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Executive Summary

The 2022 Solar Grazing Sheep Survey provides a national assessment of sheep producer interest in grazing sheep under utility-scale solar arrays and evaluates the potential role of cooperative business models in supporting this emerging sector. Conducted by Cornell University’s Cooperative Enterprise Program in collaboration with the American Solar Grazing Association and supported by the USDA Agricultural Marketing Service, the survey examined producer demographics, production experience, perceived opportunities, barriers to participation, and interest in collective solutions.

Nearly half of all respondents (47 percent) expressed interest in solar grazing but had not yet participated, indicating substantial untapped potential. Respondents represented more than 40 states, with the highest concentrations in New York, Maryland, and Pennsylvania—regions characterized by rapid solar development and active sheep industries. These findings suggest strong geographic alignment between renewable energy expansion and opportunities for agricultural integration. Results showed strong support for a cooperative business model, with 57% of respondents interested in becoming member-owners and many willing to serve in additional roles.

Across both quantitative responses and approximately 590 open-ended comments, farmers identified persistent barriers to participation, including limited market access, processing constraints, insurance requirements, lack of water infrastructure, transportation challenges, and uncertainty around contract terms. Despite these obstacles, most respondents expressed strong interest in a member-driven cooperative model to address shared challenges. Farmer commentary reflected both optimism and caution. Some producers described solar grazing as a clear opportunity to reduce feed costs and diversify income, while others emphasized that success depends on site design, biosecurity protections, and fair compensation.

As one respondent noted, *“Solar grazing is a win–win project,”* while another cautioned, *“This could work—but only if it’s farmer-led and done right.”* Together, these perspectives underscore the importance of cooperative development that is transparent, responsive to producer needs, and grounded in trust.

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Background and Context

Solar Development and Agricultural Land Use

Utility-scale solar development has expanded rapidly across the United States as states pursue renewable energy targets and utilities seek long-term power purchase agreements. Much of this development has occurred on agricultural land, raising questions about land use compatibility, farm viability, and long-term impacts on rural communities. In New York alone, farmland is estimated to account for 84% of solar land growth through 2030 (Katkar 2021). Acknowledging the potential harm in agriculture production and farm viability, many states have proposed policies to address these issues. In addition, integrating agricultural production with solar energy development has become a priority for policymakers, developers, and agricultural stakeholders alike (USDA 2022a).

Agrivoltaics, also known as co-location, refers to agricultural production, such as crops or livestock, raised under or near solar panels (Dohlman et al. 2024). As a major category of agrivoltaics, pairing livestock grazing and solar energy production is regarded as an efficient way to benefit both farmers and solar developers at the individual and industry levels.

Sheep grazing has emerged as a promising vegetation management strategy that aligns renewable energy goals with agricultural production. Sheep are well suited to managing vegetation beneath and around solar panels, reducing reliance on mechanical mowing while maintaining appropriate vegetation height and minimizing shading. Several respondents emphasized the abundance of forage at solar sites, with one farmer remarking, *“So much grass—it’s only about 15 minutes from my farm.”*

Research previously conducted at Cornell University explored the potential for sheep farmers in New York State (NYS) to offer grazing services (Kochendoerfer and Thonney 2021). According to data from the New York State Energy Research & Development Authority (NYSERDA), they find an estimated 10.6 GW of solar installations are anticipated to be in planning or production phases by 2030, which could result in the conversion of over 68,000 acres of land to utility-scale solar. If fully utilized for grazing and assuming a stocking rate of three sheep per acre, 204,000 sheep would be required to maintain the land (Kochendoerfer and Thonney 2021). To put that in perspective, NYS is currently home to about 79,000 sheep, implying a sheep farming industry growth of 258% to meet new grazing demand (USDA 2022b).

