Ohio's Professional Soil Scientists

2022 Fall Newsletter
Volume 49, Issue 4 Part 2

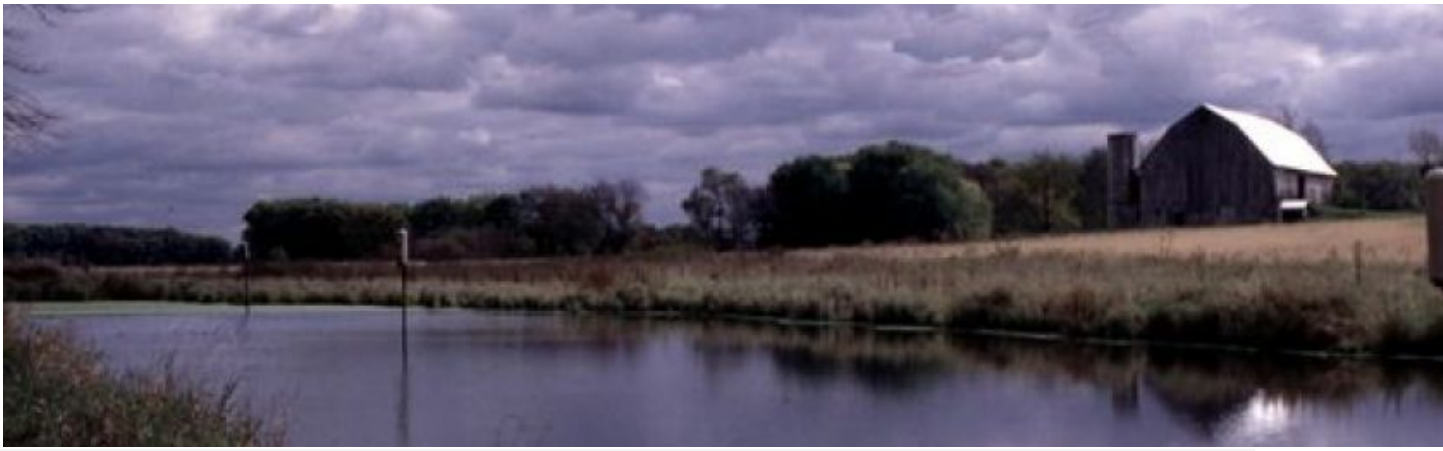
I was at a Flint Cemetery gathering last night with my friend Debra Knape who is a noted plants person, naturalist, garden designer and author. In her spare time she oversees the gardens at the Ohio's Governor's mansion in Bexley that Hope Taft installed. I was telling her about this section of the newsletter that I was writing and she asked me to make certain that we thought about solar and wind arrays in one circle, they can be placed anywhere, and farms in another. Where they overlap, like a Venn diagram, we have the best of both worlds.

Kathy Sasowsky found this very informative Blog from Ohio State University and as I have also been studying the interaction of wind turbines and solar panels with agriculture since my first trip to Denmark in 1998, I have added some additional information. However, before everyone gets excited and thinks this is the best thing since sliced bread, you all need to be aware that the Ohio House and Senate has done everything they can to ban the growth of wind and solar energy in the state. There is a very good reason for that; they get significant campaign contributions from the fossil fuel industry whereas wind and sun is free.

For instance, a drilling company can apply for a permit to drill unconventional oil and gas horizontal wells 100 feet from your house and there is absolutely nothing that you or your township or your county can do to stop them. The decision to permit is completely at the digression of the ODNR Div. of Oil and Gas Management and they are funded by permitting fees and severance taxes. If they denied the permit, they would have to buy the resource in the ground at retail value thanks to an Ohio Supreme Court decision between Pleasant City in Guernsey County and a coal company in the 1990s. But if a farmer wanted to lease his land for a wind farm, he has to have a ¼ mile setback from his property line for the wind turbine so they can only be erected on large farms. In addition, townships now have the power to vote to have no wind turbines constructed in their townships, calling them unsightly. Of course they have no problems with their eastern neighbors having their rolling landscapes strip mined or subject to mountain top removal. The rules in Ohio for solar panels are also "difficult". Basically, we are at the same point we were 20-30 years ago when the soil scientists in Kentucky and Ohio started lobbying for the planting of hemp as a cash crop to replace tobacco and to rebuild the soil. Hopefully it will not take that long but we have much educating to do, first in the farming communities and then at the Statehouse. We need to find our natural partners.

