SHORT COMMUNICATION

BENCHMARKING IRRIGATION WATER USE AND SUGARCANE YIELD IN AN IRRIGATION SCHEME

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Abstract

Benchmarking can be defined as the identification and application of best practices with the goal of improving performance. This technique could facilitate improvements within the irrigated sector of the sugar industry. The application of benchmarking to a South African irrigation scheme is described in this communication. The methodology focused on two objectives, the first of which was to assess the performance of the conveyance system to determine where improvements could be made. This was achieved by completing the water balance for the scheme with specified geographic and temporal boundaries. The second objective was to rank individual farm performance, in terms of total farm sugarcane yield and seasonal irrigation water use. Results for the 2004 and 2005 calendar years indicated that the scheme was highly efficient in delivering water to the farm boundary, and highlighted the importance and value of accurate water metering in irrigation scheme management. At an individual farm scale within the scheme, there were substantial variations in total farm yield and water use for both 2004 and 2005, indicating potential for improvement by growers relative to each other. These variations could be attributed in part to the differing irrigation water application trends for each individual farm and gross under-irrigation at a seasonal scale. The results were of interest to the growers who participate in the scheme, in particular the differences in seasonal watering patterns and associated yield trends.

Keywords: sugarcane, benchmarking, irrigation, water use, water balance, yield

Introduction

South Africa is a water poor country with limited water resources, which are spatially and temporally variable in their distribution. The demand for water is increasing (DWAF, 2004). Irrigated agriculture, the largest user of water in South Africa, is currently estimated to utilise 62% of the country's stored water resources (DWAF, 2004) and is often targeted as a potentially inefficient user of raw water. To assess this perception, the evaluation of irrigation performance through benchmarking and water balances can be a suitable method of quantifying irrigation performance at a project and farm scale (Malano, 2000; Burt, 2001). An irrigation benchmarking process identifies and incorporates a number of performance indicators that describe both internal and external aspects of the project or farm's performance (Burt, 2001). These indicators are compared with previous levels of performance and desired future targets, or with other irrigation projects or farms. At present, benchmarking is not a common practice in the irrigation and drainage sector (Malano, 2000). This communication describes the methodology and results from a benchmarking approach that was applied to an irrigation scheme in which sugarcane was the primary crop.

Methodology

A review of local and international benchmarking literature was completed and a methodology was formulated to assess the performance of the irrigation scheme chosen for this study. The first aspect of the methodology aimed at quantifying the efficiency with which the scheme management and infrastructure were able to deliver irrigation water to the farm boundary. This was achieved by computing weekly balances of the water conveyance infrastructure at the scheme for the 2004 and 2005 calendar years, to assess the extent of any water losses that were occurring. The water balance results were also presented and analysed in a graphical format, together with historical observed rainfall, to better understand the nature of any losses, and to understand the rate of irrigation water use in the scheme over different time periods and after significant rainfall.

The performance of each individual farm in the scheme was analysed. Total sugarcane biomass and water application were benchmarked to assess the relationship between yield and water application. Observed application trends for each farm were also compared to simulated irrigation demand trends as determined by the *SAsched* model (Lecler, 2004). The aim was to investigate whether the higher yielding farms were also those which followed a theoretical simulated application depth and trend. Infield irrigation system evaluations were performed to account for realistic infrastructure capacity and uniformity constraints that may have been evident.

Results

The scheme water delivery efficiency for the years 2004 and 2005 ranged between 93.5 and 99.5%, depending on the changes in water storage in the scheme between the beginning and end of the analysis. This corresponded to losses of less than 10%. A benchmark of 80% (van der Stoep *et al*., 2005) was accepted as a good level of scheme water delivery efficiency. The scheme was therefore extremely efficient when compared to the accepted benchmark. The management approach used by the scheme could thus be used in formulating best practice guidelines for improving water delivery performance in less efficient schemes of a similar nature in South Africa. Figure 1 is an example of a water balance trend analysis for one of the sub-sections within the scheme. It can be seen that the water inflow matched water outflow very closely throughout the study period. As such, there was little divergence in the cumulative trend over the 2004 and 2005 calendar years. The trend also revealed a decrease in irrigation water application after significant rainfall, showing that growers in the section made beneficial use of rainfall.

