NSW 2680

Tel: 02 69601550 **Fax:** 02 69601562 **Email:** irec@irec.org.au

Introduction

Water is the most limiting factor to the Australian rice industry. The Murray and Murrumbidgee catchments appear to face a future of reduced supplies and increased competing interests. Hence, water use efficiency (yield per unit water used) is an important factor upon which to focus.

One strategy that the industry wants to explore is expanding the area of AWD (also known as drill-sown in Australia) rice and extending the period of aerobic culture, without extending the season or sacrificing yield and hence increasing water productivity. This will require altered management techniques and importantly germplasm better adapted to this situation.

Strictly speaking, aerobic rice is grown purely on rainfall and is not irrigated. This is generally not suitable for the temperate Australian industry as rainfall is generally insufficient. Alternate-wet-and-dry (AWD) systems use flush irrigation to supplement rainfall as required. This may be for the whole growing season, or strategically for part of the season.

AWD establishment lends other advantages to the Australian system, namely reduced broadleaf weed pressure, less water applied early in the season to cope with low initial water allocation announcements, lodging resistance and reduced establishment cost. The major disadvantages are an extended growing season and increased grass weed pressure. Hence, although water efficiencies are the main thrust of this study, the diversity of benefits makes us doubly sure of the need to improve our AWD establishment systems.

What water use efficiency gains are possible?

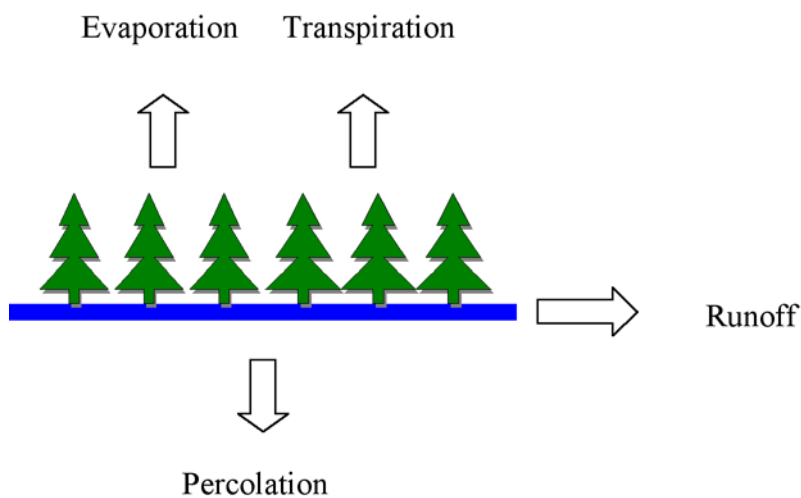


Figure 1: Water fluxes in a rice crop (when did rice look like Xmas trees?)

We can record water use efficiency improvements if we reduce losses (evaporation, percolation and runoff) or increase the conversion of transpiration through the plant into yield.

If AWD could save most soil/water evaporation and reduce percolation, and not result in an extended season as is currently the case, about 3 ML/ha could realistically be saved. Provided that yield was maintained, this could translate into a 20-25% increase in water use efficiency.

I currently perceive little ability to increase transpiration efficiency – the amount of crop produced per unit of water transpired through the plant – in our climate, short of moving to a (transgenic) C_4 metabolism in rice.

Breeding

The Australian rice breeding program needs to breed germplasm adapted to AWD culture for the first 10 weeks of the growing season. The primary parameter upon which this will be done, will be drought tolerance in the vegetative phase. Enough adaptation should be found in inbreds, but hybrids may well offer useful traits.

Transgenics could offer us C_4 rice, which should give us greater transpiration efficiency.

Nutrient management

Nitrogen losses can increase significantly in an AWD system, through volatilisation, leaching or denitrification. Due to a decrease in premium to about 40%, controlled release nitrogen formulations should be investigated for their ability to restrict denitrification and nitrate leaching, hence increase nitrogen use efficiency, in the AWD culture.

Phosphorus nutrition may well become more important, as soil phosphorus will be in its less available form.

Weed management

Grass weeds are clearly favoured in an AWD system as compared to flood and are capable of inflicting much higher yield penalties. The full range of herbicide options needs to be utilised, as many of the grass herbicides have a high resistance risk. Imidazolinone tolerant (Clearfield™) rice may need to be introduced to offer alternate mode of action for grass weed control.

Greenhouse gas emissions

Early trials have shown AWD to reduce methane emissions by about 60 percent, but nitrous oxide emissions will probably rise under AWD. The greenhouse gas emissions of AWD culture need to be further investigated, to add more resolution to methane measurements and to measure NOx emissions.

Soil suitability

Rice soil suitability may need to be redefined, from its current sole focus on percolation rates, to account for variations in moisture relations and subsequent ability to supply water in the AWD phase. Some current rice soils will not be well suited to AWD establishment.

Soil acidification

Less ponding should lead to less ferrollysis and most importantly less leaching, which should reduce soil acidification rates. The ability of AWD culture to reduce soil acidification in Australian rice soils needs to be quantified.