Spectral Reflectance of Wheat Recombinant Inbred Lines: A Computational Modelling Study

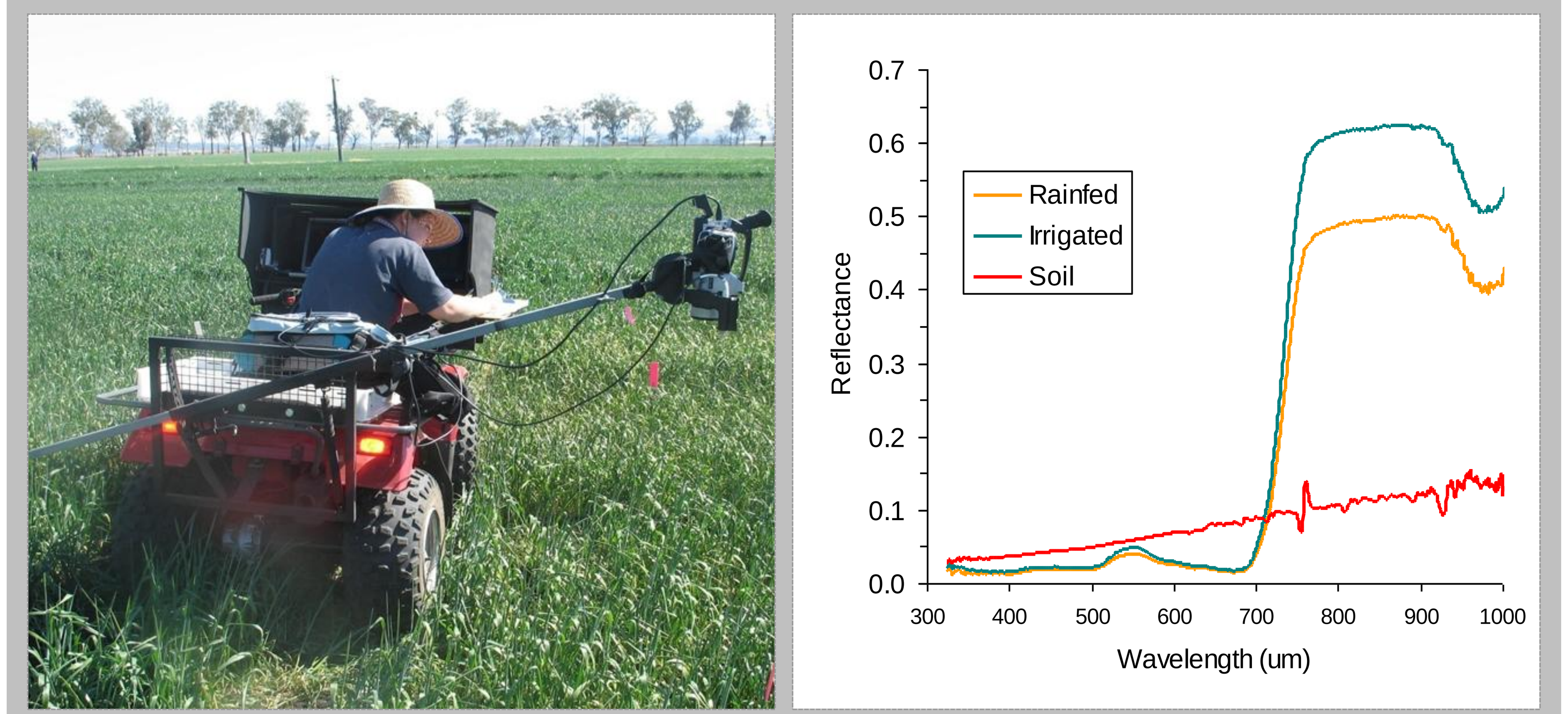
Liqi Han[1,2], Jim Hanan[3], Fernanda Dreccer[1]

[1]CSIRO Plant Industry, Cooper Laboratory, Warrego Highway, Gatton, QLD 4343, Australia
[2]School of Information Technology & Electrical Engineering, The University of Queensland, Brisbane, QLD 4072, Australia
[3]Centre for Biological Information Technology, The University of Queensland, Brisbane, QLD 4072, Australia

The light reflected by a wheat crop canopy can be used to evaluate the complex traits underlying water use efficiency in dry environments. Spectral reflectance, a non-invasive technology capable of surveying multiple traits simultaneously, is being used for identification and discrimination of traits in a breeding context (Figure 1).

In this study, we develop and integrate computational modelling approaches to simulate the complex interactions between wheat crop architecture and the light environment. There are three major components of the simulation space (Figure 2): a patch of wheat plants, the light environment, and a virtual sensor simulating the spectroradiometer used in the real field. These three components are parameterised according to field data, thus allowing the running of virtual experiments to produce predictions and study implications.

