On-farm solar arrays to enhance recharge, produce energy, and diversify farm income

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Key Points

1) Experimental solar array installed summer 2025 (Figure 1).
2) Panel effects are already influencing site moisture.
3) Starting the process of monitoring and modelling benefits.

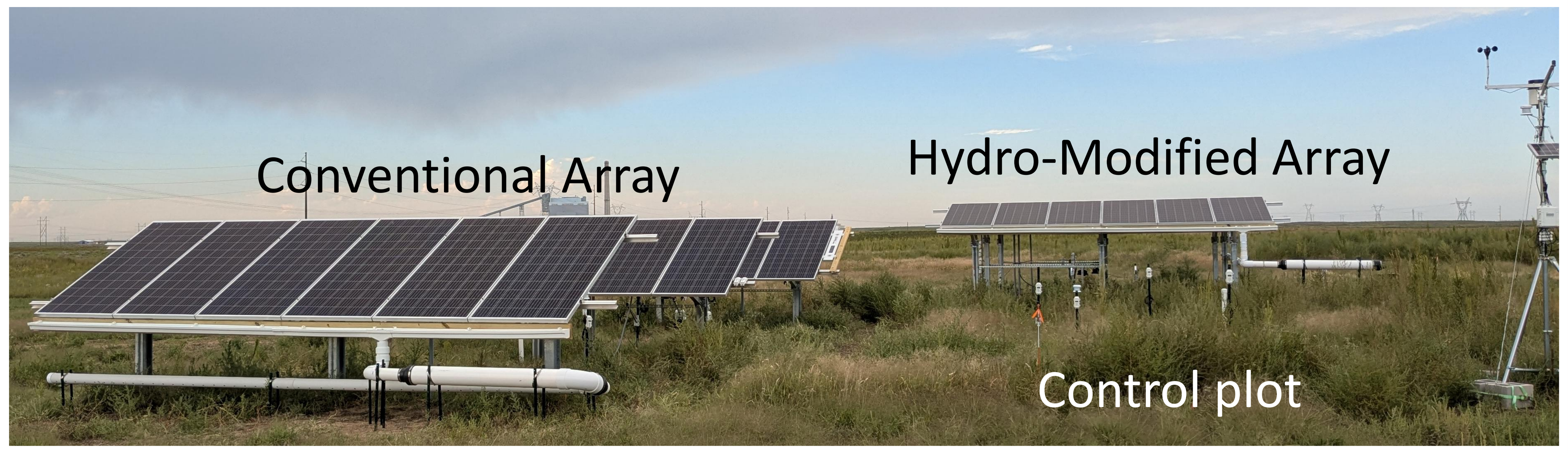

Figure 1. Experimental solar array near Garden City, KS. The Conventional Array (left) prioritizes energy production and the Hydro-Modified Array (right) is modified to maximize rain capture with the addition of an infiltration system.

Background

- Project explores the potential benefits of locating solar power on the non-irrigated corners of center-pivot fields to generate energy and enhance groundwater recharge.
- Expected to (i) improve water sustainability; (ii) increase energy system resiliency; (iii) reduce agriculture's climate footprint; and (iv) provide economic benefit to farmers.

Figure 2. Corner areas of center-pivot irrigated fields.

Monitoring System

- Goals: Characterize soil hydrologic changes, water balance, energy production, vegetation, and potential geochemical changes.
- Currently collecting ~26,000 measurements a day on soil moisture, air temperature, solar radiation, and numerous other meteorological data (Figures 3a and 3b).
- Additional measurements taken quarterly on soil moisture, saturated hydraulic conductivity, water content at depth, soil compaction, etc. (Figure 3c).
- Wireless monitoring of energy production for each array and soiling effects on production (Figure 3d).
- Soil and water quality sampling to begin in 2026.

What else should we be monitoring?