Opportunities for Sheep Producers

For sheep producers, solar grazing offers opportunities to diversify income, reduce feed costs, and extend grazing seasons. Some survey respondents reported improved animal comfort due to shading provided by panels, particularly during hot weather. One producer observed, *“The temperature is easier to control under the panels, and it cuts down on feed costs.”*

At the same time, solar grazing introduces new operational demands. Participation requires identifying and communicating with solar site operators, negotiating contracts, coordinating flocks, transporting sheep and equipment, and monitoring animals while onsite. These requirements differ substantially from traditional pasture-based systems and shape farmer perceptions of risk and feasibility.

Discussions with the American Sheep Grazing Association (ASGA) reveal that many individual farmers lack the necessary resources and negotiating skills to secure grazing contracts with solar array operators. Additionally, these operators prefer to work with a single agent for contractual agreements and grazing logistics rather than multiple farmers. Negotiating individual agreements at scale is highly inefficient, creating significant barriers to entry and reducing financial feasibility. A cooperative business owned and governed by farmers may serve as a useful intermediary between solar developers and sheep producers. Cooperative services could reduce transaction costs, pool risk, and provide professional management while also addressing broader sheep industry needs such as marketing, processing access, and training.

Farmer Survey

To have a better understanding of the demand for and potential development of solar grazing cooperatives, a needs assessment survey was administered to gather input from current and prospective sheep farmers.

The Solar Grazing Sheep Survey was administered nationally in 2022 and targeted sheep producers, grazing contractors, and individuals interested in entering the sheep industry. Survey distribution relied on producer networks, breed associations, Extension contacts, and the American Solar Grazing Association. Respondents represented a wide range of farm sizes, production systems, and experience levels. A total of 603 responses were usable for analysis.

In addition to structured questions, respondents were invited to provide written comments through open-ended questions. Approximately 590 respondents offered qualitative commentary. These responses were reviewed and coded thematically to identify recurring concerns, priorities, and points of divergence across farmer types. Qualitative insights are presented alongside quantitative findings to provide context and depth.

Farmer Demographics and Experience

At the beginning of the survey, respondents selected one of eight descriptions that most closely characterize them:

1. I am a full-time sheep farmer grazing my sheep under solar arrays,
2. I am a part-time sheep farmer grazing my sheep under solar arrays,
3. I am a sheep farmer grazing my sheep and sheep I lease from others under solar arrays,
4. I lease some or all of my sheep to another person who grazes them under solar arrays,
5. I am a sheep farmer not currently grazing under solar arrays but interested in exploring,
6. I am a sheep farmer and am not interested in grazing my sheep under solar arrays,
7. I am a non-sheep farmer interested in grazing sheep under solar arrays, and
8. I am a new or beginning farmer interested in sheep farming and grazing under solar arrays.

The breakdown of all respondents by type is shown in Figure 1. Survey results reveal a diverse population of sheep farmers with varying levels of experience, flock sizes, and geographic representation. Nearly half of respondents expressed interest in grazing sheep under solar arrays but were not yet participating. This group—sheep farmers interested but not currently grazing—provided the largest volume of written commentary, suggesting both strong interest and unresolved concerns.

