DEVELOPMENT OF WATERSCHED, AN IRRIGATION SCHEDULING PROGRAM, ON THE DARLING DOWNS

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Irrigation scheduling in cotton using the water balance program WATERSCHED has been the subject of an extension development project in Queensland for two years. The project is funded by Cotton Research Council.

Development on the Darling Downs

Development and demonstration on the Darling Downs began with the co-operation of Rob and Fay Donoghue 'Fairview' Dalby in the 1986/87 season. During the 1987/88, WATERSCHED was demonstrated on commercial crops at Dalby and Brookstead. In both seasons the program has been operated in a direct comparison with the use of neutron probes to measure soil moisture, predict crop water use and, hence, the prediction of irrigation.

1986/87 Season

The demonstration site at 'Fairview' in 1986/87 was designed to assess and demonstrate the program for irrigation scheduling and to investigate a range of irrigation deficits on crop development and yield. Three irrigation deficits (60 mm, 90 mm and 120 mm) and the farm treatment were applied. The farm treatment was irrigated according to farm schedule on an 80 mm deficit based on the neutron probe readings.

Neutron probe access tubes, 3 per plot, were installed and probe readings taken at appropriate times during the season.

Irrigation at the appropriate deficits was scheduled using the program based on evaporation data collected from the CSIRO weather station at Dalby Agricultural College. Initially, the program was calculated manually, with the Canon X-07 hand held computer used later in the season. Until water supplies were exhausted, irrigation was applied more or less according to planned deficits apart from variations required to accommodate cultivation delayed by wet headlands.

Yield and irrigation data from the site are summarised in Table 1.

Table 1 Cotton yield and irrigation - 'Fairview' 1986/87

Treatment	No. of irrigations	Total applied irrigation mm	Yield bales/ha	Water use efficiency kg/mm
60 mm deficit	5	472	6.96	2.27
90 mm deficit	3	520	6.32	2.07
120 mm deficit	3	517	7.62	2.50
80 mm deficit - farm practice	3	539	6.37	2.10

Season Rainfall 199.7 mm

Discussion

Exhausted irrigation water supplies terminated irrigation with one further application being required at the end of February for all treatments with a consequential reduction in crop yield. Another section of the crop which was irrigated at that time produced significantly better yield of the order of 8.6 bales/ha.

Throughout the season, all treatments were just under target on the SIRATAC fruit model for the predetermined yield goal of 10.0 bales per hectare. Predicted yields, which assumed full moisture supplies for the rest of the season, at the end of February were:

60 mm Deficit	10.36 bales/ha
90 mm Deficit	9.46 bales/ha
120 mm Deficit	9.40 bales/ha
Farm 80 mm Deficit	9.14 bales/ha

At that time all treaments except the 120 mm deficit were below irrigation deficit. The 120 mm treatment reached its deficit in the second week of March (12/3). The dramatic effect on yield of the inability to apply a further irrigation is well demonstrated.

The yield range across treatments was 211 kg/ha (0.94 bales/ha) but treatment differences are unlikely to be significant. The higher yields of the 60 and 120 mm treatments can probably be attributed to the fact that they had been more recently irrigated and were at a lower deficit (168 mm compared with 220 mm) at the end of the season. Likewise then the differences in water use efficiencies would be non significant.

With respect to the deficits, whilst an 80 to 90 mm deficit appears about optimum for the heavy black soils of the Downs, delayed irrigation up to a 120 mm deficit may not necessarily be detrimental to yield.

Soil water balance for the season in the Farm 80 mm deficit treatment is represented graphically in Figure 1. The program (model) graph is shown by the plain line whilst the neutron probe (NMM) graph line is marked with asterisks. Irrigation is indicated with an "I" and rainfall shown as a bar graph with a scale on the right hand side.

Prediction of crop water use by the program when compared graphically with direct measurement using the neutron probe was quite accurate.

1987/88 Season

Three crops were used during the season to compare the prediction of crop water use and irrigation date using WATERSCHED with the measurement of soil water use and prediction of irrigation date using the neutron probe.

Two crops, Summer 2 and Fair 2 were on 'Fairview' the property of Rob and Fay Donoghue. The third crop was at 'Glenidol', the property of Leigh and Marli Johnston. Details for each crop are shown in Table 1.