The results from the individual farm analyses showed that there were large variations in both biomass yields and water applications. A weak relationship (R^2=0.2987) was found between water application depth and biomass yield. The *SAsched* model was used to determine an envelope of minimum and maximum water applications, using realistic on-farm irrigation scheduling practices and system capacity constraints. Information on the irrigation systems was obtained from the infield system evaluations and by discussions with growers participating in the scheme. Figure 2 is an example of one of these analyses (2004 calendar year for farms using overhead sprinkler irrigation). It can be seen that the majority of irrigation application trends were well below the envelope of theoretical application that was determined with the *SAsched* model. Since the simulations with *SAsched* accounted for irrigation system constraints, it was deduced that irrigation system characteristics such as scheduling and capacity constraints were not the major contributing factors in the low observed water application trends. The low trends were more likely to be attributed to other factors; for example, limiting economic constraints at a farm scale.

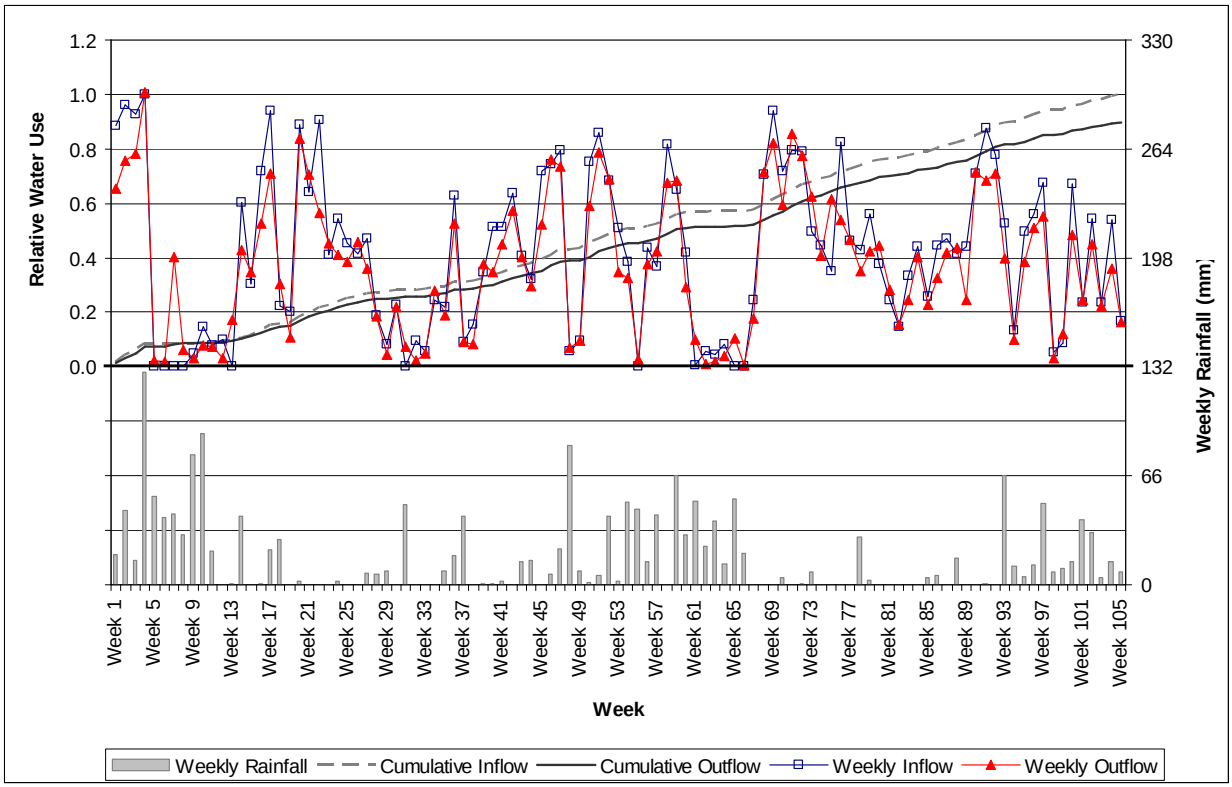

Figure 1. Example of a water balance trend graph for Section 4 of the scheme, showing relative weekly and cumulative inflows and outflows, together with weekly rainfall, for the period January 2004 to December 2005.