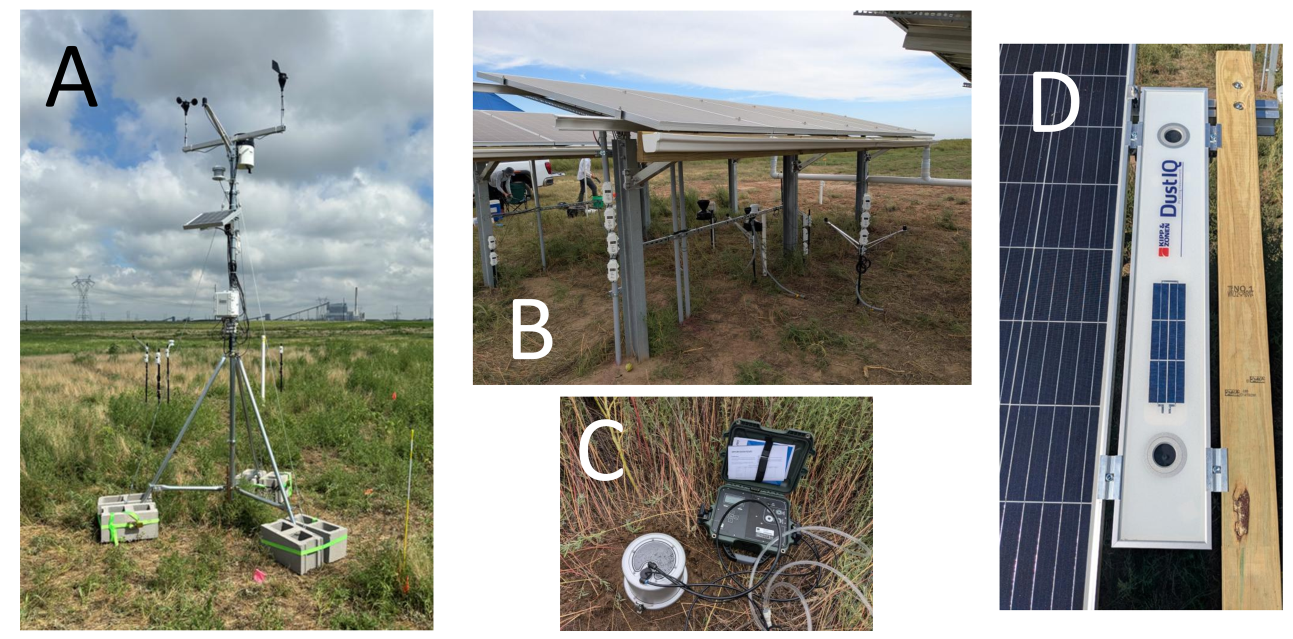

Figure 3. A) Metrological Station collecting data on air temperature, precipitation, wind speed, precipitation, etc. B) Wireless sensors located underneath solar arrays used to assess microclimates created by the panels. C) SATURO instrument used to measure saturated hydraulic conductivity. D) DustIQ used to measure soiling effects on solar panel productivity.