Table 1. Crop details

	Summer 2	Fair 2	Glenidol
Field capacity (1 m depth)	480 mm	380 mm	460 mm
Available moisture	200 mm	200 mm	200 mm
Irrigation deficit	80 mm	80 mm	60 mm
Planting date	3/11/87	3/11/87	4/11/87
Yield	8.6 b/ha	6.8 b/ha	5.0 b/ha

Neutron probe sites, with three access tubes, were installed in each crop and probe readings taken at regular intervals. WATERSCHED was run weekly on the Sharp PC 7100 micro computer based on weather data from the CSIRO at Dalby Agricultural College and rainfall at the property.

Figures 2, 3 and 4, as with figure 1, show a plot of soil water balance in each crop for the season.

The graphs generally show good correlation between the two techniques, particularly from the end of December onwards. WATERSCHED assumes, unless otherwise specified, a full profile of moisture at planting. This was not the case at 'Fairview' and, since we did not adjust WATERSCHED accordingly, there is a difference between the graphs until the first irrigation at the end of December.

In practice it is the predicted irrigation date as the crop progresses which is important. In order to compare the prediction of irrigation date by the two techniques, table 2 is arranged as a progression through the season at each site showing rainfall, predicted and actual irrigation dates.

Table 2. Predicted irrigation dates - 1987/88

Date	Rain for period mm	Predicted next irrigation		Actual irrigation	Deficit at irrigation mm
		WATERSCHED	NMM		
Summer 2					
9/12	65.9	27/12	16/12		
18/12	15.0	29/12	21/12	30/12	91
12/1	50.0	28/1	15/1		
18/1	12.0	18/1	17/1		
27/1	74.5	30/1	27/1	5/2	131
12/2		17/2	16/2	15/2 (Rain)	31
Fair 2					
15/12	109.0	27/12	30/12		
22/12		2/1	30/12	30/12	73
5/1	13.0	15/1	12/1		
18/1	12.0	18/1	18/1	19/1	79
27/1	74.5	1/2	29/1	3/2	103
12/2	23.2	15/2	16/2	15/2 (Rain)	47
Glenidol					
23/12	79.3	24/12	27/1		
29/12	8.2	30/12	2/1	1/1	83
6/2	88.5	9/2	11/2	6/2	114
27/2	87.0	29/2	27/2	28/2	103

(Rain) - rainfall saved the need to irrigate

Discussion

Whilst the predicted dates are not always the same, with three exceptions, they are within 3 days of each other. The probe provides a direct measurement of soil moisture, but there were fluctuations in the readings even though it had been directly calibrated for these soils. The error range appears to be of the order of + or - 10 mms, equivalent to 2 to 3 days of crop water use. In practice, then and given that irrigation will take several days, such a difference is not signficant.

Two exceptions occur prior to the first irrigation in summer 2 where there was not a full profile of moisture at planting and good rainfall during that period was not as effective as predicted by WATERSCHED but measured by the probe. The third exception occurred in summer 2 in mid January when, again, WATERSCHED initially overestimated the effectiveness of rain.

These exceptions demonstrate the advantage of the probe measurement in its ability to directly measure the amount of rainfall taken into the profile. In this situation, estimates of runoff must be made and the appropriate adjustment made to the rainfall entered into WATERSCHED.

In these crops WATERSCHED has effectively predicted irrigation date and compares favourably with predictions based on neutron probe measurements.

The operation of WATERSCHED is enhanced by good estimates or direct measurement of initial soil moisture at planting and of runoff following rain. In this respect a combination of the two techniques could offer maximum benefit to management. One neutron probe site on the property could be used to measure soil moislture and the effectiveness of rainfall. WATERSCHED crop files would then be established for each management unit taking into account variations in soil type and moisture holding capacity, planting date and so on.

