Advanced Temperature, Radiative, and Water Flux Dynamics in Agrivoltaic Systems.

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Introduction

A multi-source data framework, to optimize the Agrivoltaic(AV) WEF nexus planning using 2022-2025 Ghana/Benin field data, quantifying WEF outputs for data scarce West Africa [1-2]

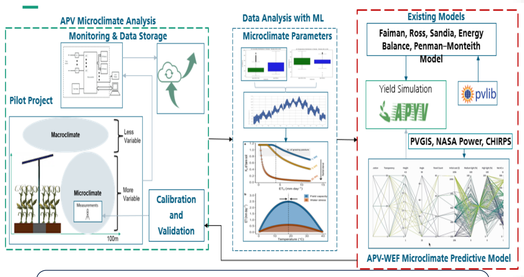


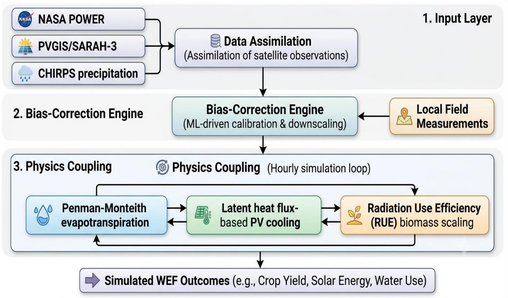
Fig. 1: Overview of Workflow

1. Field Microclimate Data and Analysis:

Crops: Tomato, Pepper, Eggplant

Pillar	Mathematical Logic	Role in WEF Nexus
Water	$V\_harv,net = \int (P\_in - ET\_c \cdot f(\Delta T))$...1	Water savings(ΔET_c) in AV [3].
Energy	$T\_cell = T\_amb + \frac{G\_poa \cdot (\alpha\_PV - \eta\_PV)}{h\_conv + h\_rad + h\_lat}$ 2	Energy yield to latent heat cooling (h_lat) [4-6].
Food	$S\_crop = RUE \cdot f(\Delta T) \cdot f(W)$.....3	Defines biological resilience via the Environmental stress factor [7-10].

2. AV-WEF Framework Model



[10-16]

The Nexus Harmony in Agrivoltaics: Water-Energy-Food (WEF) potential demonstrated

Fig. 2: Agrivoltaics pilots replicated in two different bioclimates in West Africa, Ghana.

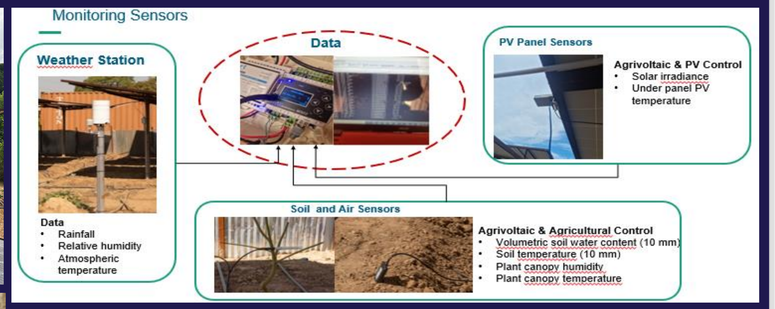
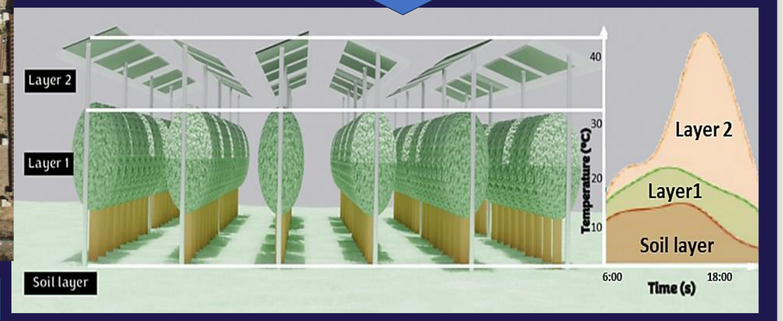
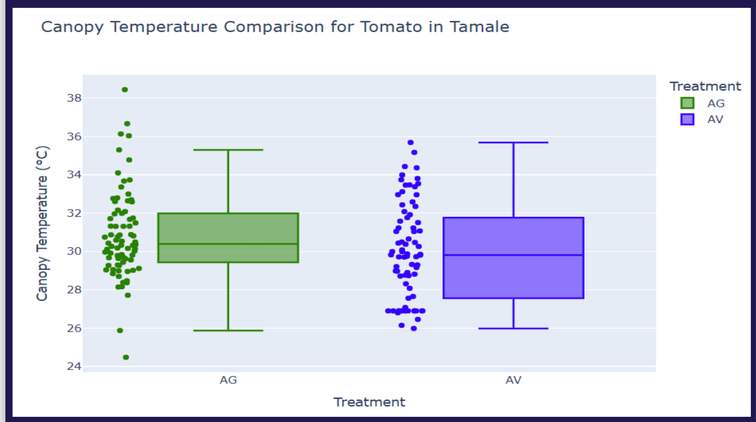


Fig. 3: Monitoring sensors and measured data





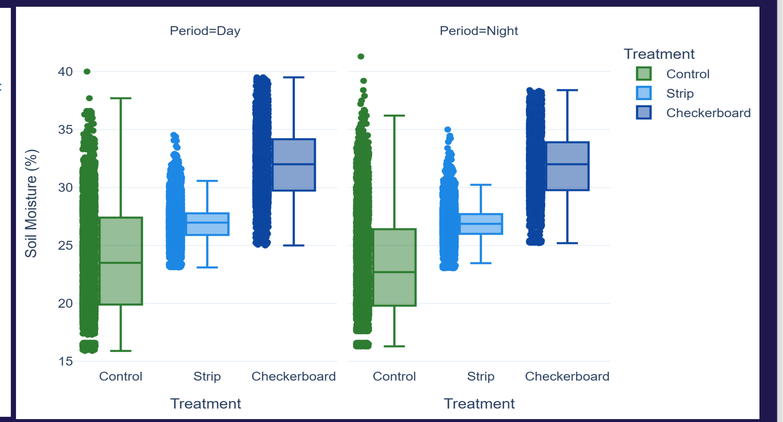


Fig. 4: Diurnal distribution and heat flux in Layer/treaments

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Key Results

Pilot Project

- AV can support off-grid electrification and potential to reduce **energy** insecurity in rural West Africa.
- **Crop** yields vary, with larger and greener leaves with less water input.
- Evaporative **water** loss reduced, and plant survival rates improved.

Additional Information

Field measurements input reduces predictive error:

- Incorporating site-specific bias correction ML functions
- WEF Nexus Performance: Our model demonstrates that PV-induced canopy cooling can be quantified. Predict water demand, PV and food stress changes in AV

References

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