From Kathy Sasowsky: https://ohioaglaw.wordpress.com/2022/08/31/the-letter-of-intent-for-solar-and-wind-energy-development-considerations-for-landowners/

Ohio Agricultural Law Blog



BY PEGGY KIRK HALL | AUGUST 31, 2022 · 11:13 AM

The "letter of intent" for solar and wind energy development: considerations for landowners

Solar and wind energy development is thriving in Ohio, and most of that development will occur on leased farmland. Programs in the newly enacted federal Inflation Reduction Act might amplify renewable energy development even more. The decision to lease land for wind and solar development is an important one for a farmland owner, and one that remains with a farm for decades. It's also a very controversial issue in Ohio today, with farmers and community residents lining up on both sides of the controversy. For these reasons, when a landowner receives a "letter of intent" for wind or solar energy development, we recommend taking a careful course of action. Here are a few considerations that might help.

Purpose and legal effect of a letter of intent. Typically, a letter of intent for renewable energy development purposes is not a binding contract, but it might be. The purposes of the letter of intent are usually to provide initial information about a potential solar lease and confirm a landowner's interest in discussing the possibility of a solar lease. Unless there is compensation or a similar benefit provided to the landowner and the letter states that it's a binding contract, signing a letter of intent wouldn't have the legal effect of committing the landowner to a solar lease. But the actual language in the letter of intent would determine its legal effect, and it is possible that the letter would offer a payment and contain terms that bind a landowner to a leasing situation.

Attorney review is critical. To ensure a clear understanding of the legal effect and terms of the letter of intent, a landowner should review the letter with an attorney. An attorney can explain the significance of terms in the letter, which might include an "exclusivity" provision preventing the landowner from negotiating with any other solar developer for a certain period of time, "confidentiality" terms that prohibit a landowner from sharing information about the letter with anyone other than professional advisors, "assignment" terms that allow the other party to assign the rights to another company, and initial details about the proposed project and lease such as location, timeline, and payments. Working through the letter with an attorney won't require a great deal of time or cost but will remove uncertainties about the legal effect and terms of the letter of intent.

Negotiating an Option and Lease would be the next steps. If a landowner signs a letter of intent, the next steps will be to negotiate an Option and a Lease. It's typical for a letter of intent to summarize the major terms the developer intends to include in the Option and Lease, which can provide a helpful "heads up" on location, payments and length of the lease. As with the letter of intent, including an attorney in the review and negotiation of the Option and Lease is a necessary practice for a landowner. We also recommend a full consideration of other issues at this point, such as the effect on the farmland, farm business, family, taxes, estate plans, other legal interests, and neighbor relations. Read more in our "Farmland Owner's Guide to Solar Leasing" and "Farmland Owner's Solar Leasing Checklist".

Further Thoughts and References

It's important to remember that allowing the development of solar or wind generation on a farm setting does not necessarily preclude continuing to use that acreage for profitable production farming. Modern wind turbines are found in agricultural fields all over the world. The farmers simply plant and harvest around the wind turbines, leaving an access route open for maintaining the turbines. This duel application of farming and wind energy has been successfully undertaken in Denmark for more than 30 years.

