Vegetation Management Lessons Learned and Helpful Tools

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REWI 2023 Solar Symposium

16 November 2023

Photo by Dennis Schroeder, NREL 55200

The InSPIRE Project-

Innovative **S**olar **P**ractices **I**ntegrated with **R**ural Economies and **E**cosystems

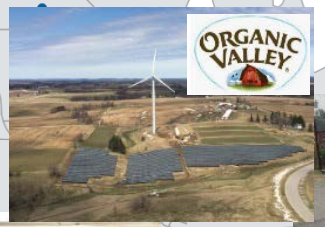
- Established in 2015
- InSPIRE has 25 active field research projects across the United States
- **Field-based research:**
  - Novel agrivoltaic and traditional utility-scale PV designs integrated with multiple activities
  - Assessing agricultural yields and irrigation requirements in arid environments
  - Grazing standards and best practices
  - Pollinator habitat and ecological services
- **Analytical research:**
  - Cost-benefit tradeoffs of different agrivoltaic configurations
  - Assessing research gaps and priorities
  - Tracking agrivoltaic projects across the United States

https://openei.org/wiki/InSPIRE

Oregon State University · Cornell University · PINEGATE RENEWABLES · HYPERION SYSTEMS Harvest the Sun! · Argonne NATIONAL LABORATORY · REGENERATE Integrated Systems for People and Place

THE UNIVERSITY OF ARIZONA · UNIVERSITY OF MASSACHUSETTS AMHERST · Colorado State University · Fresh Energy · NREL NATIONAL RENEWABLE ENERGY LABORATORY · MNL · enel Green Power · TEMPLE UNIVERSITY

InSPIRE Project Research Sites



Overview of Research Layout at the MN sites

- 3 Enel Green Power PV sites (Atwater, Chisago, and Eastwood) and 1 Connexus Site
  - Represents 3 different ecoregions with different soil and hydrologic conditions

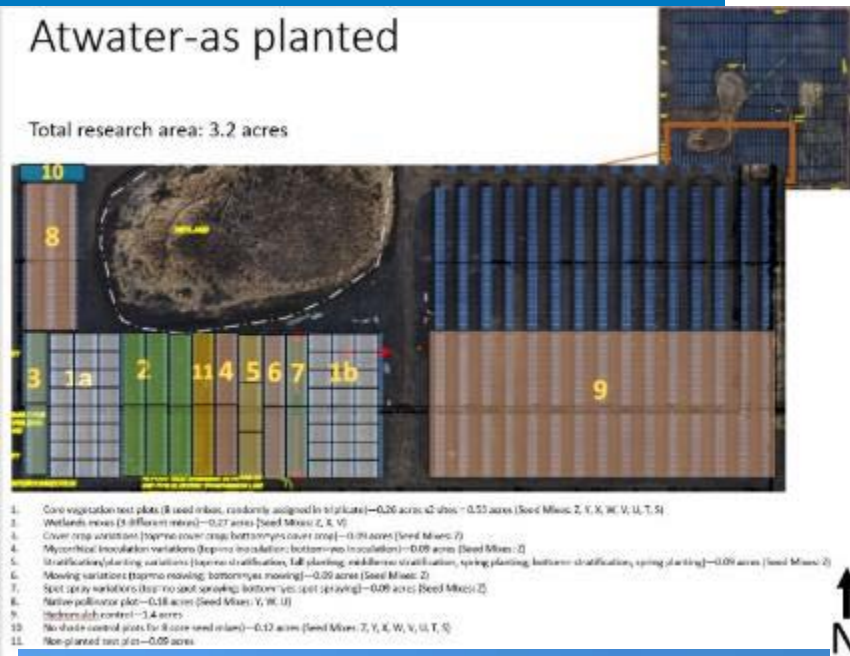
- Each site has 3 areas of research
  - PV panels with bare ground underneath
  - PV panels with pollinator habitat underneath
  - Open-air (No PV) with pollinator habitat

- Overarching Goals
  - Understand differences between bare groundcover and pollinator habitat on temperatures and PV performance
  - Evaluate best-performing seed mixes under partial-shade environment
  - Characterize various on-site and broader benefits of pollinator habitat at solar sites
  - Conduct most comprehensive long-term study on pollinator-friendly solar to-date