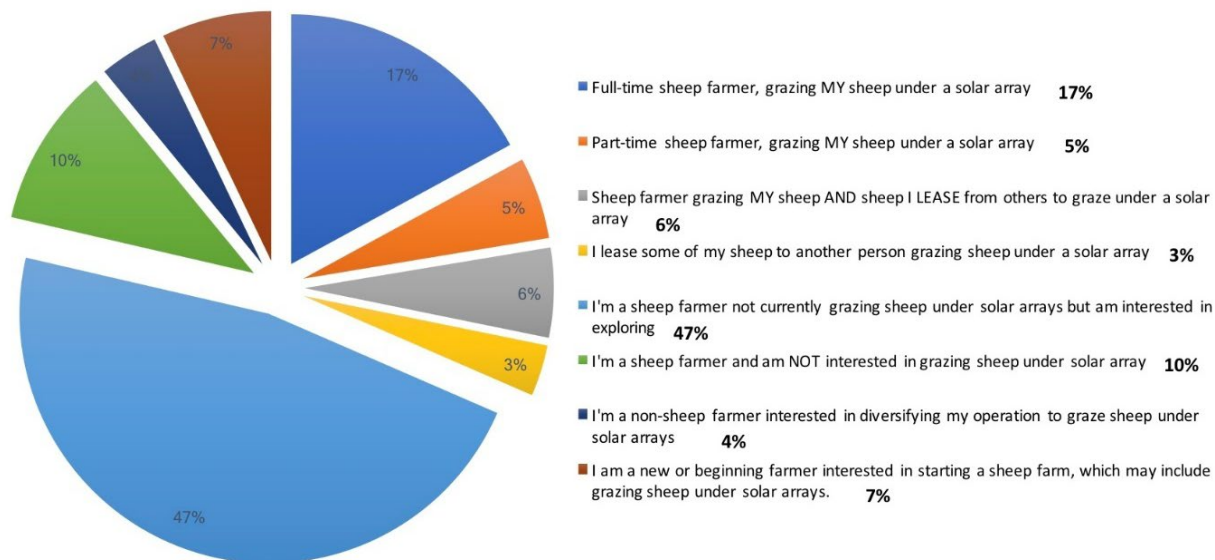


Figure 1 – Respondent farming status distribution (N = 603)

Experience levels were well distributed. Approximately 28 percent of respondents reported managing sheep for six to ten years, representing a strong mid-career group positioned for expansion. An additional 20 percent reported more than 20 years of experience, highlighting the presence of seasoned producers who may contribute valuable knowledge and leadership to cooperative efforts. Beginning and early-career farmers were also well represented, underscoring the importance of training and mentorship.

Flock sizes ranged from fewer than 30 sheep to more than 400 head. Twenty-seven percent of respondents maintained small flocks, often as part-time or diversified operations, while only five percent managed large flocks exceeding 400 head. This variation suggests that cooperative models must remain flexible, accommodating both small and large producers. As one respondent noted, *“This should be offered to small and growing sheep farms first to give the next generation a step up.”*

Geographically, interest in solar grazing was national, but participation clustered in regions with active solar development. New York alone accounted for 22 percent of respondents, reflecting strong alignment between energy development and sheep production. Maryland and Pennsylvania each accounted for eight percent of responses, reinforcing regional momentum in the Mid-Atlantic. Given differences in sheep farming practices and utility-scale solar energy installations across the country, we limit our focus to the Northeast region subsample; i.e., the states of NY, ME, MA, VT, CT, NH, PA, MD, NJ, DE, OH) and the District of Columbia (N =392).

Further we aggregate the eight respondent types into four groups (A, B, C, and D) by the nature of their solar grazing activity and interests:

- A. Sheep farmers whose sheep graze under solar arrays currently (1, 2, 3, 4),
- B. Sheep farmers not grazing sheep currently, but are interested in pursuing it (5);
- C. Existing, new, or beginning farmers without sheep considering solar sheep grazing (7, 8);
- D. Sheep farmers not interested in solar sheep grazing (6).

Barriers to Sheep Production

Respondents identified several ongoing challenges that affect profitability and growth in sheep production, independent of solar grazing. Market access and processing capacity emerged as dominant concerns. Many farmers reported difficulty securing timely access to slaughter and processing facilities, particularly USDA-inspected plants. Long distances to processors increase transportation costs and reduce margins, especially for small-scale producers.

Labor availability was another recurring constraint. Many sheep farms are operated part-time or rely on limited family labor, making it difficult to expand production. Land access and predator pressure further shape farm decisions, particularly in regions experiencing development pressure.

