Integrated Agrivoltaics Systems: Driving Green Jobs and Sustainable Rural Transformation in India

Abstract

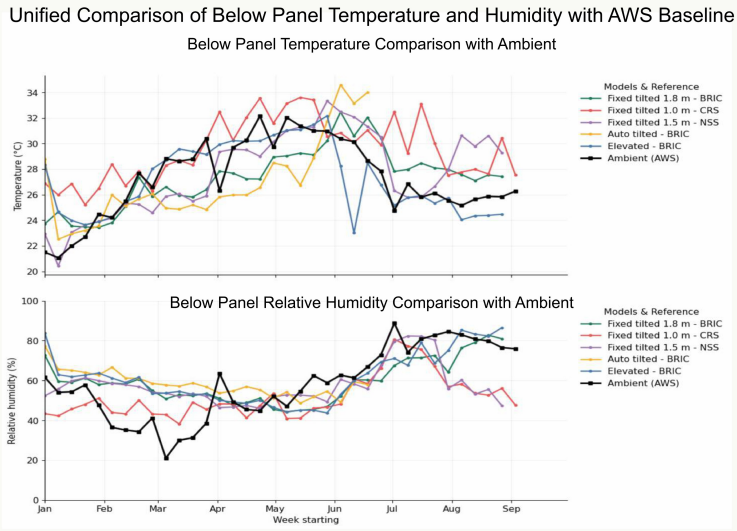
Agrivoltaics (AV) enables dual land use for crop production and solar energy generation. BAIF has established 13 agrivoltaics models with 750 kW capacity at Pune, Maharashtra, integrating agriculture, protected cultivation, and resource recycling. Initial findings from two cropping seasons indicated improved water and land-use efficiency and promising crop productivity. However, high capital costs, limited financing, and policy uncertainties hinder wider adoption. This paper examines key adoption barriers and solutions to enhance farm profitability, climate resilience, and sustainable rural livelihoods.

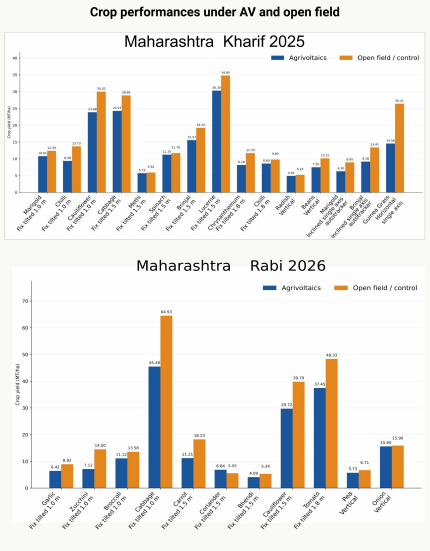
Agrivoltaics Model Name	Capacity (kWp) / Ha	Spacing in Pitch (m)	NMR from energy + Crop (Rs/Ha)	Payback period / Ha	Deployment Configuration
Fix tilted 1.0 m ground clearance	750	9.5	91.45	3.57	Grid Tie
Fix tilted 1.5 m ground clearance	750	8.5	91.92	3.89	
Fix tilted 1.8 m ground clearance	667	8.5	86.84	4.38	
Vertical model	910	4	63.90	9.5	Off-Grid
Elevated model	480	4	-	-	Grid Tie
Inclined single axis auto tilted structure	500	9.5	68.63	6.07	Pumping
Horizontal single axis auto tilted structure	500	9.5	64.35	5.98	Pumping
Seasonal Tracker system	722	9.5	89.05	6.02	Pumping
Agrivoltaics Model Name	**Capacity (kWp)**	**Cost per Kw**	**NMR from energy (Rs/system)**	**Payback period**	**Deployment Configuration**
Flexible solar panels on polyhouse roof	10	-	7	4.00	Grid Tie
Roof top solar panels on cow shade	30	-	2.30	5.01	Grid Tie
Floating Solar panels in Farm Pond	3	-	0.47	7.00	Pumping














Key Outcomes

- The crop productivity varies with season and crop in the range of **79% to 110%** against the control.
- The income ratio for energy and production was observed as **94:6.**
- The overall land productivity goes up by **1.64 to 1.71** times compared to the control depending on crop type, shading level, and system design
- Fastest Payback Period: Fix tilted 1 m **(3.57 years)** followed by Fix Tilted1.5 m **(3.89 years).**
- Highest Annual Return Rate (NMR / Total Cost): Fix Tilted 1 m at **28%,** followed by Fix Tilted 1.5 m at **24.90 %.**
- Highest Net Annual Revenue: Fix Tilted 1.5 m generates the highest net monetary return at **Rs 91.92 Lakhs/Ha/year,** closely followed by Fix Tilted 1 m at **Rs 91.44 Lakhs/Ha/year.**
- **Capital Intensive Structure :** Vertical PV has the highest total cost **(Rs 6.09 Crores/Ha) followed by tracking system (Rs 4.16 Crores /Ha).**
- Capacity building to **1000+ farmers, 107 students and 6 FPOs** from three states of India.
- The losses in generation are observed due to grid instability, system breakdown, followed by module maintenance and temperature in the range of **8% to 19%.**

Green jobs and rural livelihood opportunities

1) **Solar installation and maintenance**
   Structure installation, panel cleaning, inspection, electrical maintenance and system monitoring, employed 5 technicians
2) **Agrivoltaics farm management**
   Women farmers in Agrivoltaics for crop planning, nursery raising, irrigation management, harvesting and crop-quality monitoring.Employed 15 farm managers
3) **Technical training and entrepreneurship**
   Local service providers, solar technicians, irrigation operators and agrivoltaics advisory services. 5 youth got placement
4) **Diversified rural enterprises**
   EV charging stations, High-value crop cultivation under hydroponics, livestock based enterprises and other locally suitable activities. Employed two operators

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