INNOVATIVE NEW IRRIGATION WATER MANAGEMENT TOOL ENHANCES PRODUCTION EFFICIENCY

With benefits at field, farm and irrigation scheme level

The level of subsidisation of agriculture in South Africa is one of the lowest in the world compared to other countries. Indirect government support to commercial farmers, such as through publicly-funded research and extension, has moreover declined in recent years. This means that South African farmers, like those in other developing countries, face greater challenges to raise the efficiency of their operations, which they must do if they – and the economies of their respective countries – are to prosper against the backdrop of a globalised market.

Water management, mainly in respect of irrigation practice, is one of the most critical determinants of economically efficient crop production, particularly in a seasonally dry country like South Africa. It is for this reason that the development of an integrated computerised information system for the management of irrigation water – at field, farm and irrigation scheme level – has been undertaken under the leadership of South Africa's Water Research Commission (WRC).

As with any other research, however, the irrigation water management model must be tested in practice and then transferred to those who are able to use it, if the ingenuity, effort and money that went into its development are to have the desired output at producer level. Field tests have been conducted at two irrigation schemes, and the WRC is now gearing itself up for a major technology transfer project, to commence in 2004.

The opportunity also arises for the integrated information system on irrigation water management to be used by the advisory bureaus of co-operatives or agribusinesses as part

of the service they provide to farmers. Furthermore, there is an opportunity for the establishment of private management consultancies – a relatively new service industry with potential for entrepreneurs skilled in this discipline. Their function would be to render water advisory services to irrigation farmers whose skills may be orientated more towards field crop production than to computers, and to irrigation schemes which may need some technical guidance in adopting the latest computer-aided technologies.

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The chairman of the steering committee that assisted the project team in integrating three high-tech water management models in such a way that they can be applied to optimal effect in irrigation schemes, Dr Gerhard Backeberg of the WRC, says that, initially, the model will perforce have application at the commercial farming level. Once it has been widely adopted by users, and the necessary infrastructure of practitioners and advisers has been built up, it will be possible to give attention to extending the system to the developing farmer level.

The basic requirement underlying the project was "that water resources be used productively and greater efforts be made to increase productivity growth and thereby the competitiveness of agriculture," emphasises Dr Backeberg.

The three computer models which were integrated into a workable irrigation-orientated Geographic Information System (GIS) are the **SWB**, **RiskMan** and **WAS** models. The purpose and functions of each model are briefly as follows:

SWB – SOIL WATER BALANCE MODEL

Soil Water Balance is a real-time irrigation scheduling computer model and was developed as an irrigation scheduling tool to help crop producers to save water, energy and fertiliser. It simulates the crop growth and soil water balance on field scale for the purpose of providing recommendations on irrigation timing and amounts. For research purposes at this stage, it can also calculate the salt balance.

When used as an irrigation scheduling tool, weather and irrigation data need to be entered into the model on a daily basis. SWB can also be used for scenario modelling and as a planning tool.

SWB can be run in three modes:

- **Irrigation mode** – the basic mode – for real-time use by farmers whose field and soil input data have previously been set up by irrigation consultants;
- **Consultant mode**, for use by consultants and by farmers able to run SWB independently;
- **Research mode** – the most complex mode – which is not recommended for consultants and farmers.

The extent of SWB's applications is illustrated by the fact that, among other capabilities, it takes into account no fewer than 11 layers in its soil profiling function, and that when applied to hedgerow-type crops it calculates canopy radiation interception, potential evaporation and transpiration and the limitation on supply of water to the soil surface or plant root system.

Mechanistic models such as SWB have to date been largely out of reach of irrigators in the past due to the specialist knowledge required to run them. The high management cost has been drastically reduced by packaging SWB in an extremely user-friendly format which eliminates the need for detailed understanding of the intricacies of the soil-plant-atmosphere continuum.

The main benefit of the SWB model lies in the accuracy that it makes possible in estimating crop water requirements.

THE RISK MANAGEMENT (RISKMAN) MODEL

The function of the RiskMan computer model is to enable or to assist farmers on irrigation schemes in their farm planning at enterprise or whole-farm level – assessing the various factors present in order make decisions with the best economic effect. It weighs up alternative actions in order to reduce exposure to unfavourable financial outcomes, and it provides reliable and relevant information on which decisions can be based. It supports, but does not replace, the decision-maker in risk management.

Amongst the factors that it takes into account are production, price, irrigation quantities, interest rate variability and hail damage – and

even the user's attitude toward risk, namely risk-seeking, risk-neutral or risk-averse.