Several respondents cautioned against rapid expansion without parallel market development. Beginning farmers expressed concern about oversupply. One farmer wrote, *“We need to make sure the market isn’t flooded with a bunch of living meat and no place to go.”* Others noted that fiber markets are already saturated, with one respondent stating, *“The fiber market is already flooded with poor quality wool.”*

These perspectives highlight the need for market-aware strategies that prioritize value, quality, and coordination rather than volume alone.

Barriers to Solar Grazing

While solar grazing presents opportunity, respondents identified numerous barriers specific to grazing under solar arrays. Insurance requirements were frequently cited as difficult or costly for individual farmers to obtain. Many respondents expressed uncertainty about liability and responsibility in the event of animal injury, infrastructure damage, or loss.

Access to fresh water was another major concern. Several farmers emphasized that many solar sites lack adequate water infrastructure, making grazing impractical without additional investment. As one respondent succinctly stated, *“Fresh water is a must.”*

Transportation of sheep and equipment adds logistical complexity and expense, particularly when arrays are located far from the home farm. Travel time, fuel costs, and wear on equipment were frequently mentioned as factors that erode potential profits.

Farm-level concerns related to site design were widespread. Respondents described arrays with panels set too low for safe grazing, hazardous wiring, and insufficient access roads. One farmer noted bluntly, *“The array is NOT designed with any concern for grazing.”* Predator protection and fencing were often overlooked in site planning, further increasing risk.

Biosecurity emerged as one of the most significant barriers. Many respondents opposed commingling sheep from multiple farms due to concerns about disease transmission, parasites, and flock health. These concerns were particularly pronounced among producers with closed flocks or breeding operations. As one respondent explained, *“Mixing flocks risks spreading disease, and that’s not a risk I’m willing to take.”*

Communication challenges with solar operators compounded these issues. Farmers frequently report difficulty identifying appropriate contacts or negotiating terms. Several called for a trusted intermediary, with one respondent stating, “*There needs to be a go-between—the solar company doesn’t understand sheep farming.*”

Table 1 provides a numerical summary of barriers by type of respondents. Experienced solar graziers were primarily concerned with travel distances and time demands for monitoring sheep during the season. Monitoring sheep represents a significant cost in farmers’ time, fuel, and other expenses. They were also concerned with time and equipment constraints for supplemental mowing.

Sheep farmers not currently solar grazing see access to water, travel distances, and the cost of liability insurance as primary constraints. Availability of and access to water is part of the contract negotiation process. In many cases, drilling a well to access water on site for sheep is necessary and comes with a significant cost (at least initially). However, the relatively low value of this barrier for current solar graziers likely implies that this is often provided by array operators. Liability insurance requirements for solar grazing are likely beyond insurance limits currently used by farm operators. Accordingly, the additional cost can be a significant issue for farmers and scored relatively high by group A as well.

New and beginning farmers particularly recognized capital constraints in terms of needed trucks and trailers. Mobilization and shepherding services require significant capital investments related to trucks, trailers, and fencing, along with the reinvestment of the depreciation of those assets over time. The primary barriers appear to align well with potential services that could be offered by a cooperative.

Table 1. Barriers to solar sheep grazing, average scores by group.^a

Barrier	All N = 392	A N = 75	B N = 229	C N = 37	D N = 51
Easy access to water	1.79	1.16	2.01	1.78	1.73
Travel distance to monitor sheep	1.79	1.50	1.94	1.50	1.79
Cost of insurance	1.77	1.38	1.89	1.83	1.79
Insurance requirements	1.68	1.24	1.84	1.43	1.79
Negotiating the contract	1.62	1.08	1.79	1.62	1.70
Time on site to mow or trim	1.62	1.44	1.74	1.33	1.54
Access to person willing to lease my sheep	1.58	0.97	1.75	1.65	1.67
Time on site to monitor sheep	1.52	1.24	1.60	1.32	1.73
Lack of knowledge about solar grazing	1.52	1.23	1.58	1.62	1.58
Equipment needed to mechanically mow or trim	1.50	1.40	1.55	1.49	1.44
Access to handling equipment at the solar site	1.48	1.10	1.51	1.64	1.82
Identifying the array operator	1.43	0.77	1.69	1.16	1.43
Access to trucks/trailers to move sheep	1.14	0.96	1.13	1.73	0.98

Source: Author survey, Northeast U.S. region.

