EGU21-13541, updated on 22 May 2022
https://doi.org/10.5194/egusphere-egu21-13541
EGU General Assembly 2021

Co-locating Food and Energy Production to Create Sustainable Agricultural Systems

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We have significant vulnerabilities across our food, water, and energy systems – any of which could undermine societal resilience in light of growing populations and climatic change. Rising average temperatures, extremes in precipitation, and more severe storms present increasing agricultural production risks – particularly across dryland regions. Land managers across the southwestern United States are already feeling the pressures of a changing climate. Between 11–21% of the total irrigated acreage experienced yield declines over the past 40 years due to irrigation interruptions — despite increased water usage. Food producers are experiencing increased uncertainties around production security from severe weather, interest rates to invest in climate adaptations, income support payments or incentives, and climate-related risks to pollinator abundance that affect crop yields and labor conditions and availability. Combined with trends towards increases in retirements from farming, these risks are leading to more land moving out of food production — often shifting to energy production. A growing demand for photovoltaic (PV) solar energy from ground-mounted systems, projected to require ~8,000 km2 by 2030, is resulting in an increase of land-use conflicts for these two primary needs — food and energy. Is it possible to improve both food and renewable energy production security sustainably? An 'either-or' discourse between food and PV solar energy production unnecessarily compounds issues related to allocating space, water, and capital for development of sustainable strategies.

We believe that a hybrid agricultural-PV solar 'agrivoltaics' can increase resilience in food and renewable energy production, water and soil conservation, and rural prosperity and economic development—critical sustainability metrics. However, successful adoption of this technology requires research from a socio-environmental systems perspective to optimize bio-technical trade-offs at the field scale, while also rigorously assessing the sociopolitical barriers and how to overcome them at both individual and societal levels. Our research design is centered on stakeholder engagement approaches with impactful, associated outreach activities to communicate and enhance the reach of potential benefits of agrivoltaics. An emerging trend in

sustainability research has been to recognize that resource challenges need to be addressed as integrated and interconnected sets of issues, where outcomes result from interacting social (S), ecological (E), and technological (T) subsystems (SETS). Often, sustainability transitions are seen more as a governance challenge than an infrastructure or technological challenge. That is, while technological solutions such as agrivoltaics can be developed, the adoption and spread of innovations takes place through a myriad of social, political, and economic processes. This is further complicated across food and energy systems, where multiple stakeholders present different backgrounds, cultures, demographics, and decision making processes. We describe an evaluation of agrivoltaic systems from a holistic SETS perspective in order to develop implementation pathways for widespread adoption of agrivoltaics across the US.