Amongst the users to which RiskMan lends itself are:

- **Consultants**, to advise farmers according to their circumstances and needs;
- **Water User Associations** on irrigation schemes, to advise farmers;
- **Various agribusinesses** that provide inputs and have an interest in the welfare of the farming community, especially regarding the risks associated with various activities or enterprises;
- **Small-scale producers**;
- **Researchers and Extension Officers** in Provincial Departments of Agriculture;
- **Universities and colleges**, to demonstrate theoretical principles and to develop problem-solving skills.

Amongst the many benefits of RiskMan are the simulation of risks and definition of variables, including the effects of day-to-day changes such as variable interest rates, which are inserted into the program. Alternative production plans, including alternative crop rotation plans, are evaluated as routine.

WAS – WATER ADMINISTRATION SYSTEM MODEL

The Water Administration System (WAS) is a database for use as a management tool by irrigation schemes in managing their water accounts and their water supply to clients through canal networks, pipelines and rivers. It replaces the old manual water distribution system commonly used on government irrigation schemes.

WAS uses four modules – the Administration module, the Water Request module, the Water Release module and the Water Accounts module. The different modules are fully integrated, which makes it possible to cross-reference relevant information.

Among its many capabilities, WAS calculates water releases for canal networks and river systems, taking lag times and various water losses into account. All data are archived on a single database, enabling rapid accessing – only one file is used (which, as with all computerised data, must be backed up as protection against lost data). Enhanced financial control and the minimization of water losses through an improved water distribution system are further important features.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

The major advance that the project team has now made under the auspices of the Water Research Commission – and the object of the important technology transfer project for which the WRC is gearing up – is the integration and practical implementation of the SWB, RiskMan and WAS databases by means of a purpose-built Geographic Information System (GIS).

The application area of this integrated management tool is to display relevant information from the SWB, RiskMan and WAS databases on irrigation scheme maps.

The main benefit of this is that information displayed spatially on a map gives the user a much better understanding of the available data and provides him with a tool to analyse the data in various ways. It is much easier to do one's planning with the aid of a map and to communicate information to others from this base.

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When linked with strategically placed weather stations in the irrigation scheme, the GIS system is kept up to the minute in respect of current environmental conditions and thus of the water needs of individual farmers – whose soil types and current crops are known to it via the basic models integrated into the GIS.

In formal terms, this GIS, by integrating the SWB, RiskMan and WAS computer models, provides an irrigation system with an extensive suite of tools to improve irrigation scheme management, minimise water distribution losses, deliver an irrigation scheduling service to farmers and provide a tool that can be used by farmers to do on-farm planning, make the most economic decisions and minimise risk.

FIELD TESTING

It is of course necessary for computer models to be tested in the field before claims can be made that they are successful. For this purpose, the Loskop irrigation scheme in Mpumalanga Province and the Orange-Riet irrigation scheme in the Free State Province were selected for implementation of the integrated information system.

Automatic weather stations were successfully installed at both schemes, and can be remotely accessed by cellphone.

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The WRC reports that although the project team did not successfully implement all modules of the integrated information system on both irrigation schemes, it managed to transfer new technology to both schemes, which will definitely grow and make a difference to their daily operations.

Some of the technologies are new and it will take some time before the majority of farmers accept them. The integrated information system cannot be forced onto given irrigation schemes, the report notes – but the project has demonstrated that a visual tool such as the GIS program is easily accepted by irrigation schemes and has great potential in managing the schemes and in communicating information.

The current project has shown that the implementation of the integrated system at two very similar irrigation schemes produced different outcomes. What is important to one scheme is not necessarily important to another. A given irrigation scheme might not be ready to implement the complete system, but can take advantage of parts of it.

It is therefore important to implement the system in stages and in manageable bits. Factors that influence the success rate include the availability of resources such as computer hardware and personnel.

The WRC reports, however, that once users have started using a model successfully, they seldom go back to the old methods.

The report recommends that the integrated information system should be introduced to other irrigation schemes and water management offices in South Africa.

"We have some of the tools to provide decision support to commercial farmers," Dr Backeberg says. "The objective of the Water Research Commission in the coming year is to market our research output – to inform farmers, irrigation scheme managers and consultants what is available to them at field, farm and scheme level. The subsidies on agriculture in the EU, US and elsewhere put pressure on South African farmers, and at present their best recourse is to greatly enhance their productivity, competitiveness and profitability. Our integrated information system for irrigation water management is an important tool in that direction, and we invite farmers and their advisers in South African agriculture to take a close look at what it offers."

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Copies of the WRC Report No 946/1/02 titled ***The Development of an Integrated Information System for Irrigation Water Management Using the WAS, SWB and RiskMan Computer Models*** are also available from the WRC, Private Bag X03, Gezina 0031