Aurora Vegetation Seed Mix Study Overview

Vegetation and seed mix field study

- 8 unique seed mixes tested across all sites
- Roughly 105 different species planted in test areas
- Multiple planting and management approaches
- Partnership with State of Minnesota to evaluate their recommended seed mixes



Seed Mix Response at Different Sites (Sept 2021)

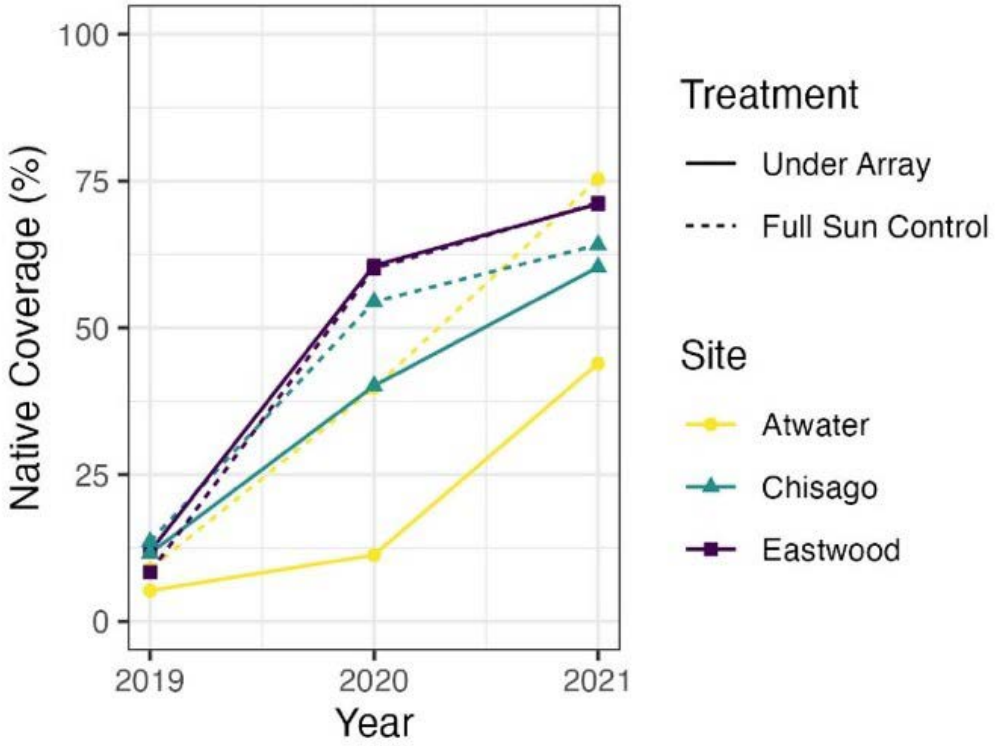
Atwater – Z1

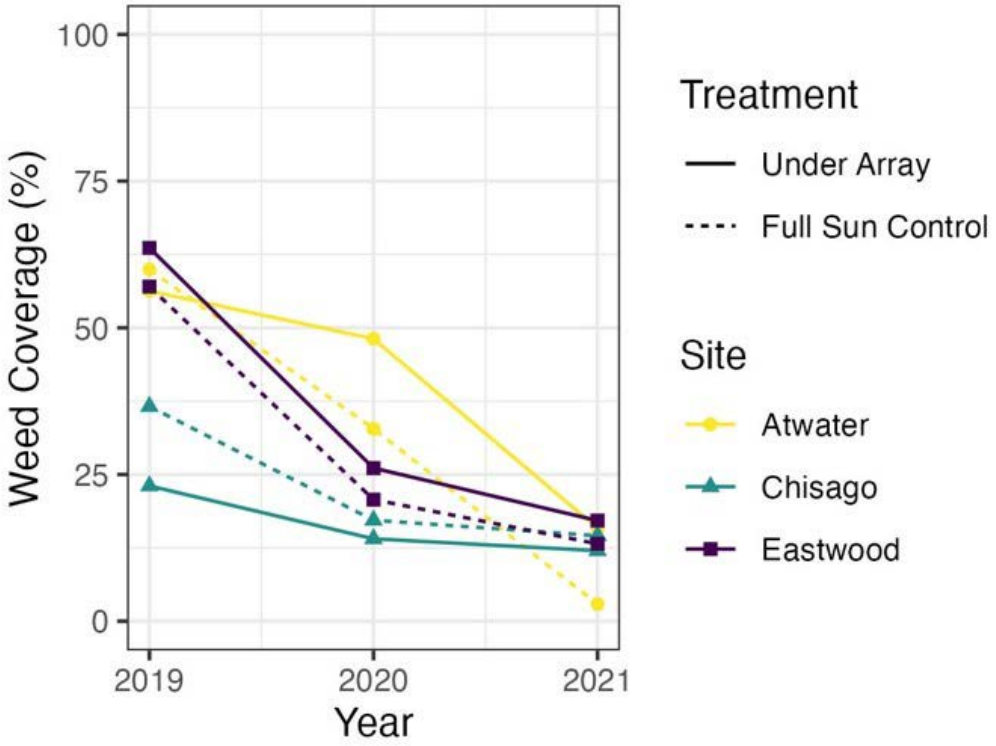
Chisago – Z1

Eastwood – Z1

Photos by James McCall, NREL. September 2021

Enel Aurora Vegetation Results (2019-2021)





