

FREE REPORT

# Agrivoltaics Planning Guide: Crops, Grazing, Water and Power on One Site

A practical, evidence-based guide to scoping a first agrivoltaic project in the United States.

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A free educational report from Funding Regeneration, sponsored by Planetary CARE.

## Who this report is for

This guide is for farmers, ranchers, landowners, rural community leaders and project developers in the US who know the basic idea of agrivoltaics and want to think through a real first project.

Because results depend heavily on climate, the guide also points to research in several North American bioregions, from the Sonoran Desert and the Pacific Northwest to the Front Range of the Great Plains, the Northeast and southern Ontario.

It picks up where our introductory posts on crops, grazing, water and farm batteries leave off. The focus here is decisions: which design fits your land, what the research can and cannot tell you, how the money tends to work, what you will sign, and what to check before anyone breaks ground.

## Key findings at a glance

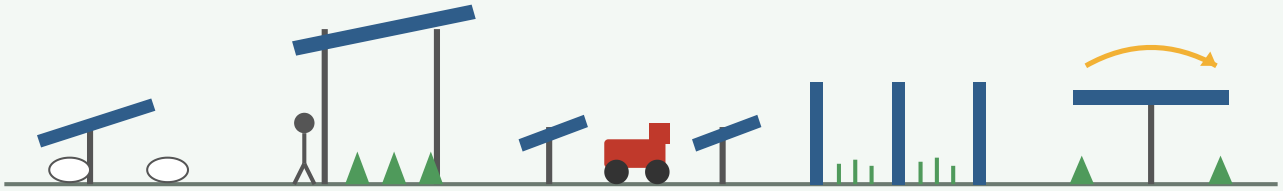
- **Design follows the farm.** The farming you want to keep should set panel height, row spacing and layout. Fitting farming into a standard array later is harder and usually less productive.
- **Sheep grazing is the most common dual use.** A USDA Economic Research Service review found just over one-fourth of US agrivoltaic sites pair solar with sheep, while fewer than 5% include crops.
- **Shade helps some systems and hurts others.** An Oregon trial found 38% less herbage under panels yet nearly identical lamb weight gains, while an Arizona study found some pepper and tomato yields doubled or tripled.
- **Dual use usually costs more to build.** A National Laboratory of the Rockies (formerly NREL) benchmark estimated dual-use systems cost about $0.07 to $0.80 per watt more than conventional ground-mounted solar, with crop systems at the high end.
- **Relationships matter as much as hardware.** The national lab's InSPIRE research named communication and partnerships as one of five core success factors.
- **Federal incentives changed sharply in 2025 and 2026.** Solar tax credit deadlines were shortened, and a 2026 USDA rule discourages REAP support for solar on cropland. Verify every program.
- **Start small and measure.** A pilot block with baseline data protects you from expensive surprises.



## 1. System designs and how to choose

There is no single agrivoltaic design. There are several families, each suited to different goals.

**Five common agrivoltaic design families (simplified, not to scale)**



| Conventional height | Raised array | Wide row spacing | Vertical bifacial | Single-axis tracker |
|---|---|---|---|---|
| grazing or habitat | crops, people, cattle | tractors work alleys | hay, grain, pasture | tilt can be managed |

**Conventional height with grazing or vegetation.** Panels sit at standard heights, with sheep, native grasses or pollinator plantings underneath. This is the simplest and cheapest form of dual use.

**Raised arrays.** Panels are lifted high enough, often eight feet or more, for people, cattle or small equipment to move underneath. This suits specialty crops and larger livestock but needs heavier steel and stronger foundations.

**Wide row spacing.** Panels stay at normal height but rows are spread apart so tractors can work the alleys.

**Vertical bifacial arrays.** Panels stand upright, collecting morning and evening light on both faces, with wide alleys for hay, grain or pasture. The national lab's cost benchmark found vertical mounting had the lowest installed cost among crop-focused designs, though it may produce less energy per rated watt.