This computational study provides a time- and resource-saving platform to investigate the effect of field of view versus crop height, the effect of sensor height on signal at selected ages, and the effect of architectural differences between the recombinant inbred lines.



a b

Figure 1: Measurement of spectral reflectance. A spectroradiometer (a) is used in the field to measure the spectral reflectance (b) of crop canopy.

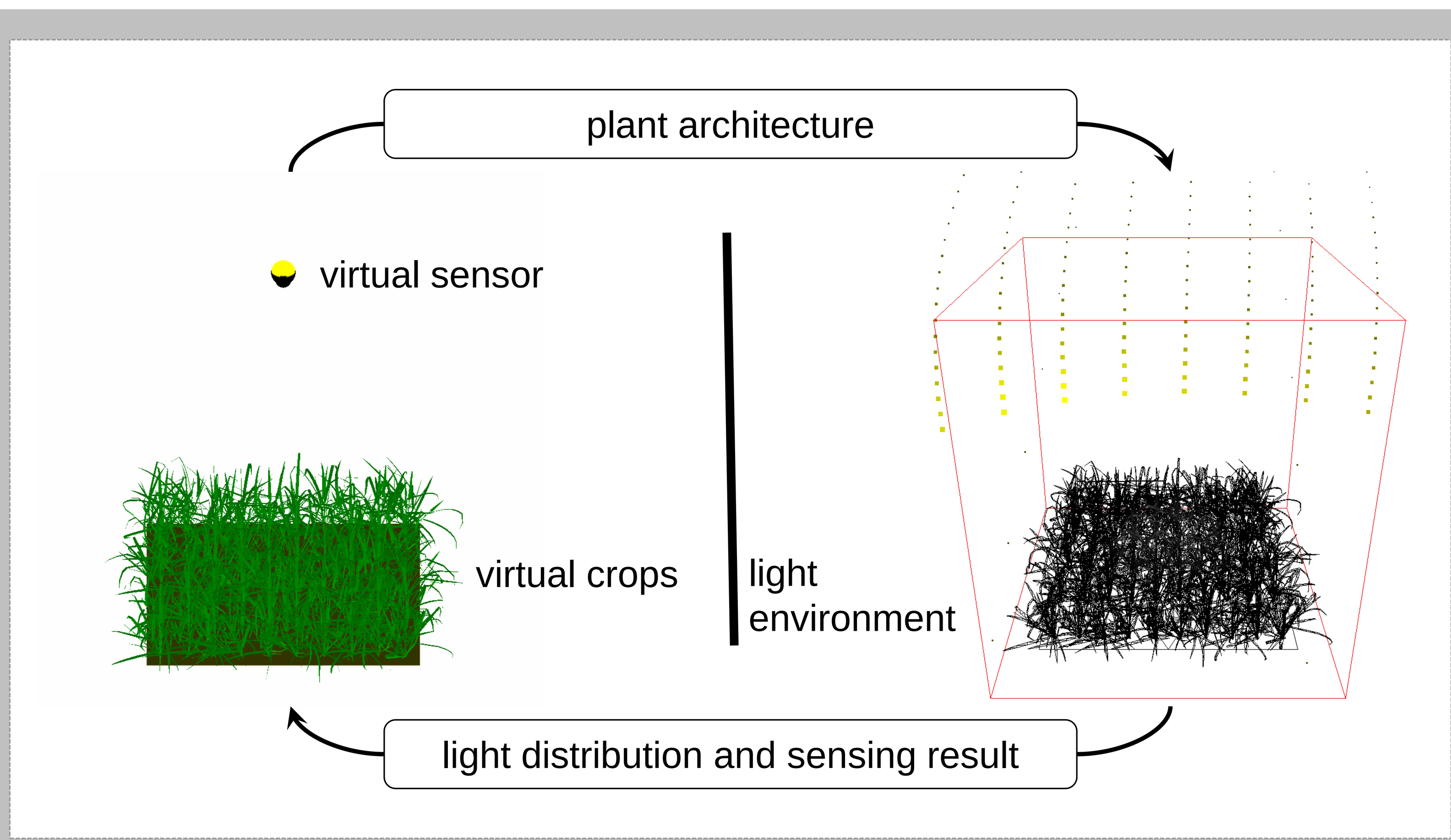


Figure 2: Composition of simulation space. The crop simulation is based on a wheat architectural model previously developed by Jochem B. Evers *et al* [1,2]. The light environment is simulated by a QuasiMC program [3]. The communication modules embedded to the virtual crops collect the architectural information and send it to the light environment. The QuasiMC program computes the light distribution among the investigated plant organs and then returns the result to the virtual sensor.

