Irrigation water use efficiency – It is all about balance

Following nearly a decade of extensive research the Water Research Commission (WRC) has published comprehensive guidelines towards improved efficiencies in the irrigation sector. Compiled by Lani van Vuuren.

The water requirements of irrigated agriculture in South Africa are estimated at 56% of the total annual surface- and groundwater requirements in South Africa. Although the contribution of irrigation to total agricultural production varies according to crop type, most of this water is used for commercial food production in response to consumer demand. With increasing water demand from the domestic, mining and industrial sectors due to urbanisation and higher standards of living, more pressure is being placed on agricultural water users to reduce consumption and so increase the amount of water available for other uses. The implication is that more productive water use in future is essential.

According to Dr Gerhard Backeberg, Director: Water Utilisation in Agriculture at the WRC, water users must understand the economic value and opportunity cost of water as a scarce resource and respond to incentives to use less water, which could then reduce the demand for sources in a river catchment. "For sustainable economic growth and development, the competitiveness of irrigated agriculture will continuously have to improve. This can be achieved through multifactor productivity growth. It requires that more food is produced through higher efficiency and without the use of additional inputs, including that of water. The challenge for profitable farming is finding innovative ways of improving management, technological progress and more efficient resource allocation."

In addition to water scarcity, energy and operating costs affects water management and will do so increasingly in future. Energy prices are rising, pushing up the costs of pumping water, applying fertilisers and transporting products. This will have implications for the lawful access to existing water allocations and use for irrigation. "In order to make best use of available water and energy, it is imperative that we develop and manage irrigation water supply and application systems with demand in mind, so that we minimise our water footprint – to determine how little we can demand

from the water source rather than how much we can supply," explains Dr Backeberg.

BALANCED APPROACH

The WRC already recognised in 2003 that the efficient use of water by the irrigation sector will become increasingly important in the future. For this reason the Commission launched a major project to investigate and formulate guidelines to improve the management and use of water by irrigated agriculture in South Africa.

The resultant publication, *Standards and Guidelines for Improved Efficiency of Irrigation Water Use from Dam Wall Release to Root Zone Application*, introduces a relatively new concept, namely the water balance approach, for achieving the necessary efficiencies in irrigation. Project leader Felix Reinders, Programme Manager: Agricultural Water Resources & Conservation at the Agricultural Research Council Institute for Agricultural Engineering, explains: "The purpose of an irrigation system is to apply the desired amount of water, at the correct application rate and uniformly to the whole field, at the right time, with the least amount of losses and as economically as possible. Optimised irrigation water supply is aimed at maximising the component of water that is used beneficially (i.e. used for its intended purpose such as crop transpiration) and that is recoverable (i.e. drainage water), while reducing non-beneficial uses (e.g. evaporation) and non-recoverable fractions (e.g. water lost to saline groundwater aquifers)."

The guidelines will assist both water users and authorities to obtain a better understanding of how irrigation water management can be improved, thereby building human capacity so that targeted investments can be made with fewer social and environmental costs. Various lessons learnt, best practices and technologies are introduced and illustrated as developed and tested through extensive fieldwork undertaken at irrigation schemes across the country.

OPTIMISING DESIGN AND MANAGEMENT

In order to apply the water balance framework to irrigation areas, typical water infrastructure system components are defined wherein different scenarios may occur. In South Africa, most irrigation areas consist of a dam or weir in a river from which water is released for the users to abstract, either directly from the river or, in some cases, via a canal.

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Water users can also abstract water directly from a shared source, such as a river or dam, or even a groundwater aquifer. Once the water enters the farm, it can either contribute to storage change (in farm dams), enter an on-farm water distribution system or be directly applied to the crop with a specific type of irrigation system.