The Mutual Benefits of Wind Energy and Agriculture

MAY 11, 2021

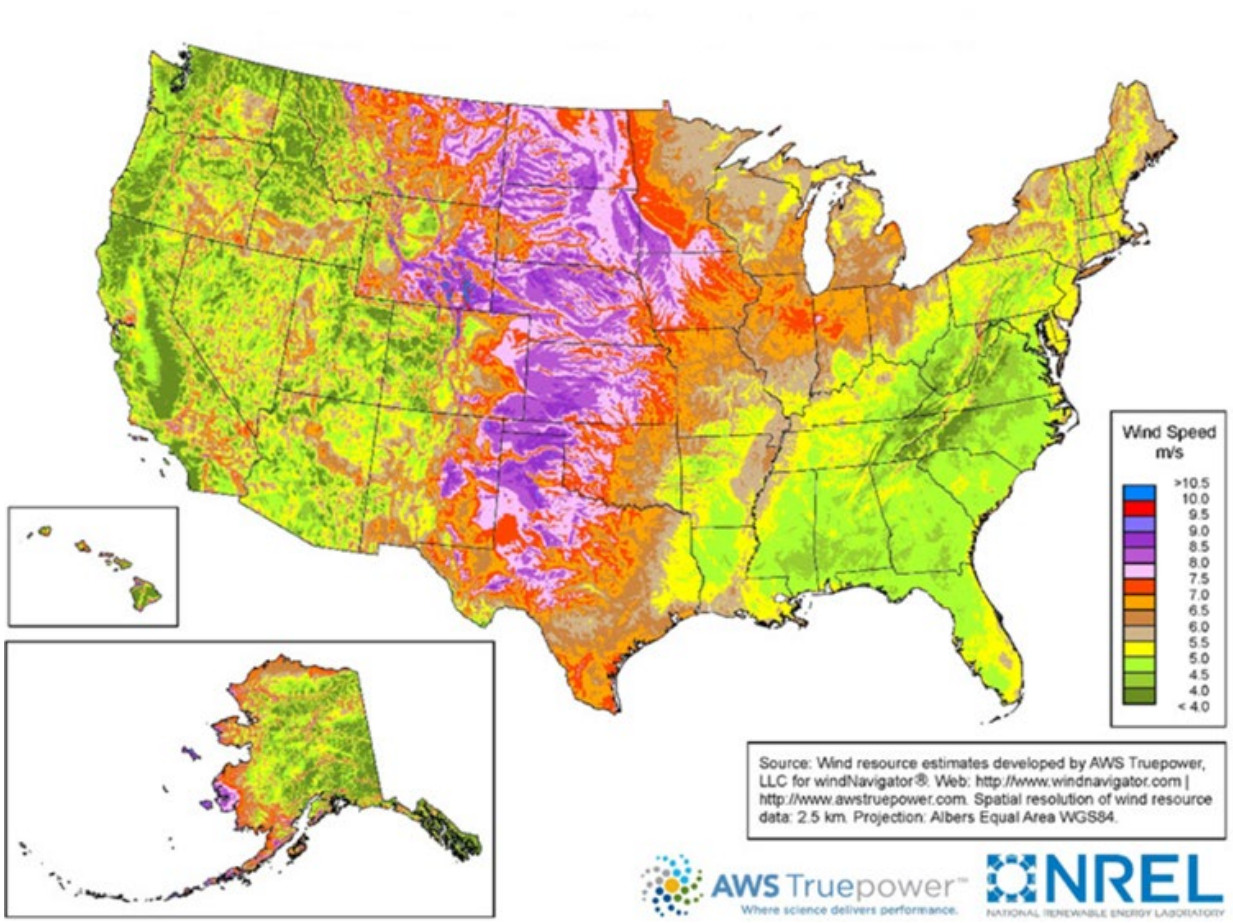
In a previous blog post, I examined the viability of colocating solar PV with agriculture—a combination that has the potential to yield significant benefits for farmers. But not only solar pairs well with agriculture. The colocation of wind energy and agriculture can also be beneficial to farmers by generating additional income and serving as a means of insurance, thanks to the stable income it can provide.

Where There Are Farms, There Is Wind

Wind and agriculture pair well. The two maps below illustrate this point well. The first is a map showing the annual average wind speed in the US, and the second is a map showing the share of land under cultivation in the US. These maps present significant overlap between farmland and land suitable for wind development. The wheat-producing states of the Great Plains and the maize-producing states of the Midwest are well-suited to wind development in particular.

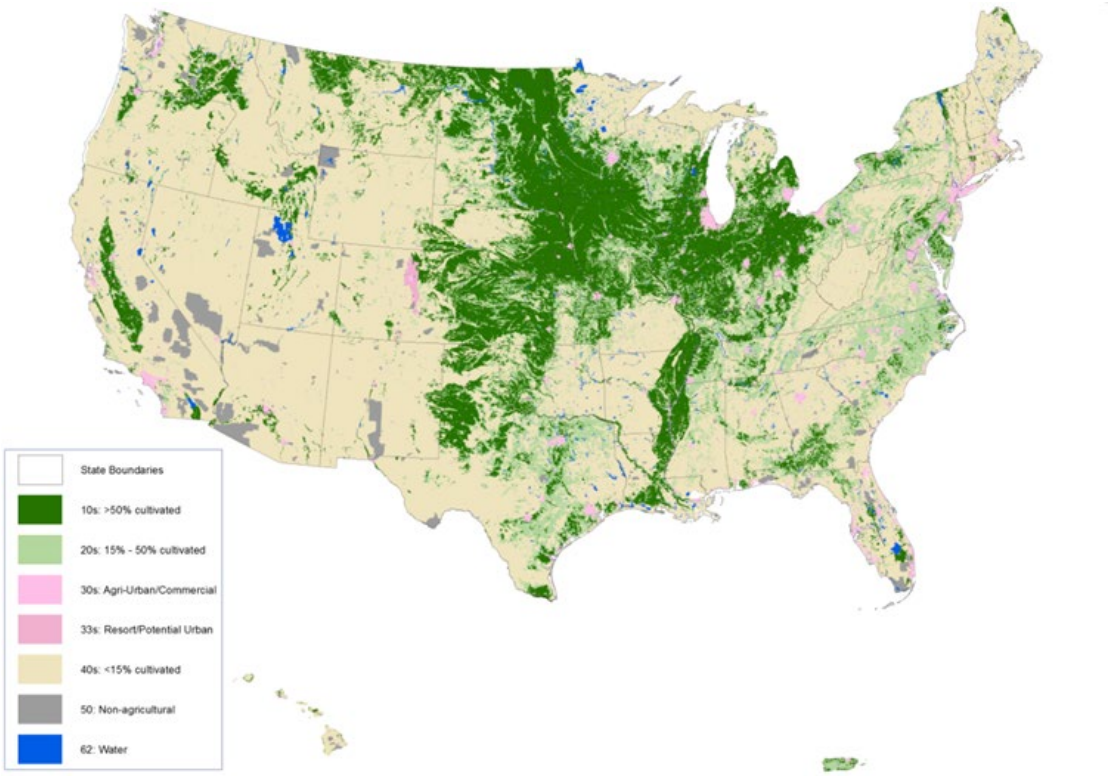
Each wind turbine can take up less than half an acre of land, often far less than what would be needed for a solar farm. It is possible for farmers to plant crops and graze livestock right up to the base of the turbines and therefore make use of about 95% of the land in the immediate area around the turbine.

