64. Virtual water of sugar production in Spain

J. Soler-Rovira*, P. Gómez de la Calle, J.M. Arroyo-Sanz

Escuela Universitaria de Ingeniería Técnica Agrícola, Universidad Politécnica de Madrid, Ciudad Universitaria, s/n 28040 Madrid, Spain, * Corresponding author. E-mail: *jose.soler@upm.es*

Food production and consumption contributes to water use and abstraction, mainly during the phase of cultivation. Water footprint of agricultural products is made up of blue, green and grey water. Green water is the rainfall water evapotranspirated from cultivated soils. Blue water is the fresh water used in irrigation, taken from water bodies that is used and not returned. Grey water is the volume of water required to dilute pollutants to such extent that the water quality reaches acceptable standards. Irrigated sugar beet crop in Spain accounts for 93% of the 70,000 ha of cultivated surface. Beet is the main source of sugar and every Spanish inhabitant consumes 5.5 kg per year, although 50% is imported.

The aim of this work is to evaluate the virtual water content of sugar beet crop and industrial sugar in Spain. The main provinces of sugar beet cultivation were considered. Virtual water content of the beet crop was calculated taking into account the root and sugar yield and the evaporative and non-evaporative water used for crop production. The water consumed in evaporation was made up of green and blue water. The green one was computed from rainfall and crop evapotranspiration plus soil evaporation computing a soil water balance with site specific soil data, climatic data and crop growth cycle. Reference evapotranspiration was computed with both Penman-Monteith and Hargreaves method. Blue water was obtained from soil water balance as the difference of crop evapotranspiration and rainfall and the efficiency of the irrigation system (gravity or sprinkler). Seedling emergence water applications were also accounted in sprinkler irrigated crops. Grey water was considered as the polluted water, and was calculated with the site specific fertilisation rate of the crop, estimated nitrate leaching and water quality standards.

The estimated water footprint per surface unit in Burgos and Valladolid provinces is shown in Figure 1. The volume of water is higher than 1,000 L per m^2. Total water footprint of Valladolid province is greater than that of Burgos. Blue water (irrigation requirements) is higher in Valladolid because the increased ETo values and the decreased rainfall in that province. However, green water is lower due to the less rainfall. As nitrogen fertilisation rates are higher in Valladolid than in Burgos, grey water is also higher. The water footprint is larger for gravity irrigation systems than for sprinkler ones, because their lower water application efficiency.

Water footprint estimated per kg of sugar is more than 800 L (Fig. 2). The most important component of sugar water footprint is the blue one, because the sugar beet is sown in spring and the maximum canopy development and water transpiration is during summer, when ETo is high and the rainfall is low. Green water is less than 35% of total water footprint, and it is lower in provinces with decreased rainfall values. Grey water account for 100-200 L per kg of sugar, and it depends on nitrogen fertilisation rates.

