Benchmarking cotton water use efficiency in Australia using earth observation

Brombacher, J.[1], Pelgrum H.[1] and Degen.J.[1]*

[1]eLEAF, Stadsring 65-B, Amersfoort, Netherlands [*](*henk.pelgrum@eleaf.com*).

a. **KEYWORDS:** ETLook; water use efficiency; benchmarking; cotton;

A proof-of-concept (PoC) study on the use of Earth Observation (EO) technologies to benchmark water use efficiency (WUE) in the Australian cotton industry has been carried out for the Cotton Research and Development Corporation (CRDC). Traditional benchmarking methods, such as the Gross Product Water Use Index (GPWUI) [1], rely heavily on labor-intensive farm-level data collection and grower participation, limiting scalability and timeliness. The objective of the project was to develop and validate an EO-based methodology capable of estimating cotton yield and water use at scale, while minimizing dependence on local data.

The study, conducted by the WaterSENSE consortium in collaboration with industry stakeholders, developed a calibrated EO-based WUE approach that integrates satellite-derived data (e.g., soil evaporation, plant transpiration, biomass, precipitation) with limited ground-truth data. Data on soil evaporation, plant transpiration and biomass were derived using the ETLook model [2]. Three methodological options were evaluated, with the selected approach combining field-level EO estimates of crop water consumption and yield with calibration using local farm records. This method balances scalability, spatial detail, and accuracy.

The methodology was applied to the Namoi and Gwydir catchments over six growing seasons (2018–2024). Results demonstrate that EO-based WUE estimates capture spatial and temporal variability in cotton water productivity and show comparable trends to existing GPWUI benchmarks. While initial results overestimated WUE due to underrepresentation of total water use, incorporating effective rainfall significantly improved alignment with established benchmarks. **Error! Reference source not found.** shows the comparison between the GPWUI benchmarks and the newly implemented EO-based benchmarks.

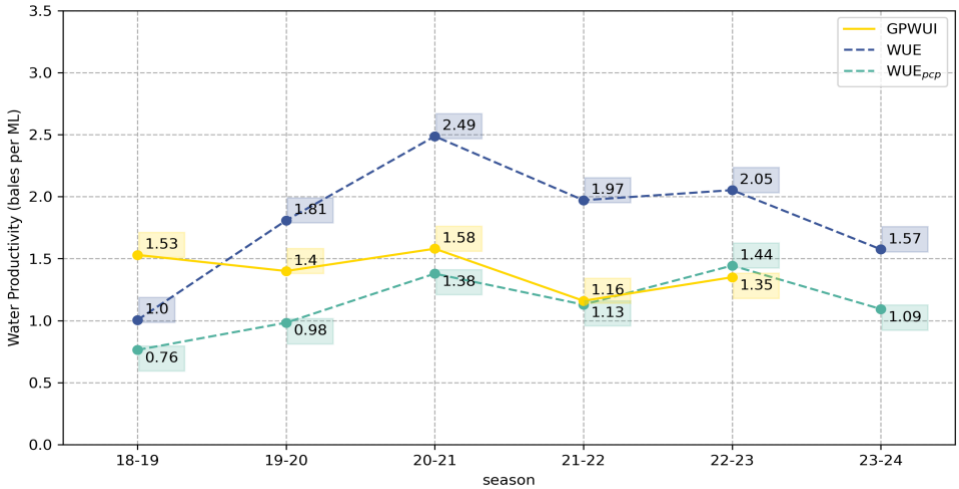

Figure 1 Comparison between the EO-based WUE estimates (dark blue) and the GPWUI (yellow) benchmark for Northern NSW from the CRDC grower surveys. The WUE with the effective rainfall included to the total water use (WUE_{pcp}) is added in light blue.

The findings confirm that EO-based approaches can provide reliable, scalable, and spatially explicit water productivity metrics. Additionally, EO enables full coverage of agricultural areas, offering advantages over

survey-based methods constrained by sample size and privacy limitations. Stakeholder engagement highlighted strong interest in EO-derived datasets, particularly for operational decision support, such as crop water demand forecasting.

The study concludes that EO-based WUE benchmarking is a viable alternative to traditional methods, with potential for both industry-level reporting and on-farm decision-making. A pilot phase is recommended to further validate the approach across regions and support transition toward operational implementation.

ACKNOWLEDGMENTS

This project has been sponsored by the CRDC.

REFERENCES

1. Montgomery, J., Hoogers, R., Shepherd, K., Bray, S.: Water use efficiency in the Australian cotton industry. Australian Cotton Conference 2014, https://l1nq.com/njh4khq
2. Bastiaanssen, W.G.M., Cheema, M.J.M., Immerzeel, W.W., Miltenburg, I.J. and Pelgrum, H. Surface Energy Balance and Actual Evapotranspiration of the Transboundary Indus Basin estimated from satellite measurements and the ETLook Model. Water Resources Research, 48(11) (2012)