Annual Average Wind Speed at 80 m in the US



(Source: Energy Information Administration)

Share of Land under Cultivation in the US



(Source: US Department of Agriculture)

A Virtuous Cycle

Wind generation in agriculture is beneficial in that pairing wind with agriculture leads to a virtuous cycle, in which the additional income generated by the turbines can be reinvested back on the farm. According to a survey conducted by the University of Michigan in 2014, landowners with wind turbines on their property invested twice as much money in their farms over the last 5 years compared with their neighbors without wind turbines. These investments went toward improving aspects of the farming operation such as farm equipment and irrigation and toward buying more farmland. While landowners with turbines may already be in a better financial position or more likely to experiment with new farming methods, these results still show that wind turbines have the potential to improve the land in the long term by allowing famers to invest more in their farms.

Do Wind Turbines Negatively Affect the Productivity of Adjacent Farms?

Thankfully, no. A study by Tengjiao Chen at the University of Illinois at Urbana-Champaign examines how wind farms may affect agricultural production via microclimate effects. Chen finds that the

development of wind energy has a significant positive effect on nearby crop yields—revealing that a 50 MW increase in installed wind capacity will increase soybean and corn yields by 1.3% and 2.4%, respectively. Changes to the microclimate were the primary driver for increased crop yields, with results indicating that sizable wind farms decreased the number of growing season extreme degree days (defined as days above 30°C during the growing season) by 2.2%-2.6%.

In summary, farmers in the Great Plains and the Midwest are well-situated to benefit from installing wind energy. Research suggests that wind turbines do not have a negative effect on crop yields—if anything, they can increase yield by reducing temperature extremes. Farmers who have installed turbines on their property benefit from the additional income and are more likely to reinvest that money to ensure the sustainability of their farm operation.

https://guidehouseinsights.com/news-and-views/the-mutual-benefits-of-wind-energy-and-agriculture

Here is a research study from Iowa State that actually looks at increased benefits to the growing plants from the presence of wind turbines in the fields.

Iowa State University Research Finds Wind Farms Positively Impact Crops

March 5th, 2018

AMES, Iowa — Iowa State University researchers have found that wind turbines located in agricultural fields are a plus for the crops growing around them.

The overall effects on crops growing in wind farms appear to be positive said Gene Takle, Iowa State agronomy professor. He has led a team of plant and soil scientist along with extension specialists who have been looking into the effects since 2009.

They started their work after seeing more wind farms and turbines pop up around the state. The new land use was positive for the landowners where they were located, but the researchers wondered if it was the same for the farmers growing crops.

“It’s unusual because we’re continuing the previous land use and we’re adding another,” he said. “We’re sort of double-cropping because these can be thought of two forms of energy production. The Chinese do this when they plant soybeans in between horticultural crops. We’re planting turbines.”

If the turbines change the microclimate for corn and soybeans, the team wanted to learn if it is a big enough change to be measured and the potential impacts.

He said wind blowing across a corn or soybean field without turbines creates a certain turbulence that carries moisture from the transpiring crop, which rises into the atmosphere and pulls down cooler, drier air. At night the wind is calmer and the land cools.