**Single-axis trackers.** Panels rotate to follow the sun. Some operators can adjust tilt to let more light reach crops or to clear space for equipment.

To choose, rank your goals. If keeping a cash crop in production comes first, expect a higher build cost and lower energy output per acre. If energy revenue comes first, grazing or habitat under a conventional array is usually the better fit. Then check practical limits: the height and width of your equipment, harvest crew access, soil and drainage, and how much energy the site must produce to pay for itself.

**Quick decision guide**

| If your main goal is... | Consider... | Trade-off to expect |
|---|---|---|
| Energy revenue at the lowest added cost | Conventional height with sheep, grasses or pollinator plantings | Simplest dual use; little room for crops |
| Specialty crops, hand harvest or cattle under panels | Raised array, often eight feet or more | Heavier steel and foundations; highest added cost (up to about $0.80 per watt in the national lab benchmark) |
| Hay, grain or pasture worked with field equipment | Vertical bifacial or wide row spacing | Vertical had the lowest installed cost of the crop designs, but may produce less energy per rated watt |
| Changing light or clearance through the season | Single-axis tracker | Tilt changes must be agreed with the system operator |

Before you settle on a row, measure your tallest and widest equipment and confirm the design clears both.

**THE NATIONAL LAB'S "5 CS" OF AGRIVOLTAIC SUCCESS**

The InSPIRE team at the National Laboratory of the Rockies (formerly NREL) grouped what makes US projects work into five factors (Macknick et al., 2022). Use them as a design checklist:

- **Climate, soil and environmental conditions** at your site.
- **Configurations**, meaning the solar technology and array design.
- **Crop selection** and cultivation or vegetation management.
- **Compatibility and flexibility** between farming and solar operations.
- **Collaboration and partnerships** among landowners, farmers, developers and researchers.

## 2. What the crop and livestock evidence really says

The research base is growing but young. Most US studies are small, short and site-specific. Read results as signals, not guarantees.

**Specialty crops in drylands.** In a University of Arizona study at Biosphere 2, in the Sonoran Desert of southern Arizona, published in *Nature Sustainability*, Barron-Gafford and colleagues found chiltepin pepper production was about three times greater under panels and cherry tomato production about twice as great. Jalapeño yields were similar, with 65% less water lost through transpiration.

**Pasture and forage.** At an unirrigated Oregon State University pasture in Corvallis, in the Willamette Valley of the Pacific Northwest, Hassanpour Adeh, Selker and Higgins reported in *PLOS ONE* that shaded areas held more soil moisture and produced about 90% more late-season biomass. The authors cautioned that the sample was small.

**Sheep performance.** A later Oregon State trial by Andrew and colleagues in *Frontiers in Sustainable Food Systems* found solar pastures produced 38% less herbage, mainly because fully shaded strips grew sparsely. Yet lamb weight gains were nearly identical and liveweight production per hectare was comparable.

**Grazing intensity and insects.** A 2026 Cornell study led by Zoller in *Environmental Research Letters* found two sheep per hectare raised the combined abundance of wild bees, honey bees and lady beetles by 38% compared with mowing. At eight sheep per hectare, vegetation control was strongest but honey bee abundance fell by 45%.

**Total land productivity.** Early modeling by Dupraz and colleagues in *Renewable Energy* predicted a 35% to 73% increase in total land productivity when crops and panels share a field. The authors called these results preliminary.

The takeaway: shade-tolerant crops, cool-season forages and crops that suffer heat stress are the safest bets. Light-hungry crops like corn are harder. Look for trials in your own climate before committing.

### WHAT THE STUDIES ABOVE FOUND

**~3x**
chiltepin pepper production under panels in Arizona (Barron-Gafford et al.)

**65%**
less water lost through transpiration by jalapeños under panels

**38%**
less herbage on Oregon solar pasture, with nearly identical lamb gains

**<5%**
of US agrivoltaic sites include crops (USDA ERS)

### BEFORE YOU RELY ON A STUDY, CHECK THESE

☐ Was it done in a climate like yours? The Arizona pepper and tomato gains came from a dryland site.