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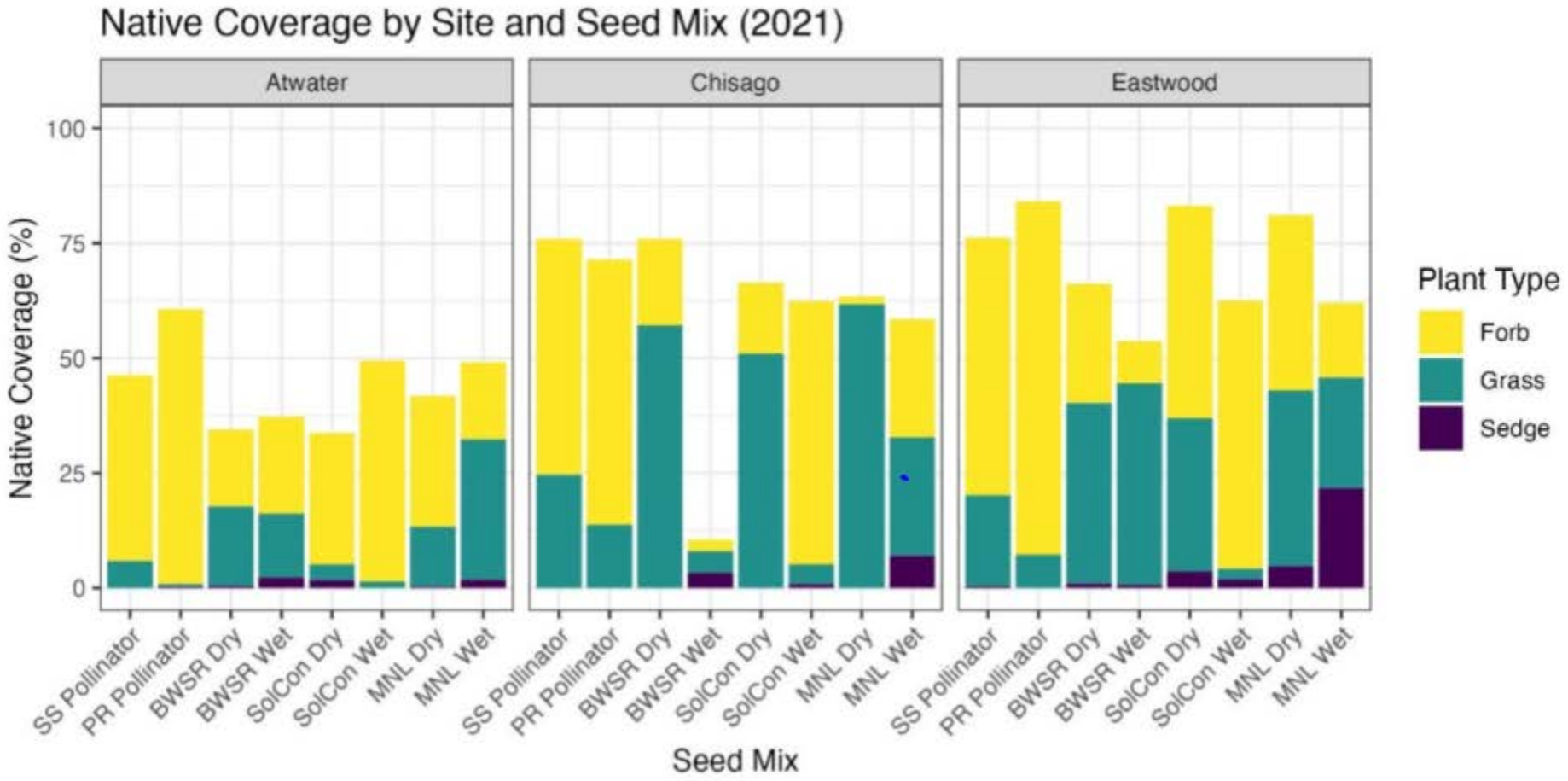
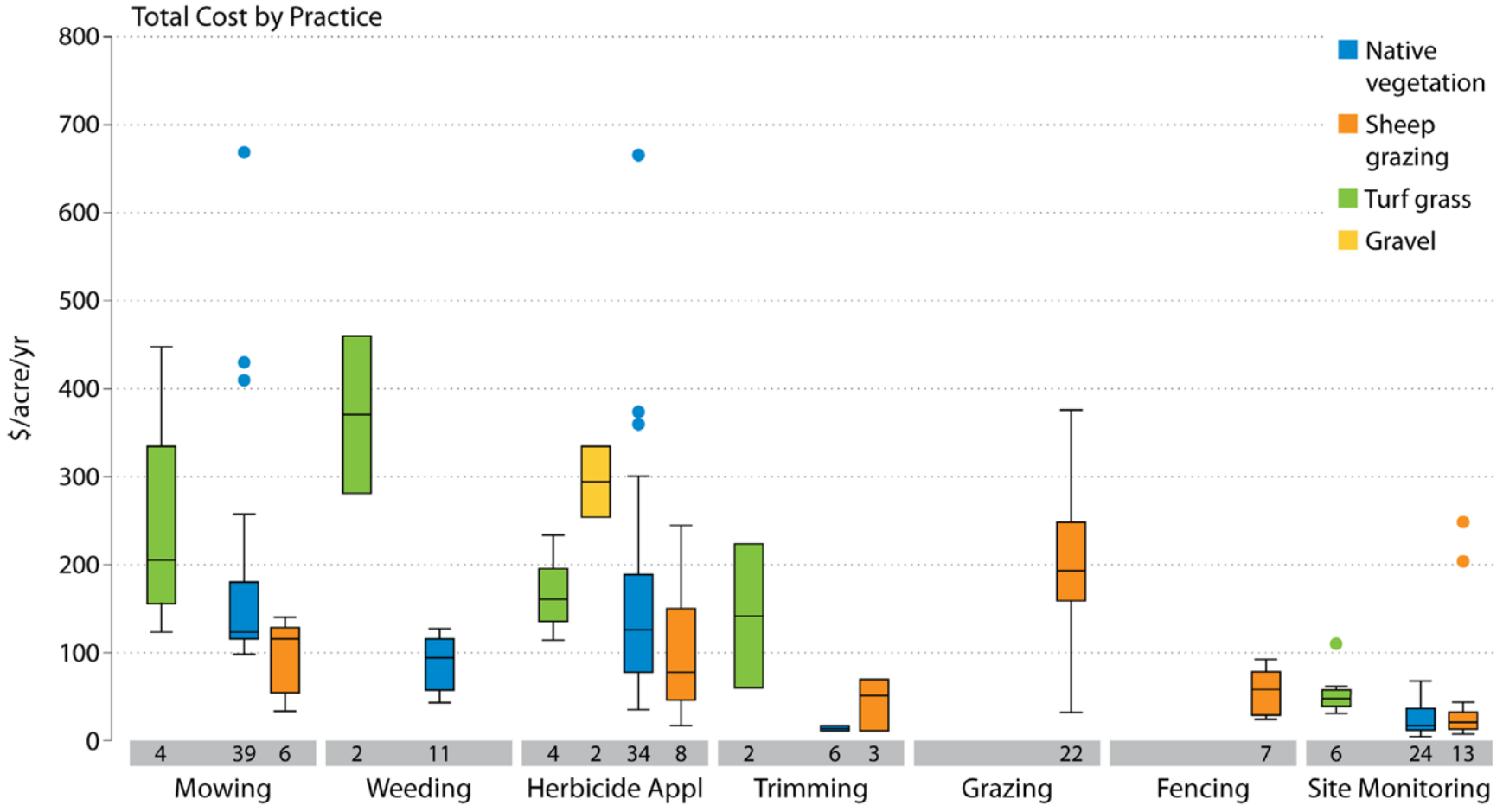


