The agricultural, economic and environmental potential of co-locating utility scale solar with grazing sheep

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INTRO
Operation of solar sites in summer, which is the prime period for electrical generation, hinges on ensuring that the vegetation does not shade the panels. Typically, sites in warm, humid, summer continental climate zones are mowed two or three times per year and undergo one string trimming to remove the vegetation underneath the panels. We evaluated the option of grazing solar sites with sheep to control vegetation.

OBJECTIVES
The aim of this study was to compare economic and agricultural benefits and challenges of traditional land management strategies (mowing, string trimming) with rotationally grazed sheep on solar sites.

METHODS
A FIELD TRIAL
- Data were collected from the Cornell University Musgrave Research Farm solar site located in Aurora, NY. Sheep were grazed between May and November 2018 to obtain agronomic and economic data, as well as to gather knowledge of the feasibility of grazing sheep on solar sites. Data for traditional management (labor and equipment running hours) were obtained from a landscaping contract for a comparable Cornell University solar site at Harford, NY.
- The site was divided by permanent and Electronet® fencing into 4 plots for the grazing trial. The 56 Katahdin ewes (medium sized sheep less than 3 feet high with an average weight of 120 pounds) were rotated 8 times through the plot from the first time they were put on site on May 1st, 2018 until they were removed on November 5th, 2018. The stocking rate (total sheep on the site, per acre) was 2.5. The stocking density (number of sheep over a certain timeframe in subplots of the site, per acre) varied between 3 and 7 sheep per acre. The site was checked every three days. Each visit had a duration of ~45 minutes and included adding water to the water tank, checking animal health and welfare, and – when necessary – moving the sheep into a new plot. Prior to each rotation, the vegetation in each plot was sampled and analyzed for the nutritive value for sheep.

A SOLAR GRAZING SURVEY
- A survey was sent to three entities: 1) sheep farmers grazing solar sites; 2) landscapers maintaining solar sites; and 3) solar site managers. The survey collected data to assess economics of solar sites across NYS and the Eastern US and to gain a better understanding of co-located, agrivoltaic systems and the emerging solar grazing industry. The survey results were used to underpin agricultural and economic analyses of solar grazing for sheep farmers.

RESULTS
FIELD TRIAL
- The sheep were healthy at the end of the season, with good body condition and low parasite load. No predator issues were recorded. The chain linked fence proved to be enough protection; no guard-animals were necessary.
- Throughout the grazing season the forage consisted of 39% grass (61% legumes and forbs) with more than suggested levels of feed components for dry ewes (female sheep who are not nursing), the subjects of this trial. The nutrition levels were sufficient for all classes of sheep.
- During the grazing trial at the 22-acre Musgrave site, all farm-side economic data for vegetation management (grazing) were recorded. The farmer’s investment costs included: water tanks, troughs, and a small water transfer pump to fill the troughs, as well as Electronet® fencing and a charger to divide sections for rotational grazing. The farmer invested $577/acre. Investment per head of sheep was $30. Farmer expenses for grazing included mileage, labor, and general liability insurance.
- The solar site was functioned as desired. Vegetation never shaded the panels, and the farmer was compensated at a profit for extra work at a remote location. The sheep farmer, landscaper, and electrical operations contractors communicated regularly throughout the study period, resulting in full compliance with safety and profitable arrangement for all the solar site O&M providers.

SOLAR GRAZING SURVEY
- Survey respondents reported a total of 3,503 acres of utility solar grazed in the eastern US, with 79 acres in NYS. All grazed sites were established between 2012 and 2018. The grazing season was March to December on average. Average stocking rates were lower in the US average east of the Mississippi (3 sheep per acre) compared with NYS (4 sheep per acre).
- From the survey, the O&M managers reported budgets of $868 per acre per year for vegetation management in 2018. Per acre income and expenses for sheep farmers under direct or subcontracts in New York State and the Eastern United States are summarized in the chart, $ per acre, per year.

CONCLUSIONS
- Grazing sheep on solar sites is a cost-effective measure to control on-site vegetation and prevent panel shading. At no time in the growing season did vegetation shade the panels. It is less labor-intensive than traditional landscaping services and, thus, less expensive. The grazing trial at the Musgrave solar site was a full success for the site owners and the operators, as well as the sheep farmer.
- New marketing strategies should emerge for sun-raised and grass-fed lamb that can also be a direct benefit for small-scale sheep farmers from co-locating sheep grazing with renewable energy.
- Solar site developers should include amenities like on-site wells and power outlets as well as high quality, predator-proof fencing to reduce investment costs for sheep farmers. Multi-year contracts should be used to encourage more sheep farmers to become interested in grazing solar sites and to ensure that agricultural land will remain in production.

WHAT’S NEXT
- In summer 2019 a team at Cornell launched a multiyear, multidepartment collaboration: Grazing Sheep at Solar Array Sites to Boost Pollinator Habitat and Sequester Soil Carbon.
- The project will document how sheep grazing density may influence pollinator habitat and the sequestration of soil carbon. Pollinators and floral resources will be quantified and identified within each grazing level, as will soil organic carbon.
- The aim of the research is to answer the following questions:
  1. Can pollinator habitat and grazing sheep be co-located, providing valuable habitat for pollinator species, particularly those of conservation concern, while meeting nutritional requirements for sheep?
  2. Specifically, what grazing intensity and stocking density creates the best habitat, and how does a high legume inclusion in the pasture influence pollinator diversity and forage quality for bees?
  3. What grazing intensity and stocking density best facilitates soil health and soil organic carbon sequestration, and what are the fundamental mechanisms connecting grazing intensity to soil organic carbon sequestration?
- Solar industry partners: Solar Farms NY at Cascadilla Solar Farm South Site, Distributed Asset Solutions & True Green Capital.
- Solar grazing partners: American Solar Grazing Association, Cornell Sheep Program & Agrivoltaic Solutions LLC
- Expect results June 2021 @ http://blogs.cornell.edu/newsheep/ & www.solargrazing.org

Cornell Sheep Program
American Solar Grazing Association