☐ How large and how long was it? The Oregon pasture authors flagged their small sample.

☐ Did it measure what you sell? Oregon's 38% less herbage still gave nearly identical lamb gains.

☐ Was the array like the one you are being offered? Height, spacing and tracking change the shade.

☐ Was it measured in the field or modeled? The Dupraz land productivity gains were preliminary modeling.

☐ Does it state the stocking rate or management? Cornell's results shifted sharply between two and eight sheep per hectare.



*Leafy greens are among the crops most often trialed under raised panels. Results depend on climate, variety and array design.*

## 3. Water and microclimate planning

Panel shade can cut evaporation, but turning that into results takes design choices.

**Map where water goes.** Panels concentrate rain along their drip edges, which can cause erosion lines and dry strips. Some designs place crops or swales at the drip line. Trackers can spread runoff more evenly.

**Measure before and after.** If water savings are part of your case, install soil moisture sensors in open and shaded areas before construction.

**Watch the cooling loop.** The Arizona study noted that crop transpiration helped cool the panels above, which can improve their efficiency, especially in hot climates.

**Plan for disease and frost.** Shade slows drying after rain, which may raise disease pressure in humid regions. Ask your extension office how these shifts could affect your crops.

**Fit irrigation to the layout.** Center pivots need clear paths and height. Decide on irrigation before the racking layout is fixed.

> **WHAT CHANGES BY BIOREGION**

- **Southwest (Sonoran Desert):** Heat and water loss are the main limits. At the University of Arizona's Biosphere 2 site, shade raised some pepper and tomato yields and cut jalapeño water loss by 65%.
- **Pacific Northwest (Willamette Valley, Oregon):** Dry summers make late-season soil moisture the key gain. Oregon State's Corvallis pasture held more moisture and grew more late-season biomass under panels.
- **Great Plains and Front Range (Colorado):** Jack's Solar Garden in Boulder County runs a 1.2 MW single-axis tracking array over about four acres, with crops grown under panels raised 6 to 8 feet and research by the University of Arizona, the national lab and Colorado State University (NCAT).
- **Northeast (New York):** In a humid climate, vegetation control is the main job. Cornell's three-year trial at the Cascadilla Community Solar Farm in Dryden, New York, tested sheep stocking rates for pollinators and plant control.
- **Canada (southern Ontario):** A Western University study in *Applied Energy*, built with a shepherd from Vittoria, Ontario, found solar sheep grazing models returned 16% to 43% on investment. Shorter seasons and provincial rules make local advice essential.

**Setting up a simple water baseline**

1. Before construction, mark three matched zones: open ground, a strip that will be fully shaded and a future drip line.
2. Place soil moisture sensors at the same root-zone depth in each zone.
3. Log rainfall and any irrigation you apply, with dates.
4. Record yield or forage from each zone at harvest or after each grazing rotation.
5. Keep logging for at least one full season after the panels go up, then compare zone to zone, not just site averages.
6. Walk the drip lines after heavy rain and photograph any erosion so it can be fixed early.

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# 4. Economics and income stacking

Agrivoltaics can create several income streams from one acre. It also adds costs, partners and complexity.

**Common income streams:**

- **Lease payments** from a solar developer, usually per acre per year.
- **Energy savings** if the system offsets your own farm load.
- **Electricity sales** if you own the system and sell power.
- **Grazing contracts** paid by the solar operator. Penn State Extension, citing Cornell surveys, reported average direct grazing fees of about $326 per acre in the eastern US and $555 per acre in New

York, usually for an April to October season.

- **Crop or livestock sales** from what you keep producing.

**Common added costs:**

- Elevated or reinforced racking, which the national lab benchmark identified as the main cost driver for crop systems.
- Extra site investigation, which roughly doubled in all three dual-use cases in that benchmark.
- Interior fencing, water access and handling gear for livestock.
- Slower field work around posts and lower yields in shaded strips.
- Insurance, legal review and coordination time.