When assessing the performance of the whole supply and application

CHARACTERISTICS OF AN EFFICIENT IN-FIELD IRRIGATION SYSTEM

- The system is planned to take the natural resources available in the field, and the management requirements of the irrigator into account.
- The system is designed according to sound design principles, based on limiting discharge variation and energy requirements in the field.
- The system consists of quality components manufactured to a high standard with low coefficients of variation and low energy requirements.
- The system is operated according to the design specifications and site-specfic irrigation water requirements of the crop.
- The system is maintained according to the equipment manufacturers' and/or irrigation designer's recommendations.
- The system is regularly evaluated to assess the level of performance and to detect problems as early as possible.

Irrigation water is sourced in a variety of ways, including direct river abstraction.

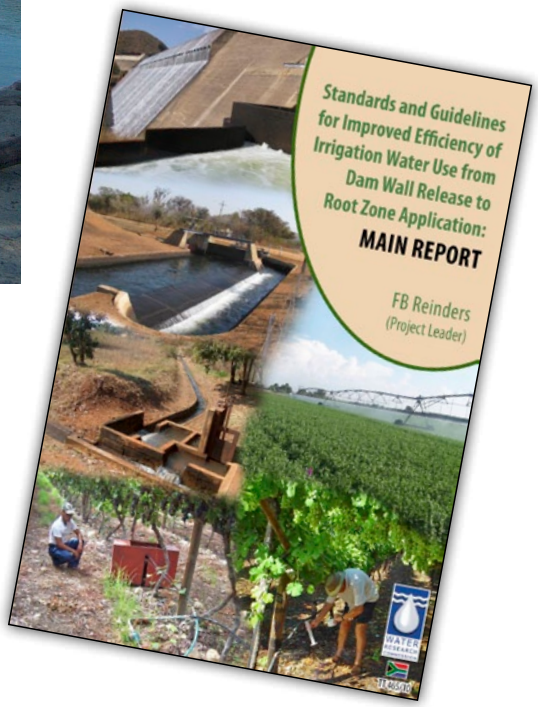
system (from the river to the field) it is important to recognise the purpose of the different components, so that optimisation can be done effectively, notes Reinders. "Optimisation of the performance of any component of these systems furthermore requires careful consideration of the implications of decisions made during both development (planning and design) and management (operations and maintenance) of the component. Every decision we make when developing and managing water supply and application systems has an effect on the water and energy demand of the system."

The guidelines consist of four modules. Each module is a standalone unit with its own table of contents, introduction and conclusion:

- **Module 1** (Fundamental concepts) introduces the concept of optimised water use, irrigation system performance and the water balance. It also touches on lawfulness of water use, demand management and appropriate technologies.
- **Module 2** (In-field irrigation systems) addresses the water balance approach at field level, and describes how each decision made during the planning, design and management of irrigation systems influences the amount of water required to irrigate the crop successfully.
- **Module 3** (On-farm conveyance systems) addresses the water balance approach at farm level, and describes how the on-farm distribution system should be planned, designed and managed to optimise water and energy requirements.
- **Module 4** (Irrigation schemes) introduces the water balance approach at irrigation scheme level, and describes how available technologies (e.g. SAPWAT, WAS, iScheme) and water measuring devices can be used to ensure greater reliability of supply to all water users on a scheme.

Higher yields, greater water productivity and reduced input costs are only some of the benefits of good irrigation management practice using the water balance approach. It is hoped that the WRC guidelines will go a long way to addressing water use efficiency in the irrigation sector in South Africa.

To order the reports, *Standards and Guidelines for Improved Efficiency of Irrigation Water Use from Dam Wall Release to Root Zone Applications* [Main Report No: TT 465/10; Guidelines Report No: TT 466/10; Supplementary Report No: TT 467/10] contact Publications at Tel: (012) 330-0340, Email: orders@wrc.org.za, or Visit: www.wrc.org.za



WATER BALANCE GLOSSARY

Beneficial consumption: The water evaporated or transpired for the intended purpose, e.g. crop transpiration.

Non-beneficial consumption: Water evaporated or transpired for purposes other than the intended, e.g. evaporation from dams and canal structures.

Recoverable fraction: Water that can be captured and re-used, e.g. drainage water from irrigation fields.

Non-recoverable fraction: Water that is lost to further use, e.g. flows to saline groundwater aquifers.