Current Findings

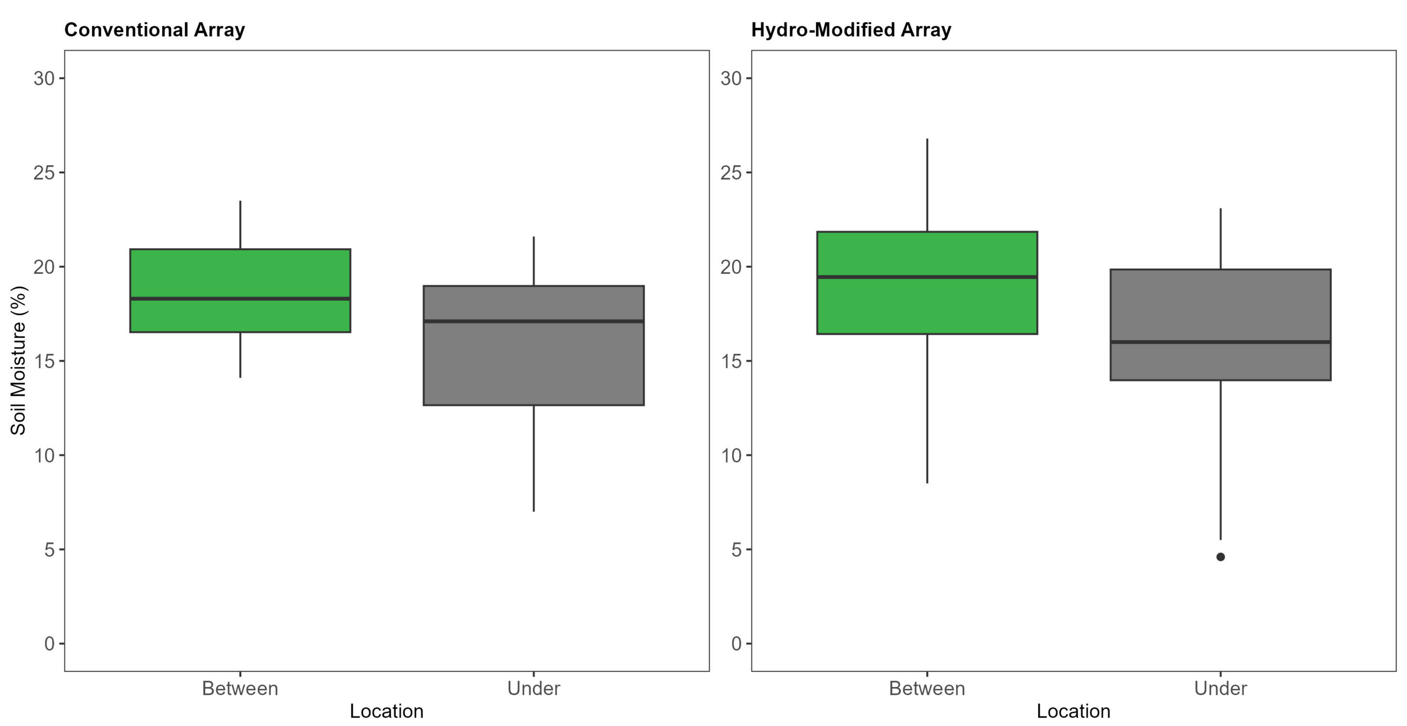

Figure 4. Soil moisture underneath the panels and between the rows of panels for the Conventional Array (left) and Hydro-Modified Array (right). Less moisture is seen under the panels due to less precipitation reaching that area.

