Report of visit of Professor Hamlyn Jones to the University of Melbourne, School of Land and Environment (25 Oct 2010 – 3 Dec 2010)

Reference: GWT 1007

Objectives of visit:

"The objective of this proposed travel is to facilitate the development of plant based irrigation scheduling techniques through the involvement of a leading international researcher, Professor Lyn Jones, in an experimental campaign at Dookie and consultations at key viticultural research and postgraduate education centres in Melbourne and Adelaide."

The overall scientific purpose of the visit was for me to develop the use of thermal remote sensing of crop water stress, using a crop water stress index (CWSI)-based approach, as a tool for irrigation scheduling and to apply this specifically to the closed loop irrigation control system being developed at Dookie College by Ashley Wheaton under the Australian Government's National Water Commission's Farms, Rivers and Markets project. I have over several years been developing the underlying theory of thermal remote sensing of crop stress, including, through a previous GWRDC-supported visit and collaboration with Dr Brian Loveys, CSIRO Plant Industry, Glen Osmond (GWT 0702; Loveys 2008). On this occasion the specific scientific objectives to be achieved were to

(i) investigate and improve the use of reference surfaces (used for normalising temperature records for environmental conditions)

(ii) to provide a workable algorithm to relate measured temperatures to crop stress and hence irrigation need.

Other objectives were to engage with staff and students in the University of Melbourne (Parkville, Burnley and Dookie Campuses) and with the researchers at other sites and the horticultural industry.

Details of the visit:

The actual dates of the visit were from 20th Oct 2010 to 18th Dec 2010 with some of the additional time spent visiting the Australian National University and CSIRO in Canberra. For the majority of my visit I stayed in University College, Melbourne (and was based at the School of Land and Environment, Parkville Campus, Melbourne) with a number of day and longer visits to Dookie College and to Canberra as required. In order to improve the replication possible in the field experiments at Dookie, I provided a number of thermal sensors (7) from my own resources to allow improvements to the experimental design. These were delivered to Dookie for initial testing and set-up on 24-25th October, 2010.

The experiment at Dookie College formed one part of a larger experiment evaluating various irrigation scheduling techniques on Shiraz wine grapes. The other blocks included a control treatment using the industry standard time/date based irrigation, a soil moisture-based automated closed loop real-time system and a scheme based on ET estimates. Within the CWSI block there were three replicates of four treatments (Soil moisture based control, a full irrigation control, and two CWSI treatments with different thresholds for irrigation. The

thermal sensors were mounted above the centre row of each treatment looking downwards at 45° to view a reasonable area of the canopy to get a good canopy average temperature. Additional meteorological data was obtained from local met stations. Unfortunately heavy rainfall during the 2010-2011 summer meant that very little irrigation was required and no substantial treatment differences achieved, so it did not prove possible to calibrate the system thresholds for wider application.

Outputs:

(1) ***"Real time computation of crop water stress index for grapevines under irrigation".*** Following earlier provision of draft algorithms for integration of thermal sensor and environmental data, a refined algorithm for application of thermal sensing to scheduling of irrigation in grapevine using a closed loop system was produced and supplied to Ashley Wheaton for testing (supplied 4 March 2011). In practice, however, the extremely wet summer in NE Victoria during 2010-2011 meant that only very limited testing was possible, with irrigation only being applied on two occasions with only very small treatment differences being achieved.

(2) ***"Seminars and discussions on recent advancements in remote sensing of plant water status".***

(a) On 23rd November 2011 I presented a keynote talk ("Thermal sensing of plant stress in horticulture" at an open day at Dookie College for industry and scientists on "Sensing plant stress as an irrigation management tool in horticulture and viticulture". For this meeting the conference presentations were complemented by field demonstrations and discussion of the irrigation systems being tested.

(b) Although diary clashes prevented a visit to the Waite Institute in Adelaide, I was involved in the remote provision of advice to Brian Loveys on a bid for the establishment of a new test vineyard on the Waite Campus, Adelaide, by Steve Tyerman and Brian Loveys.

(c) Extensive discussions were held with staff at Parkville and Dookie on various occasions, especially with Ashley Wheaton, D Nicola Cooley, Professor Snow Barlow and Professor Bill Moran (who is in the Engineering department and is developing analysis techniques for thermal data). In addition, a presentation was made to Staff and students at the Burnley Campus (9th Dec 2010). Furthermore an informal seminar on "Thermal sensing of plant stress" was given, and extensive discussions held, with researchers at the Australian High Resolution Plant Phenomics Centre, CSIRO, Canberra (especially Dr David Deery, Dr Xavier Sirault and Dr Robert Furbank) and with staff at the Australian National University (especially Emeritus Professor Barry Osmond and Professor Graham Farquhar) about the optimisation of thermal sensing for plant stres. Substantial inputs to methods for data handling and optimisation of the algorithm and relating to the choice of reference surface, were obtained from these discussions. Other discussions were held with staff at the DPI site at Tatura.

(c) Subsequent to the visit, some results of this work were presented at ComBio2011 conference in Cairns in an invited talk entitled "Thermal remote

sensing of water stress: implications of scale" in the session on "Nitrogen and water-use efficiencies". This paper addressed the problems relating to the use of thermal sensors (as being developed in the Dookie experiment) as compared with imagery; this will be submitted with a month for publication in Functional Plant Biology as a special paper (with Dr Xavier Sirault, CSIRO, Black Mountain, Canberra).

(3) ***"Formative discussions with postgraduate students in irrigation, climate change and viticulture".*** Discussions were held with students at Dookie, Parkville and Burnley campuses. Particularly extensive discussions and interactions were with a student of Professor Bill Moran's Peter Zhong who is developing in collaboration with Dr Nicola Cooley and exciting new approach to the evaluation of water stress in plant leaves based on laser speckle interferometry, Other extensive discussions were with students in Melbourne and Canberra largely relating to estimation of plant stress.

Financial aspects

I understand that a full financial report covering this visit has been submitted by the University of Melbourne.

Acknowledgements and conclusion

I am very grateful to the GWRDC and to Melbourne University for supporting my visit to Australia and for making it possible. I am also particularly grateful to my hosts including especially Snow Barlow, Nicola Cooley and Ashley Wheaton. I believe that substantial progress has been made towards the development of a simple thermally-based automated irrigation scheduling system for wine grapes, even though practical testing of the system was limited by the high rainfall during the experimental period. I am hopeful that more effective testing can be achieved in the future and I remain keen to help with any refining of the algorithm or its practical application that is required.

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