Agrivoltaics In Practice: A Policy Approach to Climate Resilience and Rural Economics Development

ECON-295D: Energy Economics
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Policy Question

How can policy support agrivoltaics (AV) to serve as both a climate resilience strategy and an economic development tool for rural agricultural communities? Are policy tools like feed-in tariffs, subsidies, production tax credits, and pilot programs effective in enabling the adoption of AV?

Introduction

Motivation

- 57% of U.S. land is used for agriculture
- Solar PV is land-intensive: 20,000m^2/~5 acres/MW
- AV combines farming & solar, resolving land-use competition by enabling co-location of crops and photovoltaic (PV) systems on the same land.



Next2Sun installs bifacial solar panels on its patented vertical mounting system (Electrek 2023)

Key Policy Challenge

- Without policy, 83% of new solar installs will occur on farmland (AFT, 2025)
- High capital costs, uncertain returns, and the absence of national policy support inhibit AV development.
- Represents a classic positive externality: socially beneficial but underproduced without policy intervention.



Photo by Lightsource bp

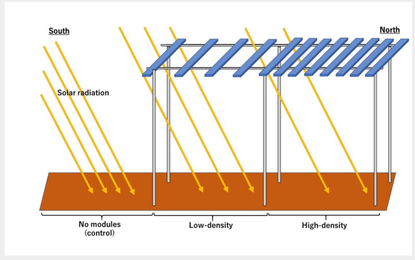
Why AV Matters

- Integrates food and clean energy production.
- Reduces biodiversity loss, mitigates water evaporation, and provides shade for crops.
- Generates dual income streams for farmers and supports energy security.
- US agrivoltaic market is expected to grow at a compound annual rate (CAGR) of 11.6%: $323.6 million in 2024 → $721.4 million by 2031 (Coherent Market Insights, 2024).

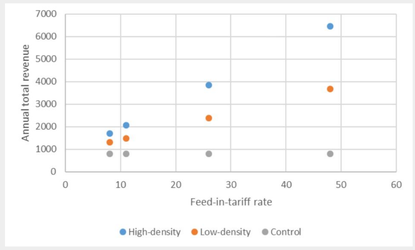
Global Case Studies of Agrivoltaics in Practice

Japan - Takashi (2019): Shade-Intolerant Corn Trial

- AV systems tested with high- and low-density panel configurations.
- Corn under low-density panels yielded 5.6% more than control crops.
- High-density PV produced 8.3x more revenue vs. control; low-density produced 4.7x.
- Break-even in 10 years; significant profits by year 20.
- Financial feasibility sensitive to feed-in tariff (FIT) rates: a 48 JPY/kWh FIT made AV viable.



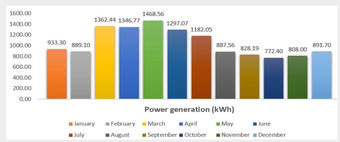
PV Module configurations at the agrivoltaic experimental farm



Sensitivity of annual total revenue per square meter to changes in the feed-in-tariff rate

India – Patel et al. (2023): Tomato Microclimate Study

- Tomatoes yields increase +6.98% to +15.09% depending on treatment.
- Best-performing treatment had a BCR of 2.59 and payback of 7.9 years.
- AV systems improved temperature (-2° C) and humidity (+10%).
- LER reached 1.65, meaning 1 hectare of AV outperformed 1.65 hectares of separate farming + solar.



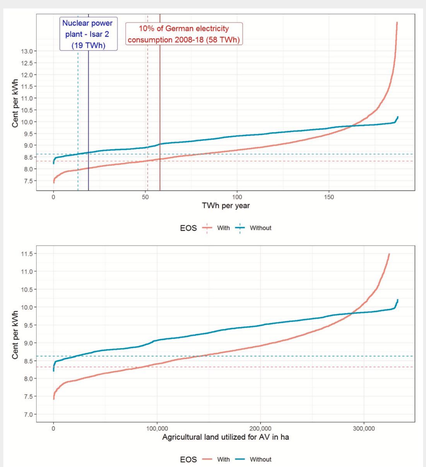
Monthly energy generation for 09/2017 to 08/2018 from AV structure



Movement of shadow over the day during crop growth

Germany – Feuerbacher et al. (2022): National Adoption Simulation

- Modeled 137,925 farms using FADN data.
- With economies of scale (EOS): AV meets 8.8% of electricity demand using 1% of arable land.
- Without EOS: Only 2.3% covered.
- Key barriers: High upfront costs, solar radiation variability, and yield loss from shading.
- EOS reduces break-even electricity tariffs and expands adoption.



Top panel: cumulative AV electricity potential (TWh/year) by electricity tariff and EOS presence. The blue line marks Isar nuclear plant output; the red line marks 10% of national electricity demand. Dotted lines represent break-even prices for the most cost-efficient 10% of adopters.
Bottom panel: corresponding cumulative AV land use (ha) across tariffs.

Country	Primary Crop(s)	Yield Impact	Benefit-Cost Ratio (BCR)	Payback Period	Key Insight
Japan	Corn (shade-intolerant)	5.6% increase (corn, low-density)	1.90 (high-density), 1.78 (low-density)	~10 years (high FIT rate)	Corn yield can improve with low-density AV; PV revenue far exceeds crop revenue.
India	Tomatoes (shade-tolerant)	15.09% increase (tomatoes, S1T1)	2.59 (S1T1)	7.9 years (no subsidies)	AV boosts yield and profit; climate moderation helps tomato growth.
Germany	Various (simulated)	Up to -40% (due to shading)	Modeled indirectly via margins	Not specified (simulated model)	EOS critical for adoption; AV on 1% land can meet 8.8% of electricity demand.

Summary of Agrivoltaics Cases from Japan, India, and Germany

Policy Recommendations

1. Feed-in Tariffs (FITs)
Ensure stable, above-market rates for renewable energy.
Drawback: Potential cost to ratepayers/taxpayers.

2. Installation Subsidies
Offset high capital costs for farmers.
Drawback: Government budget strain.

3. Production Tax Credits (PTCs)
Incentivize long-term clean energy generation.
Drawback: Risk of inequity in benefit distribution.

4. Regional Pilot Programs
Focus on climate-vulnerable agricultural zones.
Drawback: Risk of low scalability.

Conclusion

Agrivoltaics offers a transformative opportunity to align food security, clean energy goals, and economic resilience in rural communities. Evidence from Japan, India, and Germany demonstrates AV's financial viability, environmental co-benefits, and potential to reduce land-use conflict. To unlock its full potential, the U.S. must implement a coordinated support system blending tariffs, tax credits, and pilot funding. Without strategic intervention, AV will remain underutilized despite its promise to reshape our agricultural and energy landscapes.

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