O&M Cost Analysis for Utility-Scale PV



Key Notes

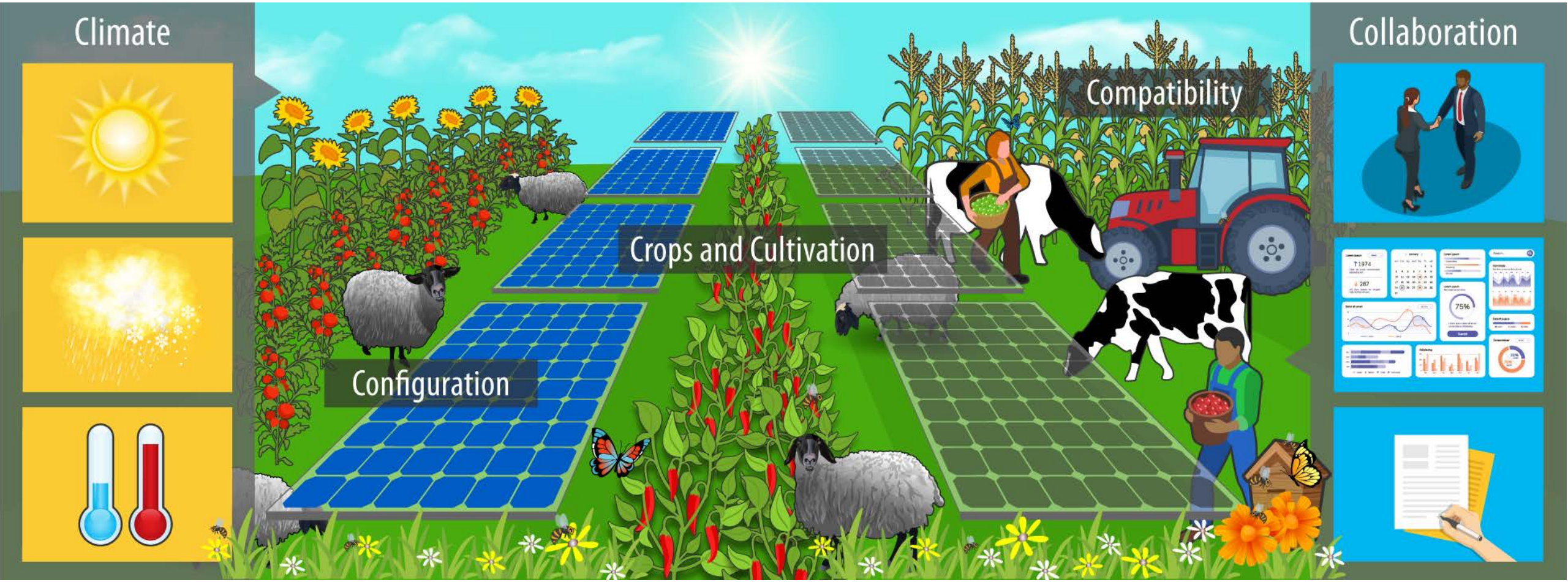
- Survey of >100 different PV sites across multiple years
- Specific activities needed can vary from site to site
- Costs can change each year due to vegetation evolution

