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International Commission on Irrigation and Drainage (ICID)

ICID WATSAVE AWARDS 2009

Young Professionals Award

Statement summarising the nominee's [Dr Malcolm Gillies]

work related to water saving/ conservation

I. The innovation

The basis of this nomination is the work by the nominee in the development and application of innovative and advanced simulation tools for the evaluation and optimisation of surface irrigation systems. Specifically the tools are:

IPARM (refer attachment). This is an inverse solution of the volume balance equation that allows calculation of the time dependent soil infiltration characteristic for a furrow or bay from measurements of the irrigation advance and runoff. The data obtained are then used in an appropriate simulation model to simulate the irrigation and determine the best irrigation for the particular furrow or bay.

IRRIPROB (refer attachment). IRRIPROB is a simulation tool to assist with managing furrow irrigation and the effect of soil spatial variability. Up till now recommendations for performance improvement were based on data from a limited sample of furrows. The very substantial spatial variability in soil infiltration characteristics and hence irrigation performance between furrows were ignored. Using relatively simple ways of defining this field variability, this model solves the full hydrodynamic equations to simulate the hydraulics of multiple irrigation furrows and determines the optimum flow rate and time to give optimum performance for a whole field or set of furrows. Additional novelty is present in the graphical presentation of the interaction of the main performance measures and the user specified objective function.

SISCO (refer attachment). This is a new generation simulation model that will replace IPARM and the current generation simulation models. Like previous simulation models it employs a solution of the full hydrodynamic equations. However, it is unique in that it:

- is applicable to all surface irrigation methods, furrows, bays, level basins and drain back basins;
- performs the functions of calibration (inverse solution of the hydraulic resistance and infiltration parameters from the measured advance, recession and runoff), simulation, and optimisation in a single model; and
- can perform the calibration with less than complete measured data; and

- allows user preferences in the selection of the optimum or preferred irrigation.

II. How the innovation saves water

Performance gains (water savings) in excess of 20% are readily achievable in surface irrigation systems through the process of evaluation and practice change. Surface irrigation (furrow, bay, and basin) remains the dominant irrigation method in Australia at 70% of the total area irrigated (in excess of 1,000,000 ha and 4,000,000 ML). Measurements of performance across the main surface irrigated crops (cotton, grains, sugar and pasture) show application efficiencies ranging from 20 to 90% but averaging about 50%. Selection of more appropriate flow rates and irrigation times better suited to the specific soils can raise average efficiencies to above 70%. This requires individual performance evaluations on each farm or field that involves:

- Monitoring and irrigation event(s);
- Inverse solution from the measured irrigation advance and other data to give the infiltration and surface resistance parameters prevailing during the measured irrigation;
- Simulation of the measured irrigation as a means of calibrating the simulation model and calculating the performance parameters for the measured irrigation;
- Conduct of 'what if' simulations to determine the preferred flow rate and irrigation time.

In Australia this evaluation service is being delivered to the cotton industry by consultants on a fee for service basis under the IRRIMATE^{TM} brand. In other industries, for example, the sugar industry the service using the same tools is being delivered by industry extension officers. To date the IRRIMATE^{TM} services has been independently assessed to have delivered the equivalent of AUD$36million in present value benefits to the cotton industry in terms of water and energy savings and productivity improvements.

III. How innovation will be introduced

The program IPARM is one of the IRRIMATE^{TM} suite of tools and is currently being used routinely in the evaluation of surface irrigation systems. The nominee is part of the team responsible for providing training and technical support to the consultants and extension staff using these tools. SISCO is presently undergoing testing prior to its release but has already proven its ability to analyse the more complex bay irrigation evaluations (Attachment 3). When the testing is complete it will replace IPARM and the current simulation models as the model of choice in surface irrigation evaluation. The in-house testing of the more specialised IRRIPROB is complete and has been made available to selected consultants for their testing and evaluation.

IV. Scope for further expansion of the innovation

The potential for expansion of the innovation is significant:

1. The improved evaluation tools will expand the uptake of the evaluation process among surface irrigators. The SISCO model has the ability to identify the surface resistance parameter as well as the infiltration characteristic and is able to use a wider range of measured data, for example, advance, recession, flow depths, and/or runoff. This improves the quality of the parameter estimates, the subsequent simulations and hence the recommendations stemming from those simulations. It also allows evaluation of systems such as basin irrigation and bay irrigated pasture where the current tools had severe limitations. This opens up further significant areas of surface irrigation to the possibility of evaluation and performance improvement. The capability of SISCO is shown in Attachment 3.

2. The simulation tools will be the core elements in new automated adaptive real-time control surface irrigation systems. The higher flow rates and shorter irrigation times required for improved performance are best delivered by automated systems. Even greater performance can be obtained if these systems can adapt to the different conditions prevailing at each irrigation. The nominee is currently the Co-Principal Investigator on a project to develop smart automation for surface (furrow and bay) irrigation. The SISCO model will be an essential component of this system.

3. The models can be adapted to new configurations of surface irrigation. Drain-back or reverse slope furrow irrigation is a technique new to Australia and its use for irrigation of summer grains is expanding. This is despite a lack of objective data on its performance. SISCO has been written to handle these systems as well as conventional flow through surface irrigation methods. For the first time this provides a tool for the analysis and evaluation of these reverse slope systems. Another PhD student, with the assistance of the nominee, is using SISCO to analyse data from his field trials on two different drain-back configurations. If successful this work will form the basis of a new evaluation process for these particular systems.

V. Role of the nominee [Dr Malcolm Gillies]

The nominee was responsible for the development and testing of all three models. IPARM and IRRIPROB were written as part of the nominee's PhD at the University of Southern Queensland. The more recent work on the SISCO model was undertaken while the nominee was employed as a Post Doctoral Fellow with the Cooperative Research Centre for Irrigation Futures www.irrigationfutures.org.au