Penn State Extension warns graziers not to treat solar sites as "free grazing." You still carry off-season flock costs, transport and labor.

**A simple model.** Build conservative, expected and optimistic scenarios with income by stream, costs and any change in farm output. Then test what happens if one stream disappears. A project that only works in the optimistic case is not ready.

**BEFORE YOU SIGN A SOLAR GRAZING CONTRACT, GET ANSWERS TO THESE**

- ☐ How many acres, which months, and what vegetation height must you maintain?
- ☐ Is the fee per acre, per season or per visit, and when is it paid?
- ☐ Who supplies and maintains water, perimeter and interior fencing?
- ☐ What is the access and gate protocol, and who do you call on site?
- ☐ Who mows or treats weeds the flock will not eat, and who pays?
- ☐ What insurance do you need, and who is liable for animal or panel damage?
- ☐ How much notice is required to end the contract on either side?

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# 5. Permitting, land agreements and grid connection

Many projects stall here, not on the technology.

**Zoning.** Rules vary by county and township. Some restrict solar on prime farmland; others ease the path for dual use. Check whether your local code defines agrivoltaics and what setbacks and hearings apply.

**Farmland programs.** Solar may affect conservation easements, preferential tax assessment or farmland preservation status. Confirm with the program administrator before signing anything.

**Leases.** The Ohio State University and National Agricultural Law Center *Farmland Owner's Guide to Solar Leasing* is a clear free resource. Pay close attention to:

- The option period and full lease term, which can run 20 to 40 years.
- Property taxes and any rollback taxes.
- Your rights to graze, farm or access land in and around the array.
- Decommissioning, soil restoration and financial security such as a bond.
- Drainage tile repair, crop damage and liability insurance.
- What happens if the lease is sold or the operator fails.

For agrivoltaics, add a written agricultural management plan setting out who manages vegetation, livestock and crops, how access is scheduled and how disputes are handled.

**Grid connection.** Every project needs utility approval to connect. Small on-farm systems usually fall under state net metering or interconnection rules. Larger systems may face costly studies and long queues. Ask your utility early for a pre-application report or hosting capacity map.

> **ORDER OF CALLS THAT SAVES THE MOST TIME**
>
> 1. County planning or zoning office: is the use allowed here, and what hearings apply?
> 2. Farmland program, easement holder or tax assessor: will solar change your status?
> 3. Utility: is there grid capacity near your site, and what will interconnection involve?
> 4. Attorney: only then review the lease or ownership structure in detail.

## 6. Funding and incentive pathways

Programs changed significantly in 2025 and 2026. This summary is general and reflects our understanding in late 2026. Check current rules with the agency, a tax professional and your lender.

**Federal tax credits.** The Inflation Reduction Act of 2022 expanded clean energy tax credits. The 2025 budget law, often called the One Big Beautiful Bill Act, shortened them for solar. According to the Solar Energy Industries Association's summary, commercial solar must have begun construction by July 4, 2026, or be placed in service by December 31, 2027, to qualify for the main credits. The placed-in-service deadline does not apply to energy storage, and foreign-entity sourcing limits apply from 2026. Eligibility depends on dates, ownership and equipment, so get qualified tax advice.

**USDA REAP.** The Rural Energy for America Program has long offered grants and guaranteed loans to agricultural producers and rural small businesses. In October 2026, USDA issued a final rule that discourages solar and wind on cropland, requires projects to be built and performing before applying, and makes multi-location projects ineligible. Farm and solar groups sued in September 2026 over how USDA applied its new solar policy to pending applications. Confirm current eligibility for your specific site before planning around REAP.

**State programs.** Some states have dual-use programs, such as New Jersey's dual-use solar pilot and Massachusetts' agricultural solar incentive. Your state energy office and extension service are good starting points.