Turbines take some of the wind energy, slowing it down but increasing its turbulence so it interacts with the crop more, possibly increasing evaporation from the crop or moving carbon dioxide down into the crop.

“The biggest changes are at night and that’s because during the day there’s a lot of chaotic turbulence, just because the sun is heating the surface and the wind is gusty,” Takle said. “At night when it gets pretty calm, the crop cools down and if it’s a humid night you start to get dew formation. If you add the turbines, it looks a little more like the daytime. So the dew formation is delayed and it may start to evaporate sooner.”

Since fungus and mold like a wet environment, the shorter the wet period makes it less favorable for the growth of those potential pathogens. In the fall, the shorter wet period could speed up harvesting because farmers typically have to wait for soybeans to dry in the morning.

Another factor is that turbines bring warmer air down to interact with the cool air near the surface. Throughout the wind farm, the surface is a little bit warmer which inhibits dew formation.”

“Satellites can measure surface temperatures and you can see little dots across the state of Iowa and locate every wind farm because they’re slightly warmer than the surrounding area. So we know it has an effect that’s large enough to be seen there,” he said.

Another plus is the air pressure fluctuation measured around wind turbines.

Takle said there is a lot of carbon dioxide in the top few feet of soil — as much as two or three times what is in the air. The movement of air by the turbines pumps air down, and the movement draws carbon dioxide out of the soil so more would be available to the plant for photosynthesis.

The air moving down also creates more plant movement, which increases sunlight penetrating the dense crop canopy.

On the negative side is the tendency of higher temperatures occurring at night in wind farms.

Considering corn, during the day it’s taking in solar energy and carbon dioxide to make plant material. At night it cools down and gives back some of the carbon dioxide, and it gives up more if it’s warmer.

“So the night time warming of the turbines is not a totally good thing,” he said. “Night time temps have been going up over the last 40 years and are becoming a limiting factor for crop yields.”

But overall crops grown in wind farms seem to benefit.

“So there are three ways the crop is being ‘fertilized’ from either the air or from the soil or from increased photosynthesis. We measured increased carbon dioxide uptake during the day, but an

increased respiration at night," he said. "But over the course of the day there was more uptake. So as far as the impact of the turbines on the carbon dioxide processes and the photosynthesis process in the near vicinity of the turbines it's a net gain."

His team would like to look at the result of wind movement through a farm as it slows and tends to move up, which could create clouds if the air is warm and moist, and potentially rain.

"Are wind farms a preferential location for cloud formation or something that's going to provide more rain in an area beyond the wind farm? We don't know, we have some preliminary measurements that suggest that this is a real effect. Theoretically, you say yes there should be an effect, but is it large enough to be measured or to be important?" Takle asked.

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https://www.cals.iastate.edu/news/releases/iowa-state-university-research-finds-wind-farms-positively-impact-crops

Solar panels also do not preclude agriculture. One of the most successful multiple use is to turn the land into sheep pastures and place the fields into rotational grazing plans. Sheep are just the right height to move under the panels, thereby reducing the need to mow the grasses growing under the panels. It not only produces a livestock source for food and/or fiber, the sheep help to fertilize the pastures with their manures. Goats are not recommended as they have a tendency to eat the wiring.

Solar panels keeping sheep fed during drought

Two Australian farmers reported that their solar panels increased grazing quality during drought periods over a four year period, aligning with research suggesting solar panel microclimates might increase water retention, and grass production.

JUNE 1, 2022 **JOHN FITZGERALD WEAVER**

Tom Warren lets his sheep run between the solar panels.

Image: ABC Rural: Hannah Jose

Two agrivoltaic installations in New South Wales, Australia are being credited with increasing the quantity and quality of fleece in sheep grazing at the facilities during a drought. Research has indicated that the partial shade offered by solar panels creates a microclimate that reduces evaporation and significantly boosts the production of vegetation in arid climates.

While these results are preliminary and anecdotal (and perhaps a tall tale from a fleece salesman down under), they offer potentially exciting field results that could be applied globally.

Graeme Ostini, a wool broker, says he's been grazing his merino wethers (a variety of sheep) at a solar farm where sheep can graze under the modules. Ostini and other grazers say that over the past few years, these sheep have been 'cutting an amazing amount of wool'.

Ostini said, "It is actually quite astonishing. Some of the sheep look fantastic. They're growing exponentially and the wool cuts are in the top 5% in the district." Ostini has been grazing sheep at the site for four years now.

