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Cotton Research and Development Corporation

Project Title: Measurement of complete water balance of a cotton field

Project Number: CSP20C

Research Organisation: CSIRO Division of Plant Industry, Cotton Research Unit

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A final report prepared for the Cotton Research and Development Corporation

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Summary:

This project involved the purchase of equipment to measure the surface water inputs and outputs of two commercial scale cotton fields. Cotton is grown on each field in alternate years and fallowed in the off year so that it was possible to compare the hydrologic behaviour of both cropped and fallow conditions. Irrigation water and rainfall inputs and tailwater outputs were measured. Irrigation water input was measured with an open flow meter installed in the head ditch of the field containing cotton. Rainfall quantity and intensity were measured with a tipping bucket rain guage connected to a data logger. Outflow of surface water from both fields was measured with v-notch weirs and water depth sensors coupled to data loggers. A computer program has been written to process data logger output into a form for graphing and analysis.

Several problems occurred with the equipment which limited the amount of data collected in this first year. However, the data that was recorded shows great promise of providing useful information for model development and general cotton irrigation management with little effort or cost.

While some of the results collected to-date will be immediately useful for model development and testing, the work is essentially of a long-term nature due to the small number of events measured in any one year. Several years may be required to collect an acceptable volume and range of data for some applications. The equipment purchased by this project will provide many years of service so that this data can be assembled.

Equipment and methods:

The following equipment was purchased:

- 1 open flow meter;
- 2 v-notch weirs;
- 3 water level sensors with data logging units;
- 1 tipping bucket rain guage with data logger.

The v-notch weirs were fabricated from sheet metal by a Narrabri firm. The weir on the field containing cotton was calibrated during a normal irrigation and now provides highly accurate estimates of outflow from the field by simply measuring the height of water flowing over the weir. The water depth sensors for automatically measuring this water height also needed calibration so that they measure water height relative to the weir crest. The weir on the fallow field will be calibrated during an irrigation in the 1991-92 season when the field will be used for cotton. The water depth sensors were installed in the tailwater drains of each field near the weirs. The tipping bucket rain guage was situated between the two fields. A portable computer was used to down-load data from the data loggers. This was usually done every two or three weeks or after an irrigation or storm. The data loggers can store data for up to three months if necessary.

The open flow meter consists of a propeller connected to a simple mechanical accumulating meter (just like a domestic water meter). The meter is calibrated for a given pipe diameter. The flow meter was installed at the end of the appropriate size pipe in the head ditch of the cotton field. While an irrigation was taking place the meter reading and time would be recorded every two to three hours or before and after a syphon change.

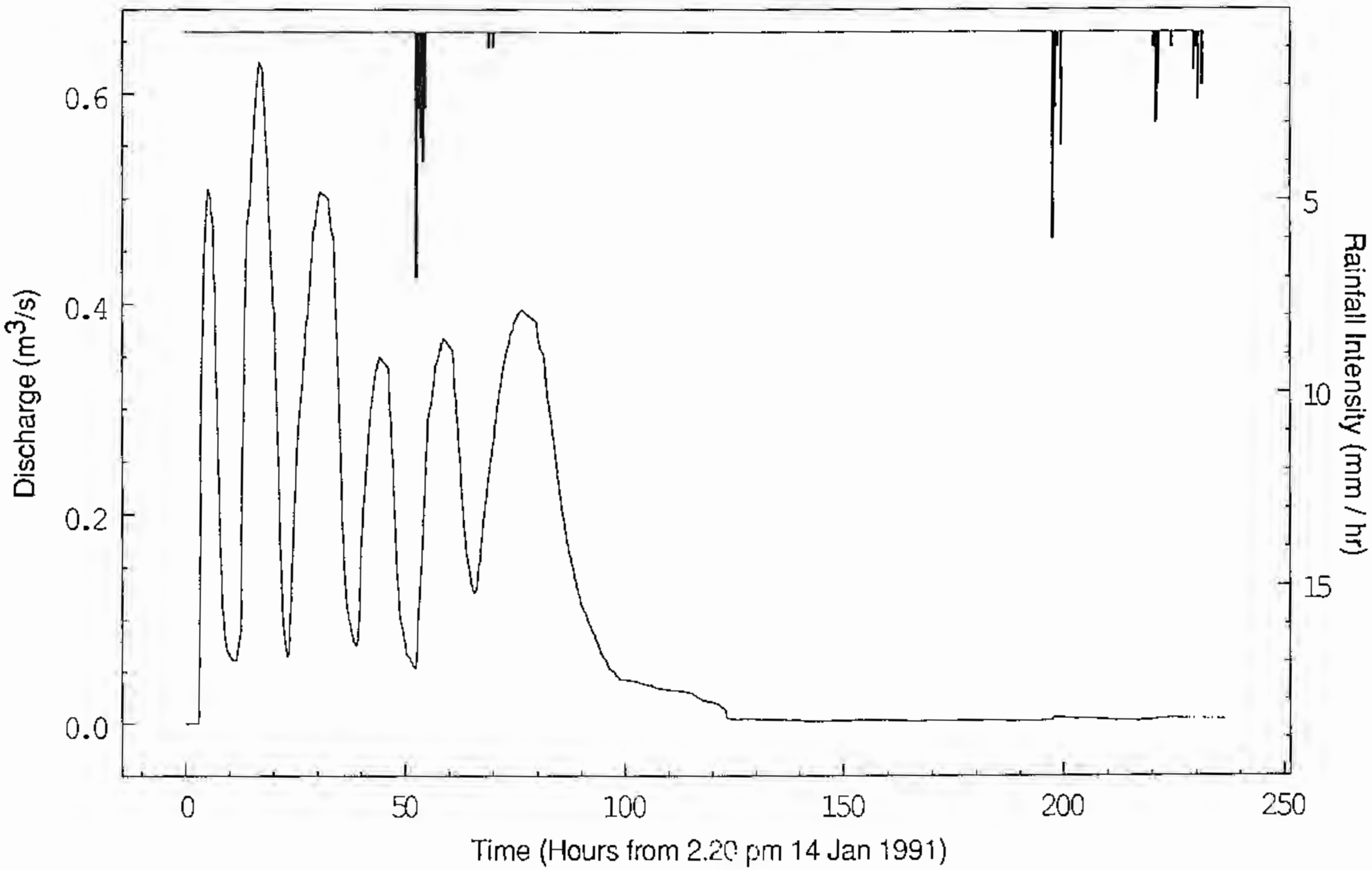
A program was written on an Apple Macintosh micro-computer to process the data logger output into a form for graphical and statistical analysis.

