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# listen to your mother (nature)

by Lee Allen

Mother Nature has come up with many great strategies and designs in her time, so why not follow her lead? Using natural concepts as models for solutions in the human world is a process called biomimicry and in this story, Lee Allen takes us to Arizona where two scientists are applying this method in agrivoltaics.

**B**iomimicry is the innovative approach of creating sustainable solutions by emulating nature's time-tested strategies. Mother Nature has had a long time to work these things out, and if we're really smart, we'll listen to our mother.

"Humans are clever, but without intending to, they've created massive sustainability problems for future generations," says Janine Benyus of the Biomimicry Institute in Montana. "Our goal is to create processes, policies, and products—new ways of living—that are well-adapted to life on Earth over the long haul. The core idea here is that nature has already solved many of the problems we're grappling with because microbes, plants, and animals are consummate engineers. After billions of years, failures are found in the form of fossils and what surrounds us today are the secrets to survival."

Looking at nature is like looking at a catalog of products that have benefitted from 3.8 billion years of research and development. Given that level of time and toil investment, it makes sense putting these practical applications to use.

"When we look at what is truly sustainable, the only real model that has worked over long periods of time is found in the natural world," Benyus says.



One example of biomimicry in action is found in the northern Sonoran Desert countryside surrounding Tucson, Arizona. Here, agricultural ecologist Dr. Greg Barron-Gafford and farmer, research scientist, and MacArthur Fellow Dr. Gary Nabhan combine concepts from Mother Nature with agrivoltaics, a system in which a single piece of land is used for both solar photovoltaic power production and conventional agriculture. More specifically, they took lessons learned from nurse plant ecology and applied them to reduce water use and carbon footprints in food production. In their plots at Biosphere 2, the world's largest living research center, and at Manzo Elementary School, which was awarded Best Green School 2012 by the US Green Building Council's Center for Green Schools, Nabhan and Barron-Gafford are experimenting with using solar panels as "host plants" and growing crops underneath them.

"Solar panels create a little heat island effect and, as they warm up, they become less effective to the tune of about half a per cent efficiency loss for every one degree Centigrade increase," Barron-Gafford explains. "Traditionally, panel installers have gotten rid of under-vegetation before construction. But, plants take carbon out of the air and in the process, moisture escapes and that transpiration, like human perspiration, creates localized cooling. We theorized if we stuck some plants under the panels, the in-ground and the above-ground efforts would both benefit."

"We took biomimicry and applied it to food production," Nabhan says. "Controlled environment settings (ergo, greenhouses) help, but semi-controlled, climate-buffered shared environments adapted from 4,000 years of field agriculture using what's available—urban heat islands that allow us to grow food under elevated solar panels acting as nurse plants integrated into an agrivoltaic agro-ecosystem—work well too."

As they're in the southwest US, the researchers started with salsa gardens, growing jalapeños, tomatoes, and chiltepin peppers, both under the panels and in open plots for four months. The contrast was astounding and led to further trials with chard, cabbage, carrots, basil, and even some mango and avocado trees. After their first year of experiments, the findings are promising.

"Plants under the panels receive less direct sunlight, which leads to reduced evaporative loss of soil moisture that allows for significant water savings," says Barron-Gafford. "Even if you irrigate every day, there's still some savings. An agrivoltaic system keeps things about four per cent wetter. You have to water every day in an open system, but only every fourth day under cover."

He also notes the microclimate under the panels "is cooler because of the moisture release." In open fields where summertime temperatures soar into the triple digits for weeks on end, this is a boon to both crops and the skin of workers.

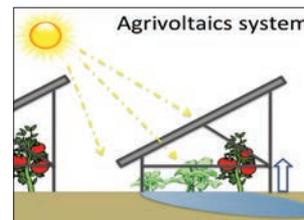
"One of the things we're excited about in our agrivoltaic gardens is they allow us to really push the seasons. The planting calendar is not the same anymore; it's now a blended calendar," says Moses Thompson at Manzo Elementary School. "There's so much flexibility. It's all unknown and exciting. We could be running all warm-season crops under cover during the winter and they would be fine. I'm curious to see how long we can push the cool-season stuff as the warmer weather arrives."

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Plants under photovoltaic panels receive less direct sunlight, but this may lead to reduced evaporative loss of soil moisture (white arrow), allowing for significant water savings. Also, the microclimate under agrivoltaic panels may be cooler than under panels in typical ground-mounted installations because of this moisture release.



Thompson says that kale, cabbage, and other cool-season crops start earlier and grow longer in the gardens. Big bush beans, basil, sweet potatoes, and other frost-sensitive, warm-season plants also do well, as the layout works like a heat sink. “We don’t have hard freezes under the roof panels like we do in our open gardens,” he says.

As these early findings are so glowing, what about possible commercial applications of this system? Researchers are meeting with agricultural policy economists and local growers to better understand the barriers to wider application. One of the negative factors might involve height from crop to top.

“If you’re doing head lettuce where the machine coming through is 30 feet or more tall, this doesn’t work. And crops requiring a lot of aerial pesticides present a different set of problems,” says Barron-Gafford.

“The biggest scaling question involves arid areas like our Sonoran Desert and many areas in Imperial Valley,” he concludes. “In some cases, it’s not sustainable to continue to grow crops there using business-as-usual methods because of drought conditions and the amount of water needed. Many of the formerly irrigated patches have now been solar-paneled—converted to renewable energy—so you don’t have to have a trade-off of one or the other. You can have both. If you’ve been farming for generations in your area, you don’t have to give that up. You can overlay something that will actually help certain crops and produce power at the same time.” **MY**

# 3 Steps

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