At a separate site, a Tom Warren runs about 250 merino ewes and wethers on 54 hectares of land, land that he also leases to a solar developer.

Sheep on Mr. Warren's farm were able to graze through years of drought, in part due to condensation from the panels.
Image: Tom Warren

Warren claims that while his wool yields remained the same, the quality of his wool improved significantly due to reduced contamination. The panels did more than provide shade for the sheep and grass: by slowing evaporation, they also prevented dust from contaminating the wool.

Mr. Warren noted that the solar panels condense water that drips onto the grasses and provide an additional source of water, increasing the carrying capacity of the land by around 25%. Warren also noted that, by leasing his land to the solar farm and grazing his sheep there, his income had increased.

The higher quantities of grass available for grazing were not surprising. Dr. Elnaz Hassapour Adeh, a researcher at Oregon State's College of Agricultural Sciences, found that several key grazing grasses were able to significantly increase their output mostly due to significantly increased water efficiency – by 328%.

Table 2. The results of biomass monitoring for different grass types in solar and control area.

Grass scientific name (common name)	Solar area (%)	Control area (%)
Hordeum (Foxtail barely)	10	25
Agrostis (Redtop bentgrass)	30	20
Alopecurus (Meadow foxtail)	50	7
Schedonorus (Tall rye grass)	5	9
Bromus (Foxtailbrome)	5	22
Calamagrostis (Reed grass)	0	6
Cirsium (Thistle)	0	10.5
Dactylis (Orchard grass)	0	0.5

https://doi.org/10.1371/journal.pone.0203256.t002

In total, the researchers found that areas that were partially or fully covered by solar panels increased their biomass production by 90%.

https://pv-magazine-usa.com/2022/06/01/solar-panels-keeping-sheep-fed-during-drought/#:~:text=Two%20Australian%20farmers%20reported%20that,water%20retention%2C%20and%20grass%20production.

More recently, farmers have found that solar panels make a great partnership with vegetable produce truck farming. The solar panels provide shade for parts of the day, important for raising leafy produce during summer months but also extend the growing season by providing coven and warmth as fall frosts and freezes approach. Of course, vegetable produce truck farming is far more labor intensive than sheep raising.

Growing Crops Under Solar Panels? Now There's a Bright Idea

In the new scientific (and literal) field of agrivoltaics, researchers are showing how panels can increase yields and reduce water use on a warming planet.

COURTESY OF AARON BUGAJ

IN JACK'S SOLAR Garden in Boulder County, Colorado, owner Byron Kominek has covered 4 of his 24 acres with solar panels. The farm is growing a huge array of crops underneath them—carrots, kale, tomatoes, garlic, beets, radishes, lettuce, and more. It's also been generating enough electricity to power 300 homes. "We decided to go about this in terms of needing to figure out how to make more money for land that we thought should be doing more," Kominek says.