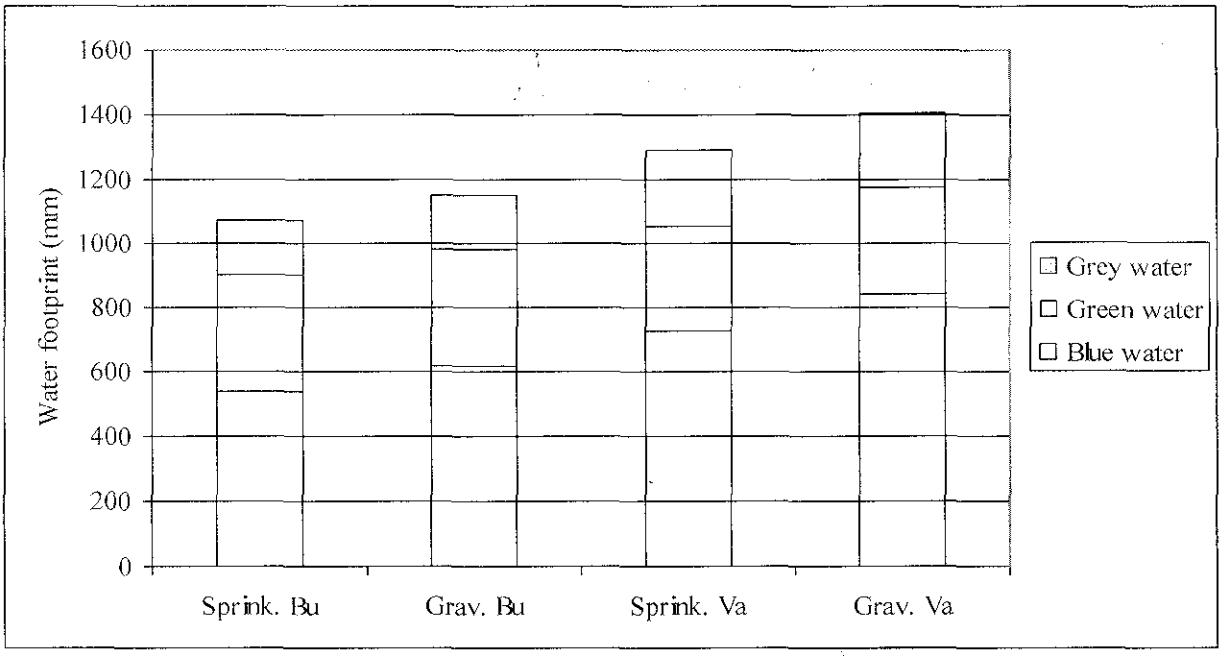

Figure 1. Estimated water footprint of sugar beet crop in two Spanish provinces, Burgos (Bu) and Valladolid (Va), with two different irrigation systems, sprinkler (sprink.) and gravity (grav.).

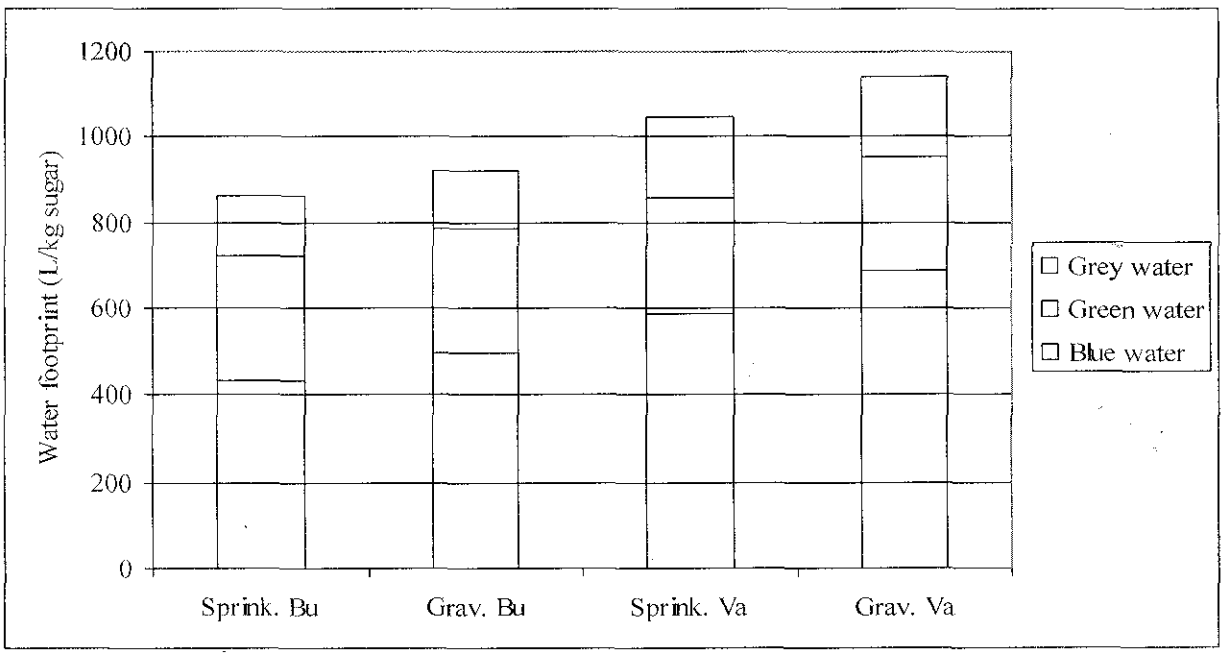

Figure 2. Estimated water footprint of sugar in two Spanish provinces, Burgos (Bu) and Valladolid (Va), with two different irrigation systems, sprinkler (sprink.) and gravity (grav.).