Interactive comment on **"Green and blue water footprint reduction in irrigated agriculture: effect of irrigation techniques, irrigation strategies and mulching"** ***by*** **A. D. Chukalla et al.**

Reply to Anonymous Referee #1

We thank Referee #1 for the comments and reply to each of the points below.

Reply to the two major comments

1) The current interest on irrigation techniques and strategies is mainly (but not only) due to present and future water scarcity (including trade-offs with other uses). I found it a pity that the study does not refer to this in any sense. Why not trying? E.g. by looking how much more production could be achieved with the saved water. Or upscaling somehow the results for a whole country/region and assessing how much "extra" water per capita would be available for households if the right combination of mulching and irrigation techniques and strategies is chosen. I think you are one little step away from having some nice and very relevant implications of your results; it would be a pity not to try to get something in that direction. In any case, it would be good to add a subsection in the discussion referring to how appropriate is your model for studies under climate change, i.e. do you think that the relationships you discover would hold under altered climate and CO_2 concentrations?

Yes, the relationships can be expected to hold true under altered climate. In the paper, the sensitivity of the water footprint to agricultural management in irrigated production systems was simulated and analysed for four climates, ranging from arid to sub-humid and for three typical years each (i.e. wet, normal and dry). With this sensitivity test, we show the effects if changing climate would entail dryer or wetter conditions. We did not simulate the effects of changes in CO_2 concentrations, but consider this outside the scope of the current study, which is focussed on the effects of improved irrigation and mulching.

Indeed, as suggested, the findings of this study will be very useful to study possible water savings (while producing the same crop amount) or possible crop production increases (without increasing water use). Results of this paper will be used in a subsequent paper, with the help of an appropriate model, to study at a basin scale the possible water saving and reduced water scarcity by implementing the irrigation and mulching strategies studied in the current paper at a larger scale. In the current paper we can add a reflection in the concluding section regarding this possible use of the findings of the current study.

2) I found the differentiation between organic and synthetic mulching a bit problematic. As you mentioned, your model does not account for the soil biochemistry. But in reality organic mulching frequently changes this aspect, supplying extra carbon, increasing fertility, decreasing requirements of fertilizer inputs, etc. At the end these changes affect also percolation, runoff, evaporation, and thus, water intake by plants and transpiration. If I understood right, the difference between synthetic and organic mulching in your study affects only soil evaporation by means of an arbitrary parameter. I found this too simplistic and am afraid that this could affect the validity of your results regarding the mulching type. Isn't there any possibility of adding a bit of complexity to this?

The AquaCrop model does simulate the effect of mulching on evaporation and represents effects of soil organic matter through soil hydraulic properties influencing the soil water balance. The model however does not simulate the effect of organic mulching on the organic content of the soil, nor does the model simulate the decomposition of organic materials. The current model doesn't allow for including these effects, but we agree with the referee that this is worth further exploring in future studies.

Reply to the minor comments

3)

a. Section 2.1. Please better explain how AQUACROP calculates yields.

Aquacrop first estimates the biomass (B) from a water productivity parameter (WP) and transpiration ($B = WP*\Sigma Tr$). The harvestable portion of the biomass (yield) is then determined by multiplying biomass with the harvest index, HI ($Y = B *HI$). WP is the water productivity parameter in units of kg (biomass) per m^2 (land area) per mm (water transpired), normalized for atmospheric evaporative demand and air CO_2 concentration. The harvest index (HI) is simulated starting from flowering to yield formation, depending on the growing conditions, crop species and cultivar (Steduto et al., 2009).

b. Section 2.2. Please better explain how capillary rise works in the model.

Aquacrop estimates capillary rise based on the depth of the water table and two parameters that are specific to hydraulic and textural characteristics of the soil (Janssens, 2006). The two parameters are estimated for different textural classes of the soil that have similar water retention curve (h-ϴ). The capillary rise from AquaCrop is comparable with the estimate from the UPFLOW model; the latter approach uses the Darcy equation that considers the water retention curve (h-θ relationship) and the relationship between matric potential (h) and hydraulic conductivity (K) (Fereres et al., 2012).

c. Section 2.3.1. How is interception loss (evaporation from leaves) accounted for in the case of Sprinkler?

Sprinkler has interception losses unlike furrow, drip and subsurface drip techniques. The AquaCrop model does not explicitly account the interception losses from sprinkler. We will add this in the discussion.

d. Section 2.3.1 Does your model account for the influence of row spacing (planting density) in soil evaporation?

Yes, the AuqaCrop model accounts for the planting density in soil evaporation. Planting density is used to determine the canopy cover, which is a factor in the calculation of soil water evaporation.

e. "It uses the conservative behaviour of biomass water productivity (WP) to simulate biomass and yield responses of crops". What does that mean?

The conservative behaviour of biomass water productivity (WP) means that WP remains constant for a given crop species after normalization for evaporative demand of the atmosphere and air carbon dioxide concentration (Steduto et al., 2007).

f. P6954 L7. Please mention the source you used for adopting those values for fm.

The model considers the effect of mulch on crop evaporation by two factors: mulch material (fm) and percentage of soil cover. Quoting the paper by Allen et al. (1998), the values of the parameters for mulch material (fm) are suggested in the user guide manual to vary between 0.5 for mulches of plant material and close to 1.0 for plastic mulches (Raes et al., 2013).

The referee’s suggestions **4 to 7** are clear and valid. These suggestions will be considered in the revision of the article.

References:

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