**Research partnerships.** According to the Economic Research Service, USDA's National Institute of Food and Agriculture invested $10 million in agrivoltaics research in 2021. Hosting a land-grant university demonstration can bring monitoring support and shared data.

**Other paths.** Community solar, cooperative ownership and farm credit lenders can all play a part. Some farmers start with a small system that offsets pumps or barns, then expand.

**Where to check first, by funding type**

| If you are counting on... | Check first | Status as of November 2026 |
|---|---|---|
| Federal solar tax credits | A tax professional, with your construction-start and in-service dates | Construction had to begin by July 4, 2026, or the project must be placed in service by December 31, 2027 (SEIA) |
| Battery storage credits | A tax professional | The 2027 placed-in-service deadline does not apply to storage, but foreign-entity sourcing limits do |
| USDA REAP | Your USDA Rural Development state office | No open application window; the October 2026 rule discourages solar on cropland and requires projects to be built first |
| A state dual-use incentive | Your state energy office | Examples include New Jersey's pilot and Massachusetts' agricultural solar incentive |
| Research support | Your land-grant university extension office | Depends on current research projects in your region |

**SEQUENCE YOUR FUNDING CHECKS SO NO SINGLE PROGRAM CARRIES THE PROJECT**

1. **Dates first.** If you are counting on federal solar credits, ask a tax professional whether construction began by July 4, 2026, or the project can be placed in service by December 31, 2027. If neither, model the project without the credit.
2. **State next.** Ask your state energy office whether a dual-use incentive exists; only some states offer one.
3. **Treat REAP as upside, not a base case.** There is no open application window, and under the October 2026 rule projects must be built and performing before applying.
4. **Stress-test.** Rerun the Section 4 scenarios with each incentive removed in turn. If one loss sinks the project, it is not ready.



*A small behind-the-meter system that powers pumps or barns can be a lower-risk first step than a large leased array.*

> **CANADIAN READERS**
>
> Federal and provincial programs differ from the US programs above. Start with your provincial energy ministry, your utility's interconnection rules and your provincial agriculture department, and ask whether solar on farmland is restricted in your area.

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## Step-by-step: scoping your first project

1. **Set your goals.** Rank production, income, energy savings, water and habitat.
2. **Gather site basics.** Acreage, soil maps from the USDA Web Soil Survey, drainage records, yields and annual electricity use.
3. **Check the rules.** Call county planning about zoning, and review easements or tax programs.
4. **Talk to the utility.** Ask about interconnection, grid capacity and net metering.
5. **Pick a design family** that matches your farming goals and equipment.

6. **Find local evidence.** Ask extension about regional trials and visit farmers already grazing or growing under panels.
7. **Build three budgets,** separating incentives you are sure of from ones you are not.
8. **Get legal review** of any lease, and add an agricultural management plan.
9. **Start with a pilot** and monitor soil moisture, yields and forage.
10. **Plan long term** for succession, decommissioning and the land's condition in 30 years.

### TEN QUESTIONS TO ASK ANY SOLAR DEVELOPER

☐ Have you built a dual-use project before? Can I visit it and talk to the farmer?

☐ What panel height, row spacing and gate widths are you proposing, and why?

☐ Who writes and pays for the agricultural management plan?

☐ How will drainage tile be located, protected and repaired?

☐ What happens to topsoil during construction, and how is it restored?

☐ What decommissioning bond or security will you post, and when?

☐ Which incentives does your financial model assume, and what if one disappears?

☐ Who pays property tax increases or rollback taxes?

☐ Can the lease be sold, and what protections do I keep if it is?

☐ What data will you share with me on yields, forage or soil moisture?

### WHERE TO GET TRUSTED HELP

- **AgriSolar Clearinghouse** (agrisolarclearinghouse.org): research, case studies and a peer network.
- **Your land-grant university extension office:** regional crop and grazing trials and site visits.
- **National Agricultural Law Center and Ohio State's Farm Office:** the free *Farmland Owner's Guide to Solar Leasing*.
- **US Department of Energy:** the free *Farmer's Guide to Going Solar*.
- **Your state energy office:** current state incentives and dual-use programs.

