WaterPIP
Water Productivity Improvement in Practice

Wonji-Shoa Sugar Plantation

Water Productivity Analyses Using WaPOR Database

The main objective of this study was to provide insight into water and land productivity, and irrigation performance at the Wonji-Show Sugar Plantation with use WaPOR derived data. This was done by analysing the spatial variation among irrigation application method. Furthermore, the productivity gaps and implications of closing these gaps for production and water use are explored, considering water allocation in Awash River Basin

Water productivity is an indicator to measure the efficient use of water on agricultural land, and is expressed in output per unit of water consumed. The output can be measured in different ways; for example, in agricultural yield (kilograms/m^3 of water), economics ($ earned/m^3 of water), and social impact (jobs/m^3 of water). In this study, the focus is on the water productivity measured with agricultural yield.

The Wonji sugarcane plantation, located in the Rift Valley in Ethiopia, is a major producer of processed sugar and relies completely on the water supply from the Awash River. Following the drought of 2016 and the subsequent stress on the sugarcane crop, it became increasingly clear that the limited water resources available should be used more effectively.

Country: Ethiopia

Climate: Tropical savanna climate (Aw)

Crop(s): Sugar cane

Irrigated land analysed: 11,450 ha

Soil types: Silandic Andosols, Eutric Leptosols and Haplic Phaeozems

Water source: Surface water from the Awash River

Irrigation method(s): Furrow, centre pivots, sprinkler and hydroflum irrigation

Study period: Data averaged over 5 (G.C.) years (2015-2019)

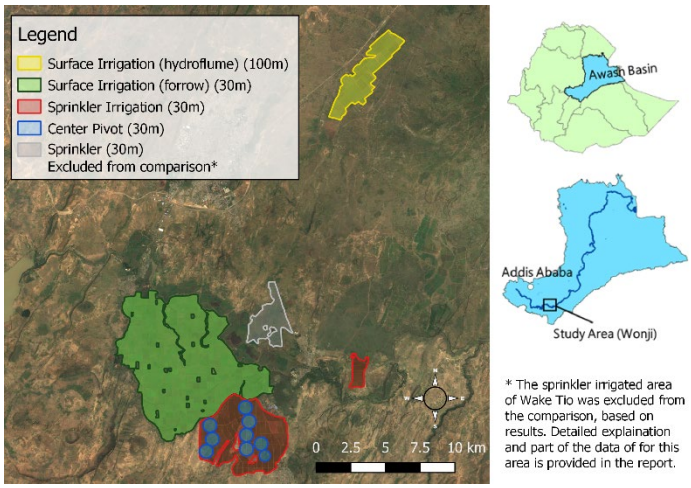

Figure 1: Wonji sugarcane plantation (EOX Sentinel-2 cloudless image)

Methodology

The methodology involved four steps:

1) remotely sensed derived data from the WaPOR portal and local data were collected and processed using Python,
2) seasonal water consumption and above-ground biomass production were calculated,
3) irrigation performance indicators were analysed, and
4) the impact of closing productivity gaps on water consumption and biomass production were explored.

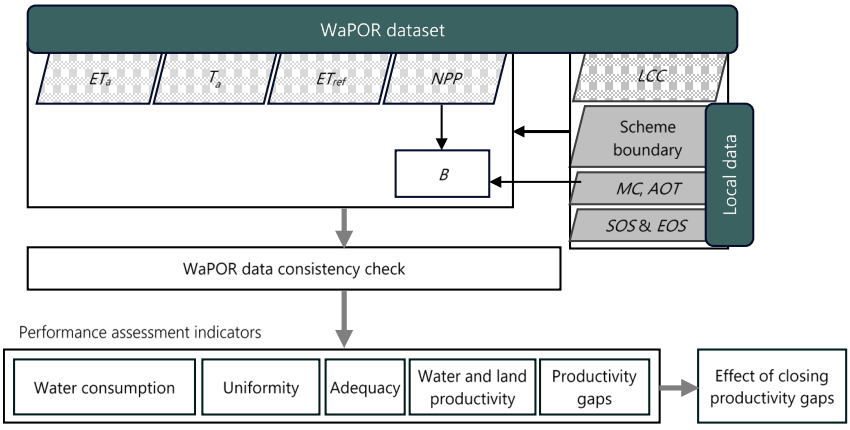

Figure 2: Flow chart for calculating indicators for irrigated sugarcane at Wonji. WaPOR is the FAO portal for viewing WAter Productivity through Open access of Remotely sensed derived data.ET_a stands for actual evapotranspiration, T_a for actual transpiration, ET_{ref} for reference evapotranspiration, NPP for net primary production, ET_p for potential evapotranspiration, LCC for land cover classification, MC for moisture content in fresh biomass, AOT for the above ground over total biomass, K_c for crop coefficient, SOS for start of season, EOS for end of season, and B for above-ground biomass.