Figure 1: SOIL WATER BALANCE
Cotton: Fairview 1986/87

Deficit 80mm

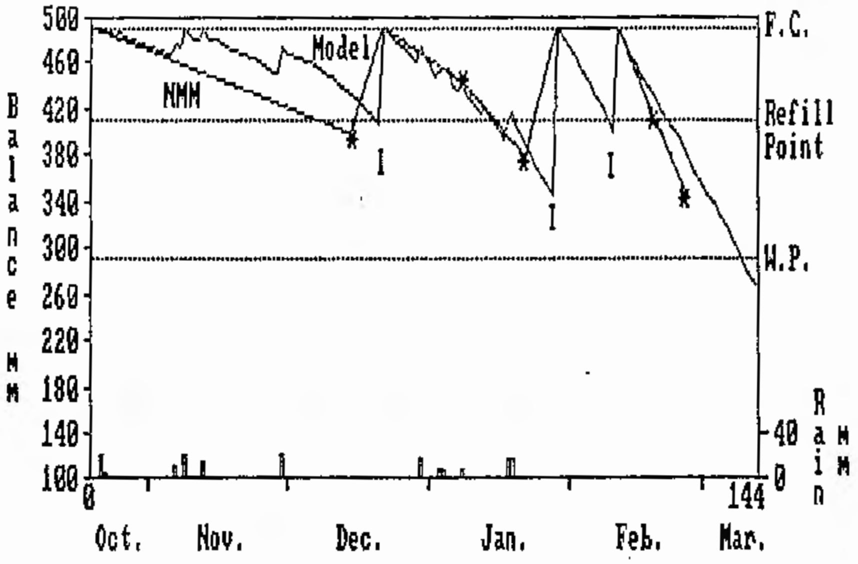

Figure 2: SOIL WATER BALANCE
Cotton - Fairview 1987/88
Summer 2

Deficit 80 mm

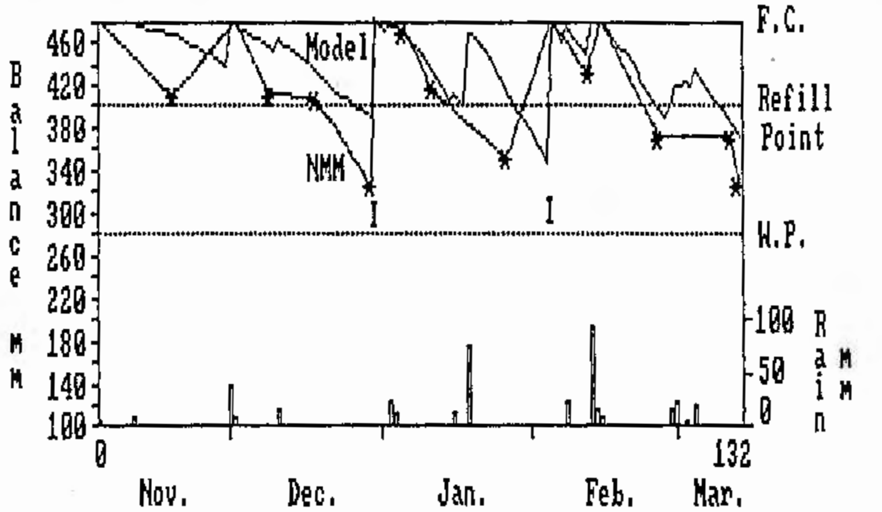

Figure 3: SOIL WATER BALANCE
Cotton - Fairview 1987/88
Fair 2

Deficit 80 mm

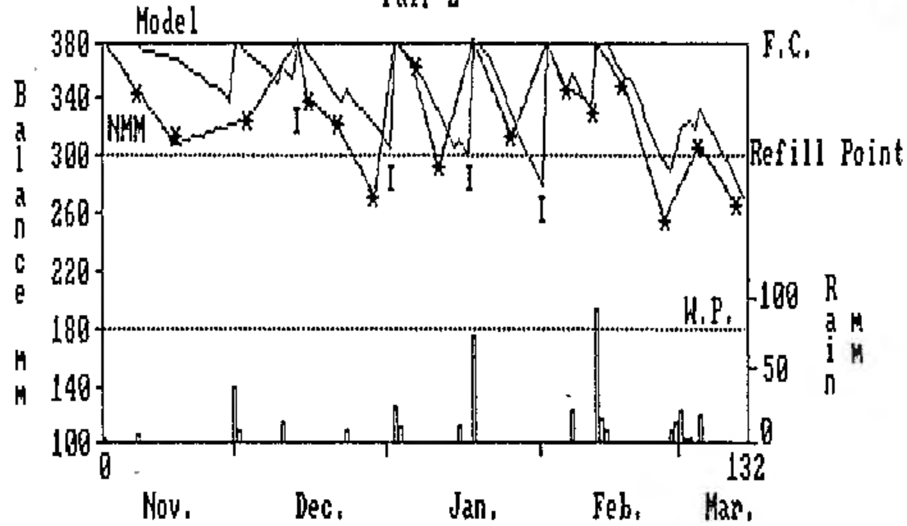

Figure 4: SOIL WATER BALANCE
Cotton: Glenidol 1987/88
Day Degrees

Deficit 60 mm