McCall, J.; Macdonald, J.; Burton, R.; Macknick, J. Vegetation Management Cost and Maintenance Implications of Different Ground Covers at Utility-Scale Solar Sites. *Sustainability* **2023**, *15*, 5895. https://doi.org/10.3390/su15075895

Helpful Tools

From InSPIRE and PV-SMaRT

The 5 C’s of Agrivoltaic Success Factors



Macknick, Jordan, Hartmann, Heidi, Barron-Gafford, Greg, Beatty, Brenda, Burton, Robin, Seok-Choi, Chong, Davis, Matthew, Davis, Rob, Figueroa, Jorge, Garrett, Amy, Hain, Lexie, Herbert, Stephen, Janski, Jake, Kinzer, Austin, Knapp, Alan, Lehan, Michael, Losey, John, Marley, Jake, MacDonald, James, McCall, James, Nebert, Lucas, Ravi, Sujith, Schmidt, Jason, Staie, Brittany, & Walston, Leroy. The 5 Cs of Agrivoltaic Success Factors in the United States: Lessons from the InSPIRE Research Study. NREL/TP-6A20-83566. https://doi.org/10.2172/1882930

InSPIRE Agrivoltaics Financial Calculator

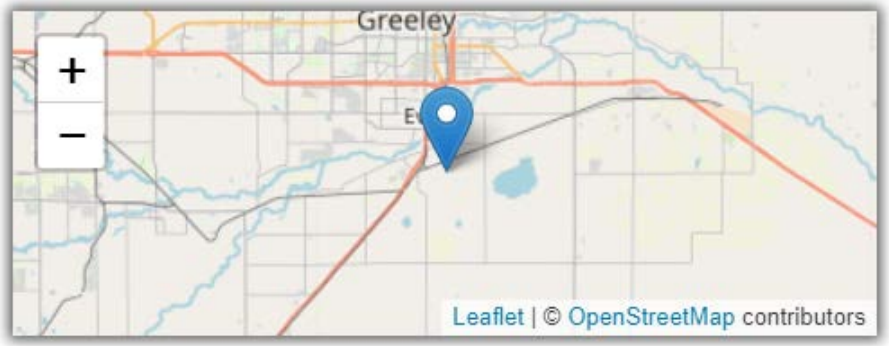
The InSPIRE financial calculator (https://openei.org/wiki/InSPIRE/Financial_Calculator) serves as the starting point for calculating economic viability of agrivoltaic projects

Adapts available tools (e.g., System Advisor Model [SAM]) plus latest data (e.g., capital cost and O&M studies) for easy-to-use, online co-location techno-economic assessment tool

Public-facing tool is customized for farmer use, but can also provide developers with validation and verification tools

User responds to questions that define inputs for the SAM API, which calculates performance and economic metrics

Additional capabilities and customization available in non-public-facing version



Agrivoltaic Activity
Crops only between panels

Solar Configuration
Traditional utility scale installation

Panel Type
Monofacial

Solar Acreage
10

Solar Tracking
One-Axis

Pre-Agricultural Value ($/Acre)
5000

Agrivoltaics Policy Incentives (¢/kWh)
0

PV-SMaRT - Runoff Calculator

Soil Texture	Loam
Soil Depth (inches)	24
Bulk Density (g/cm^3)	1.4
Vegetation Present	Newly Established Pollinator
Are Solar Panels Present?	YES
Panel Width (feet)	10
Panel Spacing (feet)	25
Array Orientation	Follows slope contours
Percent Slope	5

BLUE CELLS REQUIRE USER INPUT

MAROON CELLS REPRESENT TOOL OUTPUTS

Runoff Curve Number	80.2
24-Hr Precip Event (inches)	10.00
Expected Runoff (inches)	7.55

PV-SMaRT Calculator Site

1. Go to https://license.umn.edu/product/pv-smart-solar-runoff-calculator-version-30 (QR code)
2. Register for free using your email
3. Checkout and download the calculator and manual for free

Acknowledgements

www.nrel.gov

NREL/PR-6A20-87968

This work was authored in part by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.