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Water Footprint, New Insight for a More Sustainable Crop Production

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Agricultural water consumption corresponds to 85% of global freshwater and is projected to double in 2050 [1].The global water footprint of crop production in the period 1996–2005 was estimated to 7404 Gm3yr−1 [2]. Crops especially wheat (1087 Gm3yr−1), rice (992 Gm3yr−1) and maize (770 Gm3yr−1) require significantly amounts of water for production [2].

In the coming years, crop production will increase in order to meet the growing demand of food, the new diet preferences and the shift from fossil energy toward bioenergy [3]. Few new lands will be available so all production must come from the current natural resource base, requiring an intensification by increasing land and water use. This will lead to a bigger pressure on the limited freshwater resource. In addition, heavily impacted by climate change, crop yields may be reduced resulting in the decline of food security worldwide [4]. In fact, the increasing temperature and decreasing precipitation, will decrease crop yield and increase irrigation. With all these new challenges, optimizing water use in crop production is the challenge of future generations and it amplifies the need for detailed information on water requirements of a crop.

The consideration of the volume of freshwater used, directly or indirectly, along the supply chain of a product has gained interest with the introduction of the concept of water footprint (WF) by Chapagain and Hoekstra [5]. The water footprint can be used as an indicator to measure the volume of water consumption per unit of crop, as well as the volume of water pollution [6]. Accounting for 45% of the global blue water footprint, wheat and rice have the largest blue water footprints [2]. This footprint reports the use of rainwater during the growing period of the crop (green WF), irrigation water (blue WF) and volumes of water polluted (grey WF = volume of freshwater required to assimilate the load of used pollutants). The global average water footprint of a crop for a specific country is informative however it is more efficient to analyse the contributions of green, blue and grey WFs contributions to the total WF.

Hence, it is essential to quantify green, blue and grey water footprints to carefully balance the water use strategy in order to face the increasing water demand and the limited resource.

Green water corresponds to 78% of the total water consumed in crop production [2]. The same authors estimated the fraction of blue water to be on average equal to 12%. Spatial analysis showed that the regions where blue water footprints are large are often arid and semi-arid regions where water scarcity is high [2]. A recent study [7] also showed a spatial variability of green and blue WFs for ten selected crops across the world. This work demonstrated in which parts of the world production of each crop occurs at WFs in the range of the best 10% of global production. At country level, the total water footprint was largest for India (1047 Gm3 yr−1), China (967 Gm3 yr−1) and the USA (826 Gm3 yr−1) [7].

Grey WF only accounts for 10% of the global WF of a crop [2]. This fraction considers the pollution generated by crop production so it will decrease with the implementation of better agricultural practices.

The estimation of water footprints of crop growing islargely criticised. Studies estimated that these uncertainties in total WF for all crops were within the range of ± 18 to 20% (at 95% confidence interval) [8].They are mainly related to the input data used in the model and it has been approved on that a variety of efforts needs to be made in the future before these calculations can be considered adequate.

Even though there is still a number of uncertainties in their estimation, the approach of water footprints is very promising in crop production. In fact, in the future, modelling of WF can help identify, for each crop, potentially high production zones helping to increase water efficiency (reducing the WF per unit of crop produced) while reducing water pollution. These WFsenable farmers and decision makers to have reference levels giving them incentive to reduce the WF of their crops.

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