Fact Sheet:
Making the Case for Crops + Solar

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INTRODUCTION

Agrisolar practices, also called agrivoltaics, are the co-location of agriculture and solar within the landscape. They include solar co-located with crops, grazing, beekeeping, pollinator habitat, aquaculture, and farm or dairy processing. Agrisolar practices offer an opportunity to allow solar and agriculture to co-exist while meeting demands for clean energy and resilient rural infrastructure. One agrisolar approach is crop production under and adjacent to solar photovoltaics. Farms and research sites across the country demonstrate agrisolar as an opportunity to diversify farm revenue, decrease crop irrigation, increase crop yield, increase soil moisture, improve solar panel efficiency, and increase rural energy independence (Barron-Gafford, 2019; MacKnick, 2022; and Adeh, 2019).

Extreme heat and weather events from climate change, including the long-term drought in the American west, have led to water shortages, decreased crop yields, and increased heat stress for farm workers. Climate projections show this trend continuing, resulting in a marked decrease in crop yield in the future (Hsiagn, 2017). At the same time, an increasing population has elevated the need for nutritious local foods and food sovereignty.

Solar energy development is also on the rise, with an estimated 10.3 million acres of land projected to be used for solar energy production by 2050 (Ardani, 2021). This could include up to 1% of U.S. cropland (USDA Rural Development, 2024). Between 2001 and 2016, 99% of the 11 million acres of farmland converted out of agricultural production were attributed to urban and suburban expansion, and 1% was attributed to solar development (USDA Rural Development, 2024).

Farmland is particularly appealing to solar developers because it is typically free of trees and rocks,

Photo 1. Dryland Farming of Melons at Oregon Agrivoltaic Research Center

Photo 2. Crop Co-Location at Jack's Solar Garden

Photo 3. Crop Co-Location at Knowlton Farms in Massachusetts

and the land requires less alteration before construction. Agrisolar practices can help prevent farmland loss by integrating existing agricultural lands with solar production, while at the same time conserving forests and maintaining food production.

CROPS

Despite the shade of the solar panels, crops still receive the light they need to grow (Barron-Gafford, 2019). Solar panels that move on tracking systems and follow the sun allow the crops to receive ample sunshine and protection from extreme temperatures and excessive evapotranspiration (Hassanpour, 2018). At the same time, the microclimate created by the crops results in a cooler temperature for the solar panels, which helps them operate more efficiently at lower temperatures.

Farmers in Colorado, Oregon, Arizona, and Massachusetts have seen greater yields and longer growing seasons. They attribute this to the protection of the solar panels, which decreases extremely high temperatures in the summer and increases the cooler temperatures in the fall and spring. The reduction in evapotranspiration from the shading leads to a dramatic decrease in irrigation. In Oregon, they are able grow water-intensive crops like melons, squash, and tomatoes without any irrigation, when the crops are co-located with solar, as shown in Photo 1.

In Arizona, researchers have recorded a 75% decrease in irrigation for tomatoes, beans, basil, and peppers (Barron-Gafford, 2019). The decreased need for irrigation pairs with an increase in soil moisture. In a comparison of agrivoltaic and full-sun crops, the same researchers recorded consistent soil moisture for two days in an agrivoltaic system, compared to two to three hours in a full-sun system (Barron-Gafford, 2023). Measurements of the agrivoltaic microclimate also showed a

Photo 4. Skin Temperature Measurement Taken in the Full Sun

Photo 5. Skin Temperature Photo Taken 10 Minutes Later in the Shade of Solar Panel

Skin temperature measurements taken in full sun and under solar panels show differences ranging from ten to fifteen degrees Fahrenheit. The photos above show a 15-degree skin temperature difference between full sun and the shade of a solar panel in Colorado in September 2022.

2- to 3-degree decrease in temperature.
The shade created by solar arrays can also lengthen growing seasons for certain plants. Test farms were able to grow traditional spring crops, like lettuces and chard, well into the summer, and continued producing kale well into the winter (Held, 2022).

