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Clean Energy Extension

FACT SHEET

Dual-Use: Crop and Livestock Considerations



In 2018, the Massachusetts Department of Energy Resources (MA DOER) established the Solar Massachusetts Renewable Target (SMART) program, which regulates incentives associated with new solar photovoltaic (PV) development in the state. This document is part of a series of fact sheets designed to help farmers navigate the program. Additional fact sheets and information are available on the UMass Clean Energy Extension (CEE) website, https://ag.umass.edu/clean-energy.

Dual-use of land for agricultural and solar PV electrical production is a fairly new concept. Various systems have shown success on a small-scale on farms around the world, but it is difficult to predict at this stage what crops and solar array designs will work best at a given site, or to what degree crop yield will be reduced by shading from panels. Under the SMART program, CEE will be collecting and analyzing annual reports from qualified dual-use arrays, which will help inform farm practices in the state as the technology develops.
The landowner may choose to work with a farmer or crop production manager to manage agricultural enterprises on dual-use sites. If this is the case, both parties should consider issues including property access, safety, insurance, and terms of financial compensation.

With the current uncertainties in mind, solar PV arrays may not be best suited to your most highly productive fields. The following tips may be helpful when considering what type(s) of agricultural activity are appropriate for your situation:

Livestock and Poultry

- Farmers in Britain have found success rearing both sheep and poultry (chickens, ducks, and geese) under solar panels, even under traditional ground-mounted arrays, where there is greater shading than would be allowed in dual-use systems under the SMART program.
- Solar panels are typically mounted high enough above the ground that domestic poultry will not roost on them – if they did this could foul the panels and lead to reduced electricity production and increased maintenance costs. The array can provide some protection for poultry from avian predators, although panels can also serve as potential roosts for hawks and owls.
- Solar panel arrays can provide shelter from the weather for a variety of livestock, but with larger or more inquisitive animals, design modifications may be necessary to accommodate them. Cows and horses are large enough that when they rub on solar panel mounts they have the potential to damage them, if racking systems are not designed with these animals in mind. Curious goats and pigs can interfere with wires and other equipment associated with the solar array. If you are interested in raising these animals in a dual-use system, be sure to work with the solar array designer and installer to ensure that wiring and conduit is contained, and that mounting systems will be constructed so as to be sufficient to withstand abuse by livestock.

- The design of a dual-use array should be done with consideration of animal handling, manure management, and fencing requirements, as well as height, width, and turning clearances for farm equipment. Attention should be given not only to current practices and equipment, but to anticipated farming changes over the next 25 years.
- If working with a livestock manager or shepherd, consideration should be given to (1) property access for both solar and livestock personnel, and (2) who will be responsible for the unique fencing needs of both solar equipment and livestock.

Hay and Silage

- In general, increased shading introduced by a dual-use system is expected to reduce yields of grasses and other plant species. Attention should be given to this shading impact when predicting harvest yields.
- Some grasses (e.g., orchardgrass) and legumes (e.g., white clover) can tolerate shade better than other species. Consider a hay mix in which these two species are dominant. A custom mix is preferred to pre-mixed bags.
- The design of a dual-use array should be done with consideration of mowing patterns and height, width, and turning clearances for planting and harvesting equipment. Attention should be given not only to current practices and equipment, but to anticipated farming changes over the next 25 years.

Grains and Vegetables

- There is very little hard scientific research available on what food crops can be successfully grown under solar panels, and what reductions in crop yield might be expected. Most studies to date have occurred under greenhouse conditions or have investigated growth of tropical plants in more arid regions, where shading can reduce water loss.
- In general, temperate climate crops that are expected to be more shade-tolerant include greens (lettuce, spinach, kale, Swiss chard, mustard), some herbs (parsley, mint, coriander), Brassicas (broccoli, cauliflower, cabbage, Brussel sprouts), and peas and bush beans. Leeks and onions may also produce a crop in partial shade. Attention should be given to the compatibility of PV system design with specific crop needs. One 2021 study, for example, found that broccoli would not produce harvestable heads with less the 85% of full sun irradiance.
- Lettuce, and presumably other greens, can be expected to exhibit different growth patterns in shade, growing fewer, larger leaves than they would produce in full sunlight conditions.
- Some root vegetables (carrots, beets, rutabaga, potatoes, radishes) can produce a crop under partial shade, but the growth period is typically longer than in full sun.
- Sun-loving vegetables include tomatoes, peppers, eggplant, corn, cucumbers, and squash. If incorporating these crops into a dual-use system, it is wise to plant them in the less shaded areas between panel rows.
- Look for shade-tolerant varieties or varieties from regions with shorter growing season, which may be more tolerant of reduced sunlight and cooler growing conditions.
- Shaded areas may produce a smaller crop but plants may be less prone to bolting in hot weather.
- Viny plants should be avoided under solar panels but could be grown along security fencing around a solar array.
- Shady areas under solar panels could be a potential selling point among consumers of pick-your-own crops on hot summer days.
- The design of a dual-use array should be done with consideration of height, width, and turning clearances for farm equipment. Attention should be given not only to current practices and equipment, but to anticipated farming changes over the next 25 years.

- When choosing which crops to grow, consider weed management and the susceptibility of crops to diseases which thrive in humid conditions. Weed management will require more time under solar arrays in annual cropping systems, since extra attention must be paid to the areas surrounding array posts. The potential for disease may also increase in the shady, humid conditions persisting under solar panels.

Fruit and Berry Production

- Many fruit crops require full-sun conditions to produce a good yield. Grapes are particularly sun-loving and may grow poorly in partial shade.
- Currants and gooseberries are more shade-tolerant than other fruit species, but production of these fruits is restricted in some Massachusetts municipalities.
- Perennial fruit crops, which require significant investments of time and money to establish, may be a gamble for experimental dual-use systems. If you are interested in establishing perennial fruit crops under a dual-use system, it may be wise to start small and observe any changes in yield before deploying dual-use systems on a large scale.
- Fruit crops like strawberries which require less upfront investment may be a better choice for dual-use arrays, since they can be replaced after several years if yield is low.
- Viny plants should be avoided under solar panels unless annual pruning will keep plants from growing over the array.
- Shady areas under solar panels could be a potential selling point among consumers of pick-your-own crops on hot summer days.
- The design of a dual-use array should be done with consideration of as height, width, and turning clearances for farm equipment. Attention should be given not only to current practices and equipment, but expectations for change over the next 25 years. Consider weed and pest management issues that may arise when growing under and around solar arrays.

Literature Reviews

For further information on recent research on agrivoltaics or dual-use installations see Mamun et al. (2022) and Walston et al. (2022).

References

Mamun, Mohammad Abdullah Al, Paul Dargusch, David Wadley, Noor Azwa Zulkarnain, and Ammar Abdul Aziz. 2022. “A Review of Research on Agrivoltaic Systems.” *Renewable and Sustainable Energy Reviews* 161 (June): 112351. https://doi.org/10.1016/j.rser.2022.112351.

Walston, Leroy J., Tristan Barley, Indraneel Bhandari, Ben Campbell, James McCall, Heidi M. Hartmann, and Adam G. Dolezal. 2022. “Opportunities for Agrivoltaic Systems to Achieve Synergistic Food-Energy-Environmental Needs and Address Sustainability Goals.” *Frontiers in Sustainable Food Systems* 6 (September): 932018. https://doi.org/10.3389/fsufs.2022.932018.

More Information

For more information, visit our website: https://ag.umass.edu/clean-energy/solarag.

After reviewing website materials, you can contact Zara Dowling (zdowling@umass.edu, 413-545-8516) with any additional questions related to solar PV use on your farm.