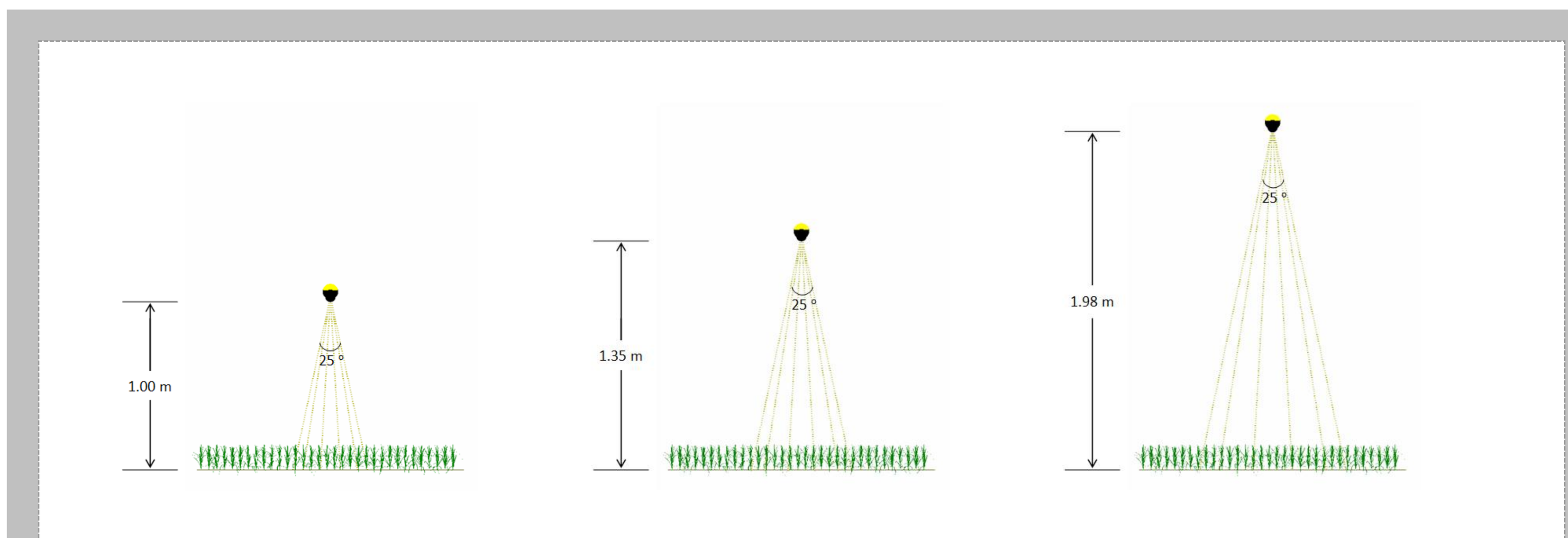


Figure 3: Investigation of the effect of sensor height.