^a Average scores are computed where not a barrier = 0, small barrier = 1, medium barrier = 2, and large barrier = 3.

Interest in Cooperative Participation

Despite these challenges, survey results indicate strong interest in collective approaches to overcoming barriers. Many respondents expressed willingness to participate in a cooperative or farmer-owned enterprise that could provide logistical, marketing, and support services. Interest extended beyond producers already grazing solar sites; many non-participating farmers viewed cooperatives as a pathway to reduce risk and gain access to opportunities.

Respondents suggested cooperative roles such as negotiating contracts, pooling insurance, coordinating transportation, sharing equipment, providing professional grazing management, and supporting marketing for lamb and wool. One farmer wrote enthusiastically, *“I think this is a wonderful idea!!”*

At the same time, skepticism was evident. Some respondents expressed concern that cooperatives could become middle-men that dilute farmer returns. As one producer cautioned, *“Another scheme to skim profits that should remain with farmers.”* Others emphasized the need for professional management and transparent governance, noting, *“We should hire professional managers to manage it.”*

These perspectives suggest that cooperative success depends not only on services offered, but on governance, accountability, and trust.

Focusing specifically on a grazing services, we asked respondents about the industry need for and likelihood of joining a farmer co-op that provided contract negotiation, mobilization, and shepherding services. The industry scores represent the average industry need (Avg.) for a cooperative to provide the service of respondents in that type, where not needed = 0, somewhat needed = 1, needed = 2, very needed = 3, and extremely needed = 4. Need+ represents the percent of respondents that answered needed or higher. The individual scores represent the average likelihood that respondents would use those services of the cooperative, where not likely = 0, somewhat likely = 1, likely = 2, very likely = 3, and extremely likely = 4. Likely+ represents the percent of respondents that answered likely or higher. The results are shown in Table 2.

Average industry scores were highest for farmers experienced with solar grazing, demonstrating farmer cooperation on services is additionally valuable to them; i.e., they identify the potential for additional benefits through collaboration. Such results may be particularly useful in communications with existing sheep farmers but inexperienced in solar grazing as their scores were generally the lowest among those considering solar grazing.

For those participating or interested in exploring solar grazing (A, B, C), mobilization and shepherding scores are lower than contract negotiation. This is consistent with feedback expressed with follow-on focus groups regarding animal health concerns for comingling of sheep and resistance to having others monitor their sheep. Scores above one, and frequently near or above two, demonstrate sufficient interest in exploring a cooperative business for the execution of collaborative grazing services. The relatively high scores for contract negotiation and shepherding by group D is recognition that these services would be valuable for the industry even though they have no interest in participating in solar grazing themselves.

Table 2. Industry need for and likelihood of using cooperative grazing services, by group.

Group	Industry		Individual	
	Avg.	Need+	Avg.	Likely+
Contract Negotiation				
A	2.09	69%	2.24	70%
B	1.98	65%	1.70	43%
C	1.89	73%	2.05	62%
D	1.86	71%	0.97	26%
Mobilization				
A	1.86	59%	2.02	65%
B	1.61	48%	1.27	36%
C	1.81	62%	2.00	64%
D	1.66	57%	1.28	31%
Shepherding				
A	2.00	72%	2.03	66%
B	1.64	52%	1.44	41%
C	1.39	46%	1.17	35%
D	2.03	71%	1.19	44%

Source: Author survey, Northeast U.S. region.