Traditional row crops, like corn and soybeans, have also started to see success in agrisolar systems. These crops need a more individualized approach, with panels being built at greater heights to accommodate farm equipment. Given the amount of agricultural land dedicated to these types of crops, finding ways to combine them with solar production will go a long way in meeting the demand for solar energy (Bowman and Miller, 2022).
Soil moisture depletion, along with heat stress, lead to decreased crop growth in areas with excessive heat, like the American west. The small reduction in photosynthetic capacity associated with partial shade from the solar panel during part of the day can be offset by a more moderate temperature, a more humid microclimate, and greater soil moisture. This trade-off is greater in more extreme temperatures and climates. Shade and increased soil moisture can be particularly helpful in dry, hot years and areas that continue to face long-term droughts.

For crops harvested by hand, the shade and microclimates from solar panels also benefit farm workers. Farm workers can plan their work around the time of day the solar panels provide shade.

ECONOMICS

Agrisolar offers producers and landowners the opportunity to diversify their operations and their income. While still using their land to produce crops, landowners can own and install solar panels or lease their land to solar developers. Solar leases can bring in up to $1,000 per acre in revenue each year (Takemura, 2022). This new source of income can provide added financial stability for a farm and community. Farmers can also own the solar themselves or develop community solar. To learn more about solar ownership, refer to the publication Agrisolar Ownership: A Guide for Farmers, Ranchers, Communities, and Landowners to Co-locate Agricultural Production and Solar Generation.

If the system is designed for on-farm usage, agrisolar can offset the cost of running a farming operation because the energy produced can be used directly on the operation. Landowners may qualify for federal funding, such as a grant through the USDA Rural Energy for America Program (REAP), or utility and tax incentives to install solar panels, which further help their operations. For an up-to-date list of potential funding, refer to the Financial Information: Funding, Incentives, Tax Breaks, and Programs atlas at the AgriSolar Clearinghouse.

Depending on the local tax code, producers may be able to continue to classify their land as farmland, and benefit from tax incentives, even after adding solar to their farm. However, in areas where farmland is wholly converted to utility-scale solar production, the producer may be subject to rezoning and higher taxes. To learn more about agrisolar policy, refer to the publication Policy Approaches for Dual-Use and Agrisolar Practices (Kolbeck-Urlacher, 2023).

Solar arrays can also provide a source of land for emerging farmers and farming groups who do not have access to or the capital to purchase land. Land between the rows of solar arrays can provide enough space for a community farming group to grow specialty crops and create the capital necessary to purchase their own farmlands. Some solar arrays have a quarter-acre or more between panels that is not being used. Farmers could lease those areas with long-term contracts to grow high-value specialty crops.

Local communities and governments also benefit from the addition of agrisolar in their county. A projected 90% of solar siting will occur in rural communities and could result in up to 1.5 million jobs before 2035 (USDA Rural Development, 2024). The communities also receive increased tax revenue, a more resilient energy source that is created locally, and continued production of local food and agricultural products. This is particularly important in low-income and remote areas with limited access to affordable energy and fresh produce.

PLANNING CONSIDERATIONS

Careful planning is needed to be successful in implementing agrisolar. Guides such as NREL's The 5 Cs of Agrivoltaic Success Factors in the United States (MacKnick, 2022), American Farmland Trust's Smart Solar on Farmlands and Ranchlands, and the AgriSolar Clearinghouse's Get Started with AgriSolar are excellent references for initial project planning.

In grid-tied systems, solar projects should be sited near transmission lines and within five miles of a substation to ensure profitability because the further the panels are from a substation, the more energy is lost during transmission (Fitzpatrick, 2022).

If dryland farming isn't an option, it is important for agrisolar projects to have water access for irrigation (InSPIRE, no date). In addition to crop co-location, water pumps and pivots can be powered by solar. Additional considerations should be made for areas with frequent flooding, as electrical equipment may need to be raised and installation may be more expensive (Energy.gov, no date).

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