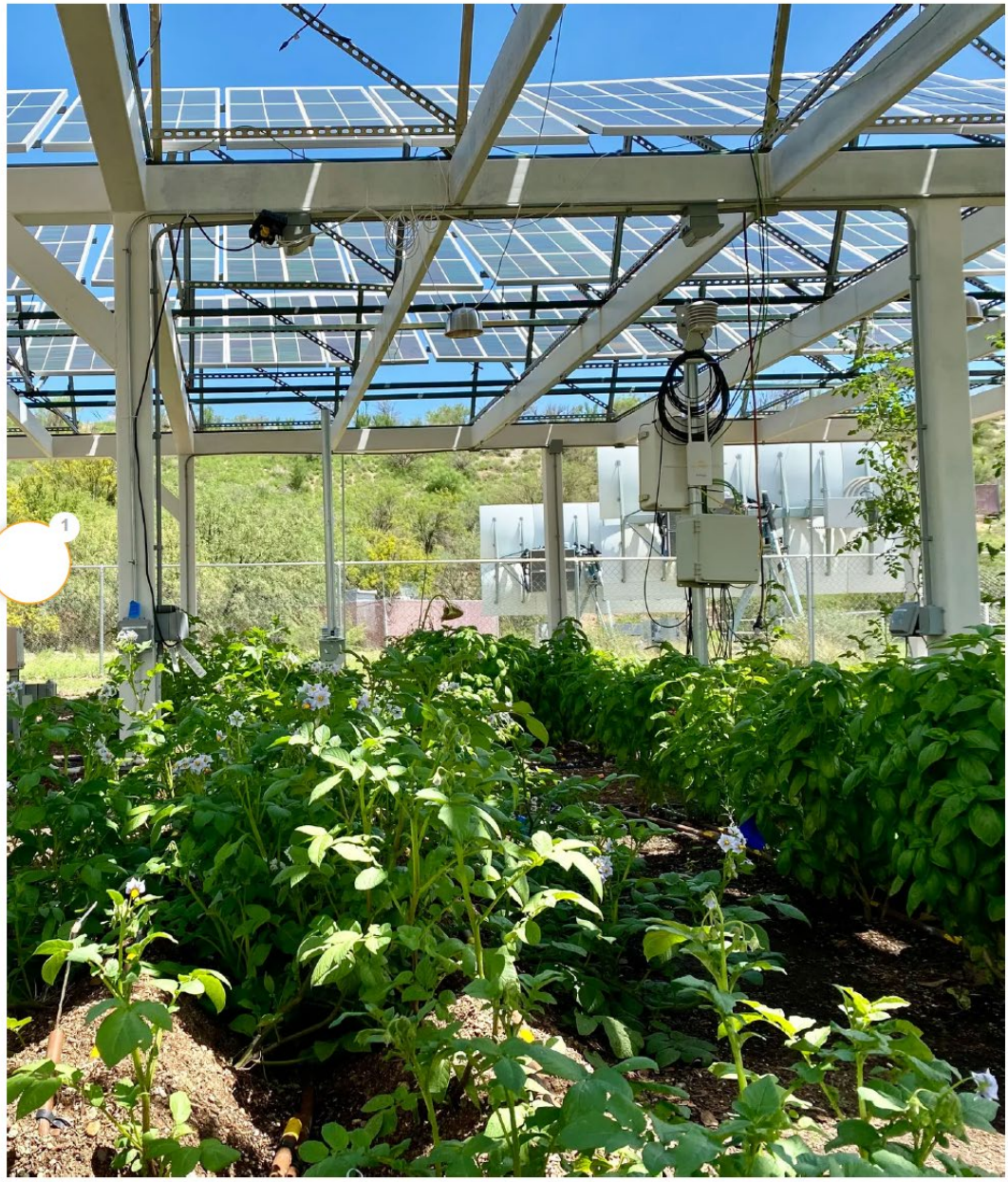
Rooftops are *so* 2020. If humanity's going to stave off the worst of climate change, people will need to get creative about where they put solar panels. Now scientists are thinking about how to cover canals with them, reducing evaporation while generating power. Airports are filling up their open space with sun-eaters. And space doesn't get much more open than on a farm: Why not stick a solar array in a field and plant crops underneath? It's a new scientific (and literal) field known as agrivoltaics—agriculture plus photovoltaics—and it's not as counterintuitive as it might seem.

Yes, plants need sunlight, but some need less than others, and indeed get stressed by too many photons. Shading those crops means they will require less water, which rapidly evaporates in an open field. Plus, plants "sweat," which cools the panels overhead and boosts their efficiency.

"It is a rare win-win-win," says Greg Barron-Gafford, an earth system scientist at University of Arizona who's studying agrivoltaics. "By growing these crops in the shade of solar arrays, we reduce the amount of that intense sunlight that bakes off the water and stresses out the plant." Barron-Gafford is among the recipients of a new $10 million grant from the USDA's National Institute of Food and Agriculture to research agrivoltaics for different regions, crops, and climates.

Barron-Gafford has been running experiments to quantify several variables—like growth, water use, and energy production—to determine which crops might benefit most. For instance, he's grown salsa ingredients—cilantro, peppers, and tomatoes—and found that they grow just as well, if not better, under solar panels than in the open. They also only use half the water. ("Think if you spilled your water bottle in the shade versus the sun," says Barron-Gafford.) He also found that the panels significantly reduce air temperatures, which would benefit farmworkers tending to

the plants. His work suggests that the panels might act as a protective bubble to shield crops from extreme heat associated with climate change, which overwhelms crops and decreases their yields.



COURTESY OF GREG BARRON-GAFFORD

Heavy precipitation that can damage crops is also on the rise, since a warmer atmosphere holds more moisture. "In times when there is extreme heat or extreme precipitation, by protecting plants in this manner, it can actually benefit them," says Madhu Khanna, an economist at the University of Illinois, Urbana-Champaign, who also won funding from the USDA's new agrivoltaics grant. "So that's another factor that we want to look at."

Khanna will be studying what the ideal solar array might be for a particular crop, for instance, if it needs bigger or smaller gaps between panels to let sunlight pass through. Height, too, is an issue: Corn and wheat would need taller panels, while shrubby soybeans would be fine with a more squat variety.