### SHADE CHANGES MORE THAN LIGHT

Panels alter soil moisture, air temperature, wind and where rain lands. The Oregon pasture study above found more soil moisture in shaded areas, while the Arizona study found crops helped cool the panels above them. That is why measuring both open and shaded areas before and after construction is so valuable: it lets you see which of these effects matter on your own ground.

# Worksheet: one-page project scoping checklist

Fill this in before your first conversation with a developer, lender or agency.

**Goals**

- My top priority: _____
- My second priority: _____
- Crop or livestock I want to keep producing: _____

**Site**

- Acres available: _____ Acres for a pilot: _____
- Soil type and drainage: _____
- ☐ I have checked the USDA Web Soil Survey
- ☐ I know about any drainage tile, easements or preferential tax status

**Equipment and access**

- Tallest equipment: _____ ft Widest equipment: _____ ft
- ☐ I have decided how irrigation will work with the layout

**Energy**

- Annual farm electricity use: _____ kWh Main loads: _____
- ☐ I have asked my utility about interconnection and net metering

**Rules and agreements**

- ☐ I have contacted the county planning or zoning office
- ☐ I know who would own the system (me, a developer, a cooperative)
- ☐ I have an attorney to review any lease or easement

**Money**

- Expected income streams: _____
- Costs I am unsure about: _____
- ☐ My conservative scenario works without uncertain incentives

**Support**

- Extension contact: _____
- Nearby agrivoltaic farm to visit: _____

## Common mistakes to avoid

- **Letting the array design come first.** Fixed panel height and spacing can doom the farming side.
- **Assuming incentives will last.** Build a plan that survives if a credit or grant disappears.
- **Skipping the baseline.** Without before-and-after data, you cannot prove benefits.
- **Underestimating coordination.** Penn State Extension notes gate closing and communication with maintenance staff are common issues on grazed sites.
- **Signing a long lease quickly.** Option periods, decommissioning and access rights need legal review.
- **Ignoring drip-line erosion.** Water problems damage soil, roads and equipment over time.
- **Choosing goats.** They can climb and damage panels, so most guidance favors sheep.
- **Going too big, too fast.** A pilot teaches you what works at a fraction of the risk.

## Glossary

- **Agrivoltaics:** Using the same land for solar energy and agriculture, such as crops, grazing or pollinator habitat.
- **Bifacial panel:** A solar panel that captures light on both faces.
- **Decommissioning:** Removing a solar system at end of life and restoring the land.
- **Ground coverage ratio (GCR):** The share of land covered by panels. Lower means more light between rows.
- **Interconnection:** The process and agreement that let a system connect to the utility grid.
- **Land equivalent ratio (LER):** Compares land needed for a combined system versus separate systems. Above 1 means the combined system uses land more efficiently.
- **Net metering:** Billing where electricity sent to the grid offsets electricity drawn from it.
- **Single-axis tracker:** A mount that rotates panels to follow the sun.
- **Stocking rate:** Animals grazed per unit of land over a season.

## Next steps

To keep learning, visit the free Agrivoltaics pathway at fundingregeneration.earth/agrivoltaics/. To see how agrivoltaics connects with water, food and waste systems on one site, explore The Integrated System at fundingregeneration.earth/integrated-system/.

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*Disclaimer: This report is educational information only. It is not legal, financial, tax or engineering advice. Incentive programs, tax rules and permitting requirements change often and vary by state and county. Check current program rules with the relevant agency and consult qualified professionals before making decisions about your land or a project.*

**YOUR NEXT THREE MOVES**

1. **This week:** fill in the one-page scoping worksheet and pull your soil map from the USDA Web Soil Survey.
2. **This month:** call your county planning office and your utility, and write down what each tells you.
3. **This season:** visit one farm already grazing or growing under panels, and ask what they would do differently.