# The effect of irrigation uniformity on irrigation water requirements

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## Abstract

Irrigated agriculture is the largest user of water in South Africa. Due to the limited amount of water resources, the efficient and equitable use of water is of paramount importance. This can only be achieved through effective design, maintenance and management of irrigation systems. The uniformity with which an irrigation system applies water has an affect on the efficiency of the system. The uniformity of an irrigation system needs to be high to ensure that the majority of the crop receives an adequate amount of water. This is needed for fields to produce high yields and to have minimal nutrient loss due to deep percolation. The uniformity of application also plays an important role in determining water allocations and the gross amount of irrigation water to apply. The concept of uniformity and calculation thereof are presented in this paper.

Results of research of the application uniformity of different irrigation systems in the sugar industry in five sugar-growing regions in South Africa will be discussed in this paper. From this study the average low-quarter distribution uniformity ($DU_{lq}$) of centre pivot, dragline, micro-irrigation, floppy and semi-permanent sprinkler systems was 81.4%, 60.9%, 72.7%, 67.4%, and 56.9% respectively. The percentage of systems that had an excellent field condition $DU_{lq}$ was 100% for centre pivot, 15.4% for dragline, 30% for micro-irrigation, 0% for floppy, and 14.3% for semi-permanent sprinkler systems. Only three floppy irrigation systems were evaluated during this study, therefore the result for the percentage of systems with an excellent $DU_{lq}$ may not be representative of these systems in general. Irrigation systems that were well maintained and correctly operated generally had a high and acceptable $DU_{lq}$. The average application efficiencies (AE) were 83.6% for centre pivot, 73.5% for dragline, 76.7% for floppy, and 78.9% for semi-permanent sprinkler systems.

## Introduction

Irrigated agriculture is the largest user of water resources in South Africa, using 53% of the total annual amount used (WRC, 1999). The National Water Act (1998) requires the economical and sustainable use of water. Thus, water resources have to be utilised in such a manner as to protect and conserve the available water reserves. In irrigated agriculture this will have to be obtained through the effective management of water consumption. Therefore, irrigation systems will have to apply water in the most efficient way possible to prevent unnecessary losses and water wastage.

In order to achieve this, the uniformity with which the irrigation system applies water will have to be high. The distribution uniformity of a system has an effect on the system's application efficiency and on the crop yield (Letey et al., 1984; Solomon, 1984; Letey, 1985; Solomon, 1990). Irrigation systems with poor distribution uniformity experience reduced yields due to water stress and/or water logging (Solomon, 1983; cited by Clemmens and Solomon, 1997). Poor distribution uniformity also has increased financial and environmental costs. Nutrients can be leached out of the soil due to excess water being applied to overcome poor irrigation uniformity. This will increase fertiliser costs and pumping costs, and may have environmental impacts if the excess runoff and deep percolation are contaminated with nutrients (Solomon, 1990).

The distribution uniformity of an irrigation system depends both on the system characteristics and on managerial decisions (Pereira, 1999). The distribution uniformity of different types of irrigation will be influenced by different factors that are characteristic of the particular system. Surface irrigation is influenced primarily by soil intake characteristics. Overhead irrigation is influenced by the condition of sprinkler packages and the pressure variation within the system. It is also influenced by the strength and direction of the wind (Burt et al., 1997). These factors of an irrigation system need to be correctly managed to ensure that the distribution uniformity is at an acceptable level. This will ensure the optimal use of water resources.

To ensure that the farmer receives an adequate water allocation for his irrigation system, the distribution uniformity needs to be included in the gross irrigation water requirement calculation. This factor can be used in conjunction with the factor representing spray and conveyance losses to estimate the gross irrigation water requirement from crop water requirement (Burt *et al.*, 1997). The distribution uniformity that is included in these design calculations needs to be determined. An acceptable lower limit to the distribution uniformity must be one that is reasonable and obtainable (Pitts et al., 1996). Farmers that follow best management practices should be able to reach these levels. This will ensure an adequate water allocation and the prudent use of water.

The Agricultural Research Council - Institute for Agricultural Engineering (ARC-ILI) conducted a study, on behalf of the South African Sugar Association (SASA), to quantify the distribution uniformity and application efficiency of irrigation systems used in the sugar industry. In total 38 systems were evaluated, including the following system types; dragline, semi-permanent sprinklers, centre pivot, drip, micro-spray, and floppy sprinklers. The study was conducted in five major sugar irrigation areas in KwaZulu-Natal and Mpumalanga provinces. The results of this study and a discussion on the importance of irrigation uniformity will be the focus of this paper.

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