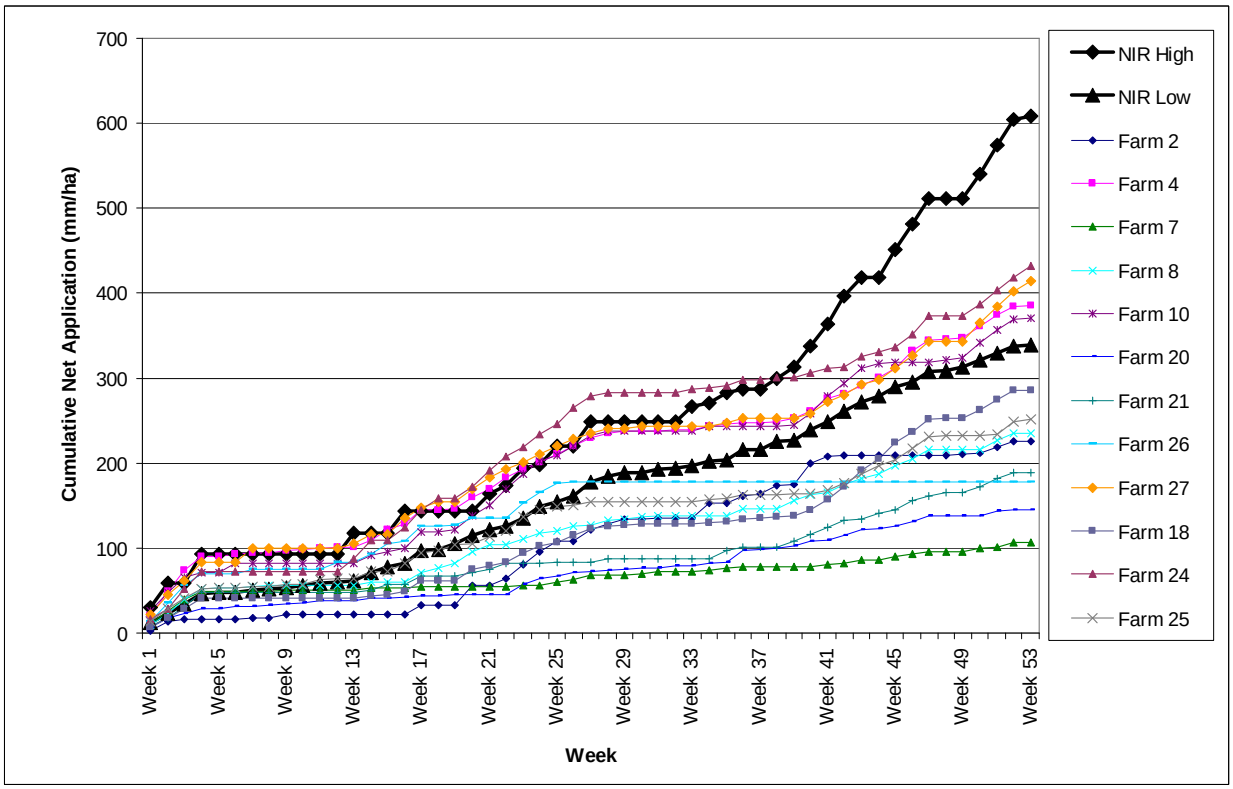

Figure 2. Cumulative 2004 net farm water applications for farms using overhead irrigation. The envelope of simulated application is represented in black.

Discussion and Conclusions

The scheme was found to be highly efficient in delivering water to the farm boundary, and the value of a sound water monitoring and associated information system was highlighted. The individual farm analyses revealed that irrigation system constraints were not limiting irrigation water applications at the scheme, and that the low irrigation water applications witnessed at the scheme were linked to other probable reasons; for example, economic constraints at a farm level. There was strong evidence from observed crop yield and irrigation water use data, and simulated yield and water requirement information, that crop yields were negatively affected by under-irrigation. Research at the scheme is continuing, with the purpose of verifying these hypotheses and providing guidelines for improving water management and profitability at a farm level.

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