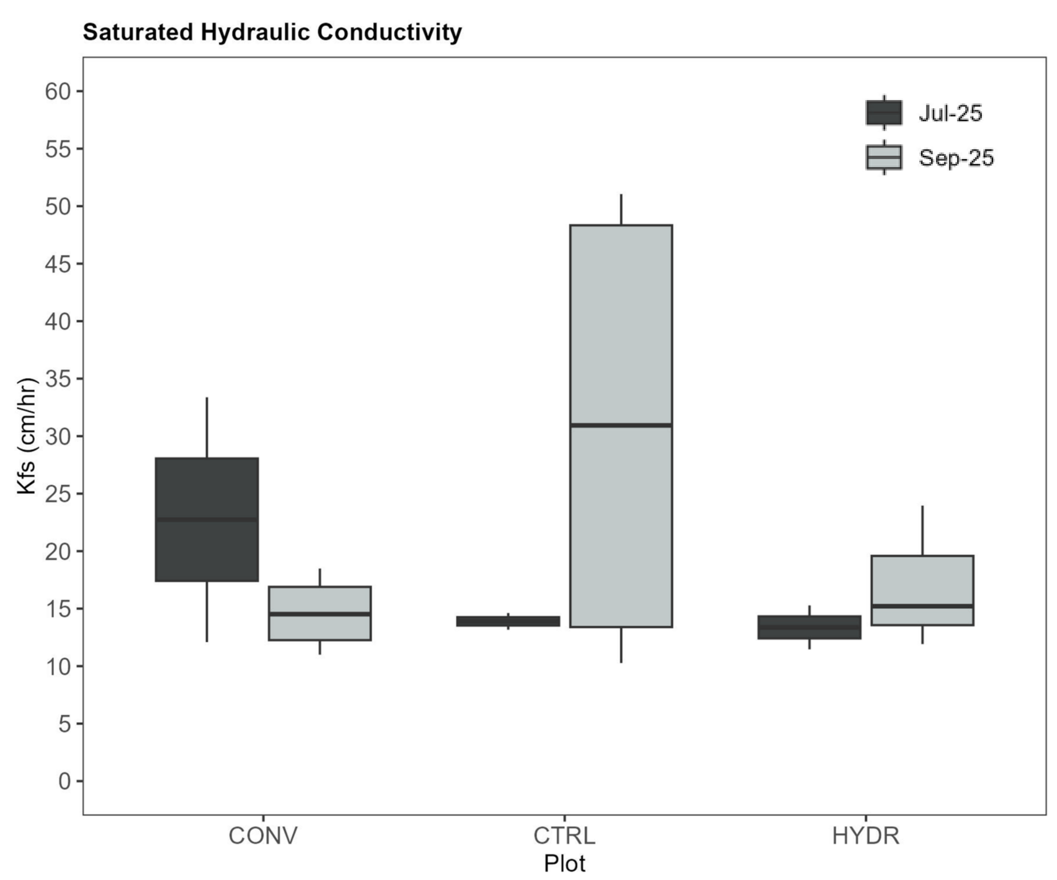

Figure 5. Saturated hydraulic conductivity (Kfs) taken using a SATURO instrument. CONV is the Conventional Array, HYDR is the Hydro-Modified Array, and CTRL is the control plot with no panels. Generally, a higher Kfs is seen in September with the exception of the CONV array which has a higher Kfs in July.

- Soil moisture under the panels is generally lower than between the panel rows (Figure 4).
- Saturated hydraulic conductivity (Kfs) is seen to change over time (Figure 5). Current results likely show the effect of soil compaction due to solar construction and a shift into fall months.
- Infiltration system on Hydro-Modified Array successfully capturing water and routing it into the ground (Figure 6a). A soil moisture probe below the infiltration basin shows increased water content after precipitation events (Figure 6b).

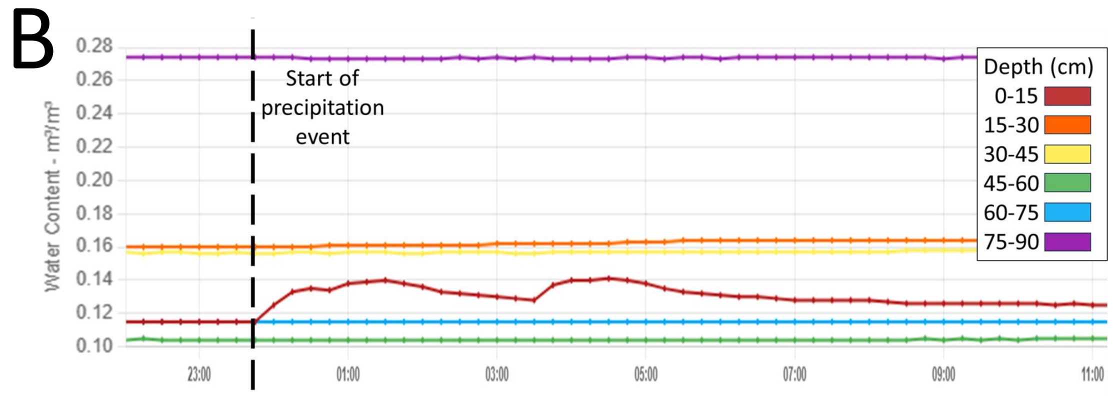

Figure 6. A) Image of infiltration point on Hydro-Modified Array. B) Water content at various depths after a precipitation event on October 28. The red line represents 0-15 cm below the infiltration basin and has the quickest and largest response to the added water. A small response is seen 15-30 cm below (orange line).

Next Steps

- Energy and hydrological monitoring and modelling through at least 2028.
- Assess how the two designs—Conventional and Hydo-Modified—affect water, energy, and economic tradeoffs.
- Model benefits to the High Plains region.
- Estimate the value of recharge to the region.

We will be featured at the 2026 Field Conference! More progress will be shared then.

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