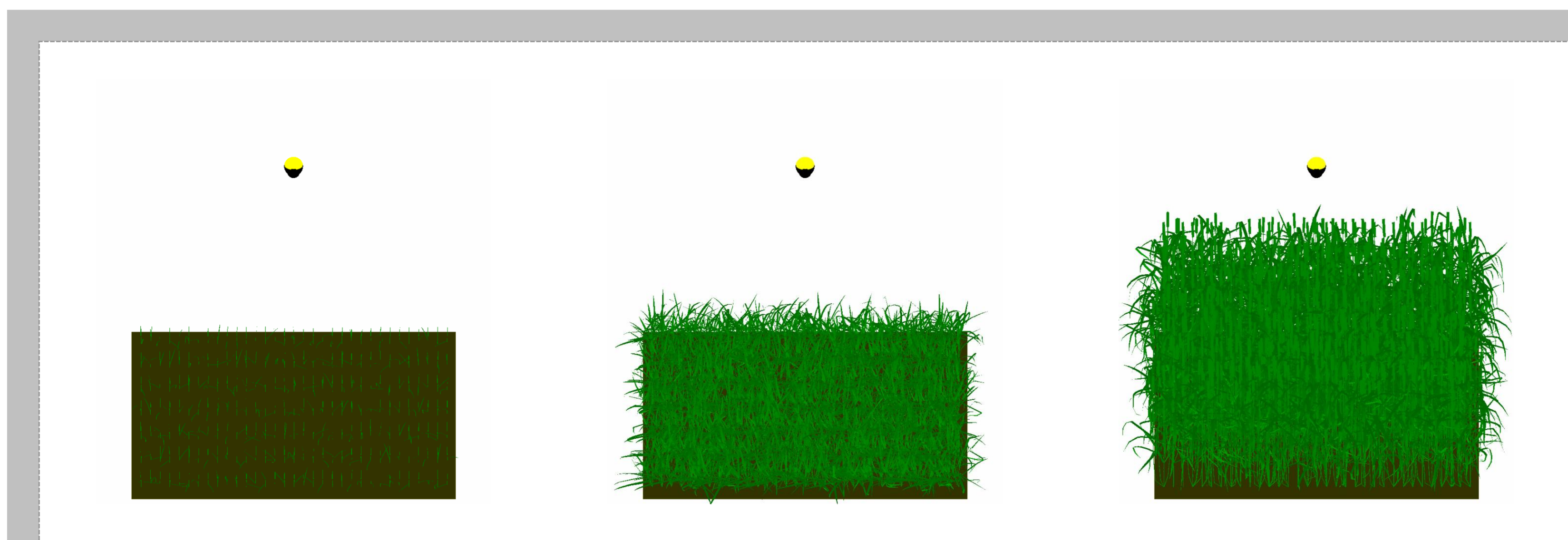


Figure 4: Investigation of the effect of developmental stage.

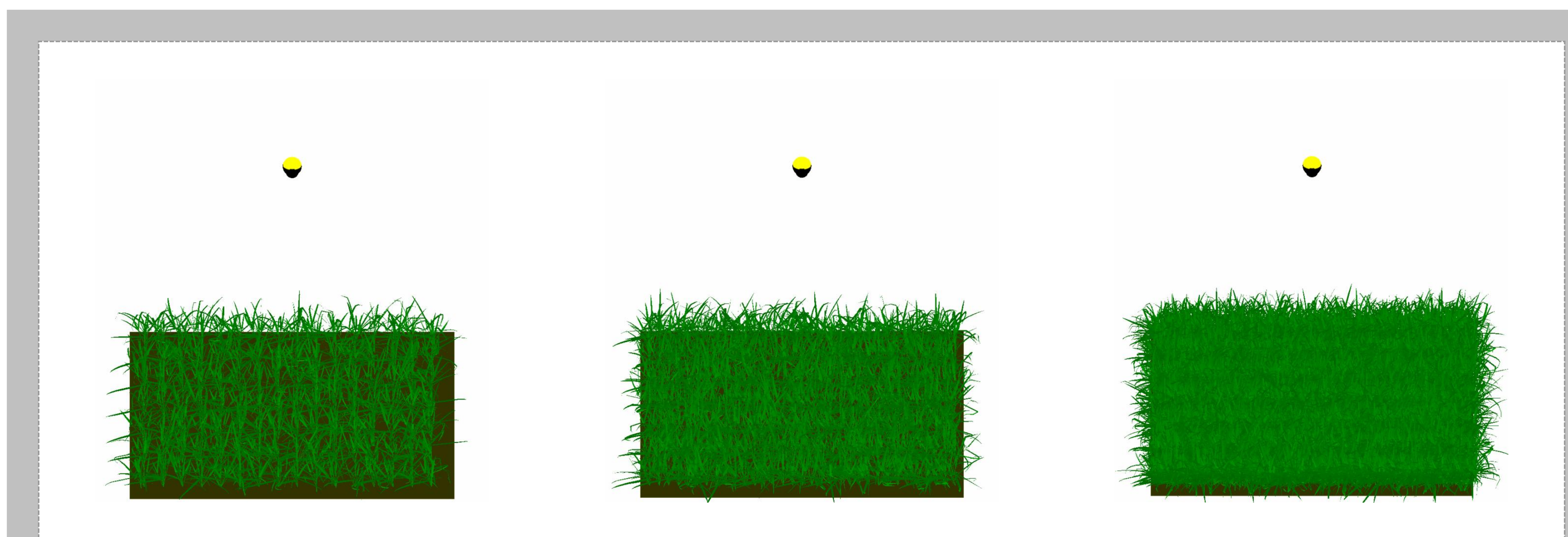


Figure 5: Investigation of the effect of planting density.

References

[1] J. B. Evers, J. Vos, C. Fournier, B. Andrieu, M. Chelle, and P. C. Struik, "Towards a Generic Architectural Model of Tillering in Gramineae, as Exemplified by Spring Wheat (*Triticum aestivum*) " New Phytologist, vol. 166, pp. 801-812, 2005.

[2] J. B. Evers, J. Vos, C. Fournier, B. Andrieu, M. Chelle, and P. C. Struik, "An architectural model of spring wheat: Evaluation of the effects of population density and shading on model parameterization and performance," Ecological Modelling, vol. 200, pp. 308-320, 2007.

[3] M. Cieslak, C. Lemieux, J. Hanan, and P. Prusinkiewicz, "Quasi-Monte Carlo simulation of the light environment of plants " Functional Plant Biology, vol. 35, pp. 837–849, 2008.

CSIRO

The University of Queensland
AUSTRALIA

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Further information

contact: Fernanda Dreccer
phone: 61 7 5466 3010
email: fernanda.dreccer@csiro.au
www.csiro.au