Assumptions & Uncertainties: Although cropping seasons in Wonji last on average 18 months, for the purpose of irrigation performance analysis and comparison, this study assumed a cropping season of 12 months (Jan 1st – Dec 31st). This offsets variances of individual fields that have different start and end dates. For land productivity (yield) calculations this study did use the 18 months to be able to compare with Wonji-Show Sugar Plantation field data.

Results

Analysis of Irrigation Methods

The comparison of the irrigation technologies using the different performance indicators showed that there is not one irrigation method that stands out the best across all indicators. Challenging the local and science based perception that sprinklers and centre pivot systems have higher uniformity, the furrow irrigated areas actually perform best, i.e. the smallest coefficient of variation of ET_a within that area. This at least sets the organisational capacity and hard work by many to distribute the water from irrigation channels to the fields in the spot light from which also lessons could be drawn for the many other furrow irrigated sugarcane plantations in Ethiopia. The uniformity in the sprinkler irrigated areas was distinctly lower, areas which also according to the irrigation manager are challenged by electricity outages and frequent failure (damage) of draglines and the difficulty to replace these. The degree of agreement between available water and the amount of water required by the crops, i.e. the adequacy, shows that the areas irrigated by means of hydroflumes score distinctly lower than the others. Main reason being that the (potential) amount of water required by the crops (expressed by mm of ET_{ref}) is relatively higher than the in the other areas. However, the productivity, both water and land score the best also in this area, which leads to suggest that although the sugarcane may endure water stress it is capable of producing more than the amounts as compared to the other areas.

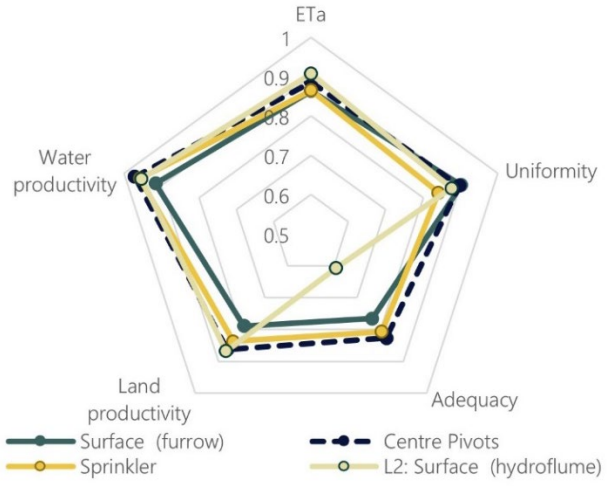

Figure 3. Summary of the performance indictors averaged over five seasons by irrigation method. The five indicators in the figure are normalized using their maximum (100%) or target values. Thus the indicators show extremely low performance at 0 and high performance at 1.

Land and water productivity

Overall land productivity averages 105 ton/ha/year in the Wonji estate, these yield estimates using WaPOR data vary between -13% to +6% when comparing with annual sugarcane production data from Wonji for the different sub-schemes. As field data and the accounts from Wonji confirm the oldest part of the plantation, called Wonji main, is also the least productive. As a detailed analysis of the water productivity, including the response to climatic evaporative demand (ET_{ref}) and the elimination of the non-productive evaporation component shows that variations in agronomic management practices or plant growing conditions can be statistically discerned within the (disaggregated) dataset from WaPOR. The outcome supports the local perception that soil fertility is the limiting factor and previous research that identified salinised groundwater at shallow levels in the furrow irrigated areas. This study however, argues that there is distinct room for increasing the yields in that furrow irrigated area without actually increasing overall water consumption (ET_a), although the exact extent of these plant stress levels within the Wonji plantation and therewith the 'room for improvement' of the Wonji main sub-scheme needs to be further determined. Overall however, in the realm of global water productivity figures for water productivity in sugarcane Wonji performs fairly good with an average WP_b of 6.6±0.3 kg/m^3 for all areas combine.

More Information on this case study and water productivity, Go to our webpage

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