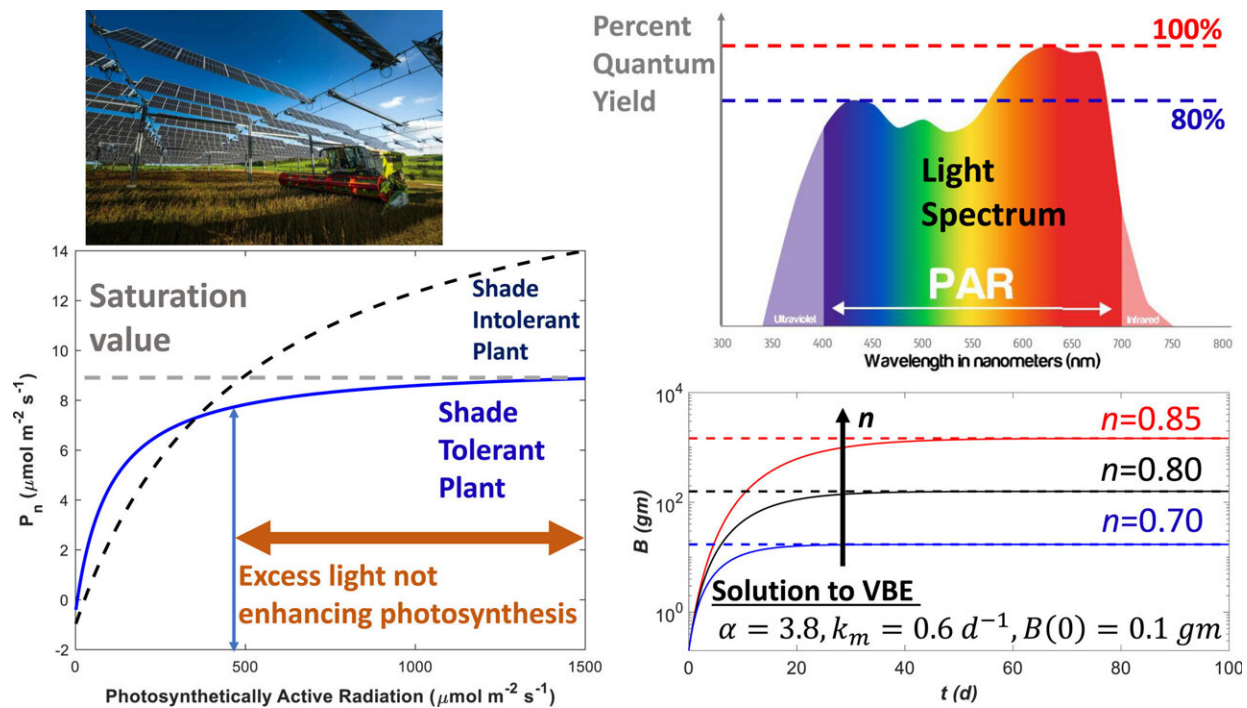


The mutual benefit of agriculture and solar energy

July 14 2023, by Aaron Sidder



Top left: Photo from an operational AV described elsewhere (Operational Agrivoltaic farm from MetSolar). Top right: Photosynthetic efficiency (ordinate) as a function of wavelength (abscissa) for photosynthetically active radiation (PAR). Bottom left: Photosynthesis (P_n) per unit leaf area as a function of PAR for shade tolerant (solid blue) and shade intolerant (dashed black) species. The P_n for the shade tolerant species saturates at low PAR compared to the shade intolerant species. Beyond the near saturation point (vertical arrow), increasing PAR leads to minor increases in P_n . Hence, excess light can be used for energy generation by the PV system. Bottom right: Solutions of the von Bertalanffy equation illustrating the time (t) variation of aboveground biomass $B(t)$ (in gm) of an individual seedling for 3 allometric scaling exponents ($n=0.7, 0.8, 0.85$).

The $B_{e,2}=\alpha^{1/(1-n)}$ is the maximum attainable aboveground biomass (dashed horizontal). The growing season (about 100 days) is much longer than the relaxation time in all 3 cases. The commentary offers conjectures about how the addition of PV impacts $B_{e,2}$ from a control with no PV. Credit: *Earth's Future* (2023). DOI: 10.1029/2023EF003512

Agricultural photovoltaics (AV) is a concept developed in the 1980s that combines agriculture and solar energy production on the same land. Practitioners grow crops under solar panels and can control the amount and wavelength of light that passes through photosynthesis. Light not needed for photosynthesis could provide clean energy production. At the same time, when plants photosynthesize, they lose water through transpiration. The loss of moisture cools the air and increases the power generation efficiency of the panels. It's a win-win situation—at least in theory.

However, significant challenges facing AV have hindered its widespread adoption. A pressing question is how AV technology can maximize [crop productivity](#) and [energy generation](#) while minimizing plant water loss and irrigation needs. That's a lot to ask for on a piece of land.

In a [previous study](#), the scientists argued that successful AV installations could divide light into wavelengths that are effective for energy production or photosynthesis, such as red for crops and blue for [solar panels](#). Building on this work, Gabriel Katul developed a [mathematical framework](#) to quantify how individual plants use different wavelengths of light in photosynthesis. The study, published in *Earth's Future*, sought to find out how combining photovoltaic systems with agriculture would affect aboveground biomass, which researchers use to estimate [crop yields](#).

The model considered individual plants and introduced variables, such as a plant's shade tolerance, that could affect its growth under a photovoltaic installation. The framework assumes that resources such as light are acquired based on leaf area, but that respiration costs are proportional to plant size. The study also considered how solar panels alter the microclimate and light availability beneath their cells.

Review articles highlight that candidate crops for AV are shade tolerant and have large aboveground leaf area. Reduced air temperature and higher soil moisture under photovoltaic systems allow plants to allocate more carbon to aboveground biomass, resulting in greater leaf area. This trait is common among shade tolerant plants, suggesting that larger leafy crops like arugula, kale, and tomatoes may be more likely to be successful in AV settings.

The next step, the author says, is to expand the findings beyond single crops by taking into account factors like crop crowding density.

More information: Gabriel G. Katul, Agrivoltaics in Color: Going From Light Spectra to Biomass, *Earth's Future* (2023). [DOI: 10.1029/2023EF003512](https://doi.org/10.1029/2023EF003512)

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