A public-private partnership to develop agrivoltaics in the US midwest

Matthew O'Neal[1,] Nick Peterson[2] , Liang Dong[3], Hongli Feng[3], Anne Kimber[3], Raymond Klein[3], Ajay Nair[3], , Suzanne Slack[3], John Tyndall[3], Hugo Villegas[3]

[1]H.A. Wallac Chair for Sustainable Agriculture, Iowa State University, Ames IA 50011 (USA), 515-451-3168, oneal@iastate.edu.

[2]Strategic Partnership manager, Alliant Energy,

[2]Iowa State University, Ames, Iowa 50011.

1. Introduction

The expansion of solar energy production in the Midwest of the USA will include land currently being used for farming. There is a lack of data and recommendations for how solar facilities can be used for agricultural purposes. To address this gap, Iowa State University (ISU) and Alliant Energy have entered into a public-private partnership to explore the agronomic, economic and social aspects of agrivoltaic practices. In this presentation, we describe how this partnership was developed and led to the construction of a solar farm that allows for measuring both the value of crop production and the impact of understory vegetation on energy production. Through a series of meetings with Alliant Energy representatives and faculty at ISU, a site design was implemented, officially titled the Alliant Energy Solar Farm at Iowa State University, referred herein as the solar farm.

2. Methods

In 2021, ISU approached Alliant Energy regarding the possibility of developing a solar farm in an effort to reduce energy costs. In response, Alliant asked if ISU would be interested in exploring agrivoltaic practices within and under the solar facility. A multi-disciplinary team of faculty was formed to work with Alliant in designing the facility to test multiple solar panel configurations and crop options.

This team consider which cropping systems would be of greatest interest to the farming community in Iowa and the surrounding midwest. Several systems were considered, as well as key disciplines needed to address agronomic and economic questions of future farmers. A series of meetings during 2022 developed a site design to address these questions through a rigorous research protocol. All parties discussed how the site could be design to facilitate extension, outreach and as an educational site by teaching faculty at ISU.

We began an multi-year experiment in the fall of 2023 to determine which sub-set of vegetation types can be grown economically under the industry standard configuration (area 1). Our initial hypothesis is that the value of these vegetation options for solar farm management will vary, as will the energy produced in the panels directly above them. These treatments (table 2) include eight types of vegetation randomly assigned to area 1 using a randomized complete block design. Upon completion of construction and planting, 3 blocks will be established each including eight experimental units (EU), for a total of 24 EUs. An Experimental unit (EU) is a 19.5 m by 8 m that includes ground on either side of a string of panels. To avoid edge effects, EUs do not include the last row of panels on the outer edges of the area. Each EU contains a single string of 18 solar panels surrounded by the assigned treatment, allowing us to account for the impact of this understory on energy production.

3. Results

3.1. Site development and construction:

After nearly a year of negotiations between Alliant and ISU, a 25-year lease was agreed to for a 10 acre tract on the southern edge of campus. previously used for crop production within a corn-soybean rotation. Construction started in May 2023 and completed by November 2023.

The multi-disciplinary team elected to test multiple vegetation options under panel configurations that considered by Alliant as options for solar development within the midwest. The solar farm consists of four distinct areas comprising configurations of biphasic solar panels that vary by hieght and tracking ability (Table 1). A critical design addition are inverters that allow for measuring energy production in subsets of each area. Two additional areas were established, a untreated control without panels (area 5) and a border comprised of native, perennial plants attractive to native pollinators (area 6).

Table 1. Solar panel configurations in the Allaint Energy Solar Farm at Iowa State University.

Area (m^2)	Panel height	Tracking mechanism
1 (12402 m^2)	1.52 m pivot height (industry standard)	Single-axis tracking
2 (2464 m^2)	2.44 m	Single-axis tracking
3 (3150 m^2)	0.762 m leading edge	Fixed Tilt
4 (6300 m^2)	1.68 m leading edge	Fixed Tilt

3.2. Vegetation options- initial assessment:

Although Iowa is a leading producer of corn and soybeans, our initial assessment is that these crops are unlikely to be profitably grown given the unique limitations of a solar farm. We selected horticultural crops that can be grown profitably in an area consistent with the footprint of this and projected solar farms across the Midwest (Table 2). Two treatments (#2,3) applied to all areas of the solar farm include plants attractive to native pollinators and serve as nectar source and eventually honey for honey bees kept at the solar farm. These small patches of native, perennial flowering can address the needs of pollinator conservation and more sustainable beekeeping in critical regions of the Midwest[1].

Table 2. Summary of treatments in the Allaint Energy Solar Farm at Iowa State University.

#	Treatment	Species/Cultivar descriptions
1	Grass-Control	Grass and clover mix planted during construction, representing an industry standard practice and serving as a control to compare to the 7 treatments.
2	Pollinator mix-Regime 1	A mix of perennial flowering plants established with an industry standard management protocol (e.g., mowed once per year).
3	Pollinator mix-Regime 2	Same mix used for Regime 1 but established and maintained with more intense and frequent management (e.g., weeding and mowing).
4	Vegetable crop 1	Broccoli
5	Vegetable crop 2	Summer squash
6	Vegetable crop 3	Bell pepper
7	Fruit crop 1	Thornless raspberry
8	Fruit crop 2	Day-neutral strawberry

This presentation will describe key aspects of this public-private partnership that could be used as a model for other Land-Grant Universities throughout the US. We will discuss how such sites could be coordinated efforts to develop longitudinal data for agrivoltaic practices and training opportunities throughout North America.

4.2. References

1. A.G. Dolezal, J. Torres, and M.E. O'Neal. Can solar energy fuel pollinator conservation? Environmental Entomology, 4 (2021) 757-761 doi: 10.1093/ee/nvab041.