As part of any cooperative development process, gauging interest in members taking on leadership, investment, and governance roles is essential. Specifically, respondents were asked: *If a cooperative or other business owned by multiple farmers was formed to provide assistance to farmers grazing sheep under solar arrays and strengthen the viability of the sheep farming sector, what is your interest in the following to support this effort?*

The set of interests related to the cooperative are shown in Table 3, with average numerical scores presented by group. The scale of interests ranges from 0 (not interested) to 3 (very interested). Some interests can be interpreted similarly; e.g., to become a “member owner of the cooperative” and to become a “part owner of the business.” Members are often (and correctly) described as member owners as they have ownership rights and responsibilities of the business; however, member and/or non-member investment (say through a preferred stock offering that pays a dividend) is also possible (subject to the bylaws of the organization) that is also (and correctly) a form of ownership in the business, albeit often without additional control rights.

It is perhaps not surprising that current solar graziers (group A) rate being a paid “contract service provider” for the cooperative relatively high given their current industry experience; however, they also rank second across all groups in terms of interests in becoming “member owners”. Perhaps also consistent with their experience, they may recognize what they prefer to “do” and “not do” with respect to solar grazing and, therefore, rank highly being a (nonmember) “customer” of the cooperative’s services. Perhaps most important is Group A farmers have the highest interest in investing in the business, providing guidance and leadership on the development of the business, and serving in a leadership capacity after the business is formed. Relevant experience is valuable to the development of a new cooperative and in using that experience to inform others who are considering being part of it.

Table 3. Interests in actions of the cooperative, average scores by group.^a

Interest	All N = 392	A N = 75	B N = 229	C N = 37	D N = 51
Become a member-owner of a cooperative	1.59	1.82	1.58	2.00	0.91
Provide guidance & leadership to develop & launch the business	1.38	1.67	1.37	1.60	0.76
Be a "customer only" with access to services when needed	1.36	1.90	1.20	1.56	1.00
Become part owner of the business	1.23	1.70	1.12	1.58	0.66
Serve in a leadership capacity (director, officer, committee)	1.19	1.71	1.09	1.25	0.69
Be a paid contract service provider	1.14	1.85	0.96	1.32	0.66
Become part of the paid management team	1.09	1.61	0.92	1.20	0.91
Become an investor in the business	1.00	1.60	0.83	1.24	0.59
Become a paid employee	0.93	1.51	0.75	1.12	0.63

Source: Author survey, Northeast U.S. region.

While lower in relative magnitude, current non-solar grazing sheep farmers rank being a member owner of the cooperative and providing guidance and leadership through the development process most important to them. Non-sheep farmers ranked being a member owner of the cooperative most important, perhaps, a reflection of less experience in sheep farming and the individual benefits they would receive by joining ownership with sheep farmers that have that wisdom to share.

The lower scores for becoming an investor in the business may well reflect the capital constraint issues described above. The time to generate adequate member equity support during the development of a cooperative often delays the start-up of the organization or even stops the process in its entirety. Accordingly, financial feasibility analyses, encompassing both operational and investment costs and returns to member investment are important in informing the development process.

Farmer Focus Groups

A series of four focus groups with farmers in the Northeast U.S. occurred in 2023 and 2024 at alternative locations. Attendees were given a fact sheet that describes the main findings of the survey analysis (Fact Sheet 1, Severson and Schmit, 2024). The results of those sessions are summarized below and are consistent with the analysis of the open-ended survey questions.

Focus Group Feedback:

- Farmers challenged to find the array operator and legal counsel that understands contract. Co-op should **prioritize contracts** first and foremost. **Insurance** is a barrier and should be addressed through the co-op.
- Keep flocks separate. **Biosecurity** with transport and equipment sharing also a big concern. Co-op should have ready access to local, knowledgeable veterinarians.
- Sheep farmers want to **monitor** their own sheep. If someone else were to monitor, farmers need to be confident that person is skilled to observe and make appropriate decisions. Same with drivers for **mobilization**.