Several problems occurred with the equipment. Firstly, the open flow meter was continually clogging up with debris in the irrigation water and no reliable measurements of irrigation water inputs could be made. The layout of the irrigation system at the measurement site also made it difficult to install any simple screen to keep the debris from the meter. Further work will be needed to remedy this situation but the circumstances are expected to be better at the other field. Secondly, the the tipping bucket rain guage was sprayed with a herbicide which degraded the inside plastic bucket assembly causing it to crack. The guage had to be sent away for repairs and no acceptable replacement guage could be found in the interval. Thirdly, one of the water depth sensors experienced electronic problems on two occasions and was sent away for repairs for considerable periods. A replacement water depth sensor was purchased to make the measurement system somewhat more reliable.

Results and Discussion:

Despite the above difficulties some rainfall and tailwater data were collected. Figure 1 shows the drainage from the cotton field and the rainfall for the same period. The highly erratic tailwater flow at the beginning of the period is caused by an irrigation. The wave

Figure 1: Drainage Hydrograph for Field L2



like nature of the flow is caused by temporary halts in the irrigation as syphons are pulled up and moved further along the field and restarted. It can be seen that this particular irrigation required six syphon changes.

Perhaps the most interesting feature of the rainfall is the negligible impact the storms made on the outflow from the field. The first and largest storm occurred during the irrigation and any runoff it my have caused is completely masked by the irrigation drainage. The later storms cause almost no runoff at all. The very small response from the largest of these later storms may just be due to localised runoff from the saturated tailwater drain. Unfortunately, no large storms or very intense rainfall were recorded. Interception of rainfall on the leaves of the crop may explain the lack of runoff response to small rainfall events.

The data collected from this project will be used to estimate crop water use for the whole field; not just point measurements. These results will be more reliable and representative than point measurements which are subject to enormous variability. We can then calibrate and validate the soil-water model on a whole field basis which is the appropriate scale for cotton irrigation decision making.

The results also provide data for calibrating the surface runoff component of the soil-water model. The relationship between rainfall and runoff is complex, especially on cracking clay soils. The collected data will be invaluable for improving the current soil-water model but may also be useful in formulating new, more realistic models.

These measurements also provide insights into the general behaviour of water on cotton fields. Graphical representation can highlight features which may otherwise remain obscured. An example of this is the shape of the irrigation drainage curve (hydrograph) in Figure 1. This shape is largely determined by the physical layout of the field (slope, length, etc) and the character of the soil (infiltration rate, antecedent soil water content, hydraulic conductivity, etc). The shape should provide a kind of signature for the field. Any changes in the hydrograph shape within a season may provide clues to soil structural change such as developing compaction.

Conclusion:

The water monitoring system for irrigated cotton fields set up with funds from this project promises to be very useful in two ways: first, for providing data for calibration and validation of soil-water models and; second, increasing the understanding of soil-water relationships in cracking clay soils. The project has experienced some technical difficulties but these are really no more than teething problems. The setup cost of the system was relatively small and it takes little time to manage. It is an example of cost effective research.