Thanks to those gaps, crops grown under solar panels aren't bathed in darkness. But, generally speaking, the light is more diffuse, meaning it's bouncing off of surfaces before striking the plants. This replicates a natural forest environment, in which all plants, save for the tallest trees, hang out in the shade, soaking up any sunbeams that break through.

Barron-Gafford has found that a forestlike shading under solar panels elicits a physiological response from plants. To collect more light, their leaves grow bigger than they would if planted in an open field. He's seen this happen in basil, which would increase that crop's yield. Barron-Gafford has also found that the pepper *Capsicum annuum*, which grows in the shade of trees in the wild, produces three times as much fruit in an agrivoltaic system. Tomato plants also grow more fruit. This is likely due to the plants being less stressed by the constant bombardment of sunlight, to which they're not evolutionarily adapted.

But every crop is going to be different, so scientists have to test each to see how they react to shade. "For example, we probably wouldn't recommend that somebody plant summer squash directly in the deepest shade, directly under a panel," says Mark Uchanski, a horticultural scientist at Colorado State University who's studying oltaics and tested that exact scenario. "The better location for that might be er out toward the edges where it's more likely to get a little bit more sun, because we did see a yield decrease in that case."

While setting up the panels entails some up-front costs, they might actually make farmers some money, as Kominek told Grist in this 2020 story before his panels were in place. They'd produce energy to run the farm, and the farmer can sell any surplus back to a utility. And since some plants—like those salsa ingredients in Barron-Gafford's experiments—will use less water, that can reduce irrigation expenses. "If we can actually allow farmers to diversify their production and get more out of the same land, then that can benefit them," says Khanna. "Having crops and solar panels is more beneficial for the environment than solar panels alone."

This kind of setup also cools the solar panels in two ways: Water evaporating from the soil rises up towards the panels, and plants release their own water. This is dandy for the panels' efficiency, because they actually perform worse when they get too hot. They generate an electric current when the sun's photons knock electrons out of atoms, but if they overheat, the electrons get overexcited and don't generate as much electricity when they're dislodged.

COURTESY OF GREG BARRON-GAFFORD

And as with putting solar panels above canals, using farmland pulls off the neat trick of not taking up any extra land. To deploy a traditional solar array, you'd need to clear space first. But canals and agricultural fields are already in use. "It's this big macro-trigger to kind of get people to the table and think about: What does rural economic development look like, and what's the future of agriculture?" says Andrea Gerlak, a social scientist at the University of Arizona, who's working with Barron-Gafford on the deployment of agrivoltaics. "If it allows smart agriculture, sustainable agriculture, and it uses less water, it's this big trigger to get people talking."

But agrivoltaics won't work for every farm. Solar panels remain a significant investment, especially on a field-sized scale. Maneuvering around them with heavy harvesting equipment will also be a challenge, so Khanna says the arrays should be designed as flexible systems. "The idea would be that you have these panels that are not just going to be fixed at a given angle and stationary," says Khanna. "They'll actually be able to rotate and become vertical, and let the equipment pass through."

Kominek adds that the United States is seeing a massive transfer of farmland from an older generation to a younger one, which has to decide what to do with their inheritance. Faced with the difficulties of drought and heat, the temptation might be to say, "To hell with crops," and cover a farm entirely with solar panels. But he and Barron-Gafford don't think it has to be an either-or proposition.

"The question for policymakers and landowners is, are we going to be taking out a lot of arable land—land where we could have chickens, cows, vegetables, perennials, and other things—and just putting in solar panels and having weeds grow underneath them?" Kominek asks. "Or are we going to create regulations that help to keep that soil active, to help it keep doing productive things, like it has been doing over the previous decades or centuries?"

Barron-Gafford also points out that agrivoltaics need not be limited to the kinds of [illegible] people eat. A farmer might let native grasses grow wild under the panels, [illegible]ding food for livestock, which would also benefit from the shade. Or they might promote the growth of plants for native pollinators like bees. With the right management, that land could pull double duty as a synthetic forest—just because it's shaded, doesn't mean life can't flourish underneath.

"I think everything likes a little bit of shade," says Kominek. "There's quite a variety of crops that enjoy it. And when it's 100 degrees outside, *I* enjoy the shade."

https://www.wired.com/story/growing-crops-under-solar-panels-now-theres-a-bright-idea/

That's all I have been able to find that people sent to me to include in this newsletter. If you sent me something and I missed it, accept my apologies and send it again to AOPeditor2020@gmail.com so it does not get lost in my normal work email site. Thanks again for all the contributions