- Arrays with 1,000 sheep or more will require **onsite sheep managers 24/7**.
- Interested sheep farmers believe they have sufficient equipment or access to needed equipment. They find **co-op investment in equipment to be redundant**. Co-op should contract with 3rd party truckers rather than owning equipment outright.
- Contract with array operator should address those things that farmers don't want to do; e.g., operator provides **water source**, operators contract for **mechanical trimming**.

Conclusions from Focus Groups:

- Farmers have multiple goals and breeds of sheep, not all conducive or can be aligned with grazing under arrays.
- Farmers do not understand the time commitment.
- Flocks tend to be small overall, and farmers have figured out how to collaborate to share equipment and transport. They believe that they can continue doing this when grazing under arrays. Don't necessarily understand the size and scale that will be needed.
- More farmers need to experience grazing sheep under solar arrays and associated challenges themselves before they see the true need for transportation, shepherding, etc.

Obstacles to Address Moving Forward

Analysis of open-ended responses in the survey and focus group responses revealed four recurring themes that must be addressed for solar grazing cooperatives to succeed: trust, costs and benefits, on-farm considerations, and marketing and pricing. Trust underlines all other considerations. Farmers emphasized the need for confidence in those transporting, managing, and monitoring sheep. Concerns about animal welfare, predator protection, forage quality, and handling of mortalities were central. Many respondents stressed that farmers themselves have the most knowledge of their sheep and the most at stake financially.

Cost-benefit considerations centered on distance, time, and risk. Farmers asked practical questions about travel distance to arrays, frequency of trips, and how time spent off-farm affects profitability and quality of life. Risk mitigation extended beyond insurance to include clarity on responsibility, communication, and contingency planning.

On-farm considerations reflected diversity in production systems, breeds, lambing schedules, feeding strategies, and lifestyle goals. Differences in breed and management practices complicate pooled marketing and require flexible cooperative approaches. Time constraints associated with off-farm employment were frequently cited as limiting expansion.

Marketing and pricing concerns focused on fairness, transparency, and consistency. Farmers emphasized the need for prices that exceed cost of production and reflect quality attributes such as grass-fed, organic, or certified humane production. Several respondents expressed frustration with consumer education efforts that did not translate into sales.

Implications for Cooperative Design and the Sheep Industry

Our findings suggest that sheep-solar cooperatives have the potential to support farmer participation in solar grazing while addressing broader industry challenges. However, cooperative development must be intentional, farmer-driven, and responsive to the obstacles identified.

Recommended next steps include developing pilot farmer-owned cooperatives to provide insurance access, shared equipment and transportation, and contract support. Initial efforts should focus on high-interest states such as New York, Maryland, Pennsylvania, Vermont, and Maine. Cooperative services could also benefit producers not directly engaged in solar grazing by addressing shared needs related to marketing, logistics, and processing.

Small, regionally grounded pilot efforts may be most effective for building trust and demonstrating value. Cooperative services should prioritize contract negotiation, education, and risk reduction while allowing flexibility for diverse farm types. Transparent governance, respected leadership, and clear communication will be essential.

In the near term, solar grazing offers a promising strategy for income diversification and cost reduction. Over the long term, cooperative development may strengthen the sheep industry by improving market access, processing coordination, and resilience.

Conclusions

The 2022 Solar Grazing Sheep Survey highlights both the promise and the complexity of integrating sheep grazing with solar energy development. Interest among producers is strong, but participation is constrained by logistical, economic, and trust-based barriers.

Farmer-owned cooperative models offer a scalable, farmer-driven pathway to address these challenges. By pooling resources, negotiating collectively, and providing shared services, cooperatives can reduce risk and expand opportunity. As one respondent summarized, *“This could work—but only if it’s farmer-led and done right.”*

With strategic support, regional pilot projects, and attention to farmer concerns, sheep-solar cooperatives can contribute to renewable energy goals, agricultural sustainability, and the long-term vitality of rural communities.

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Additional Resources

Additional resources from this project are indicated below. All are available at: <https://cornell.box.com/v/SolarSheepFinancialTool>

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