Purdue Farm Policy Study Group Meeting Summary

December 10, 2024

The following members were in attendance Mike Boehlje, David Clark, Pete Clark, Kendell Culp, David Howell, Ken Foster, Tim Galema, Bill Gelfius, David Hardin, John Hardin, Scott Harper, Stephanie Harper, David Howell, Levi Huffman, George Kakasuleff, Joe Kelsay, Bryan Kirkpatrick, Lisa Koester, Mark Legan, Marshall Martin, Tom McKinney, Doug Mills, Peyton Mohler, Doug Morehouse, John Nidlinger, Ken Rulon, Jon Sparks, Rick Ward, Steve Warner, Christy Welch, Nicole Widmar, Don Villwock, and Mike Yoder.

Excused: Brent Bible, JoAnn Brouillette, Ty Brown, Tim Brusnahan, Tim Foltz, Rachel Hyde, Steve Pithoud, Om Sharma, Rita Sharma, and Mark Townsend

NOTE: Please visit Farm Policy Study Group to access presentation documents.

View the Agenda here

Agenda Items

1. Student Attendees

A group of interested Purdue undergraduates were able to join our discussions again this year: Grant Michael Bell, Blake Buchanan, Shay Doerstler, Reagan Koester, Madison Pearson, Zachary Spangler and Nathan Thompson. We will continue to host student attendees. These will likely be undergraduate students at December meetings and graduate students at July meetings.

2. Expanding Membership

We continue to seek increased diversity in the membership of the group across a wide range of factors. We have made several great additions in the past couple of years but continue to seek new members and their perspectives. Please forward names and contact information to Ken Foster (kfoster@purdue.edu) if you would like to nominate an individual for membership. We also encourage you to invite such individuals as your guest to a future meeting. According to traditions of the group, members should be engaged in farming in the state of Indiana. The lunch and fees for any first-time attendees will be paid out of Purdue Farm Policy Study Group residual funds.

3. Crop updates and go around

With a few exceptions, most everyone felt their crops were very good to outstanding. Concern was expressed about soil moisture going into the winter and what that might lead to next summer if we do not receive some catch-up precipitation in the meantime. Pressure from tar spot continues around the state for corn and there is emerging evidence of root worm concern in some places.

4. Farm of the Future

Dr. Mike Boehlje (Professor Emeritus), Dr. Trey Malone (Michael and Rita Boehlje Chair and Associate Professor in Agricultural Economics), and Dr. Chad Fiechter (Assistant Professor in Agricultural Economics) presented an examination of the future of Midwest farming and agricultural markets through 2040. Their presentation highlighted key trends and predictions. The presenters identifed

several transformative changes affecting the agricultural sector, including the integration of new technologies like precision farming systems, automation, and biologicals, alongside evolving production and distribution systems such as regenerative agriculture and integrated value chains. A central theme was the increasing importance of consumer markets and sustainability, with the presentation emphasizing how food markets have shifted from a producer "push" to a consumer "pull" model. The analysis explored various constraints to farm growth, including labor availability, machinery capacity, and land aggregation challenges, while noting that technological innovations have helped reduce labor costs as a percentage of corn production over time. The presentation also addressed international market dynamics, predicting continued importance of global markets with particular attention to developing economies. Throughout their analysis, the presenters emphasized the need for farms to adapt to these changes through new business models, improved risk management strategies, and enhanced focus on environmental, social, and governance (ESG) performance metrics.

Dr. Fiechter asked the group to break into small groups. The groups were asked to discuss and identify three constraints they believe have hindered farm growth and the place those constraints in the corresponding time period during which the group believes they hindered farm growth. A synthesis of the responses is below.

1. **Land Issues**:
    - **Cost and Competition of Land (Now)**: High costs and intense competition for land, especially from non-agricultural users, make it difficult for farmers to acquire and maintain land.
    - **Land Availability and Aggregation (Now)**: Limited availability of land for purchase or lease and challenges in aggregating land parcels.
2. **Labor Challenges**:
    - **Labor Availability and Costs (Now)**: Difficulty in finding, compensating, and retaining labor, along with high labor costs, impact the scalability and efficiency of farming operations.
    - **Human Resource Management (Now)**: Managing labor force skills and human resources effectively.
3. **Financial Constraints**:
    - **Access to Capital and Financial Management (Now and 1980s)**: Challenges in accessing capital and managing working capital, especially during financial crises.
    - **Cost of Capital (Now)**: High costs associated with obtaining capital and managing interest rates.
4. **Market Access and Risk Management**:
    - **Market Access (Now)**: Ensuring access to markets and end users is essential for profitability, but barriers in this area can limit growth opportunities.
    - **Risk Management (Now)**: Managing risks related to market fluctuations, grain storage, and other uncertainties is a persistent issue for farmers.
5. **Logistics and Management**:
    - **Logistics Management (Now and mid-2000s)**: Efficiently managing logistics, including transportation and storage, is crucial for operational success.
    - **Farm Consolidation and Economies of Scale (Now)**: The trend towards farm consolidation and achieving economies of scale to remain competitive.

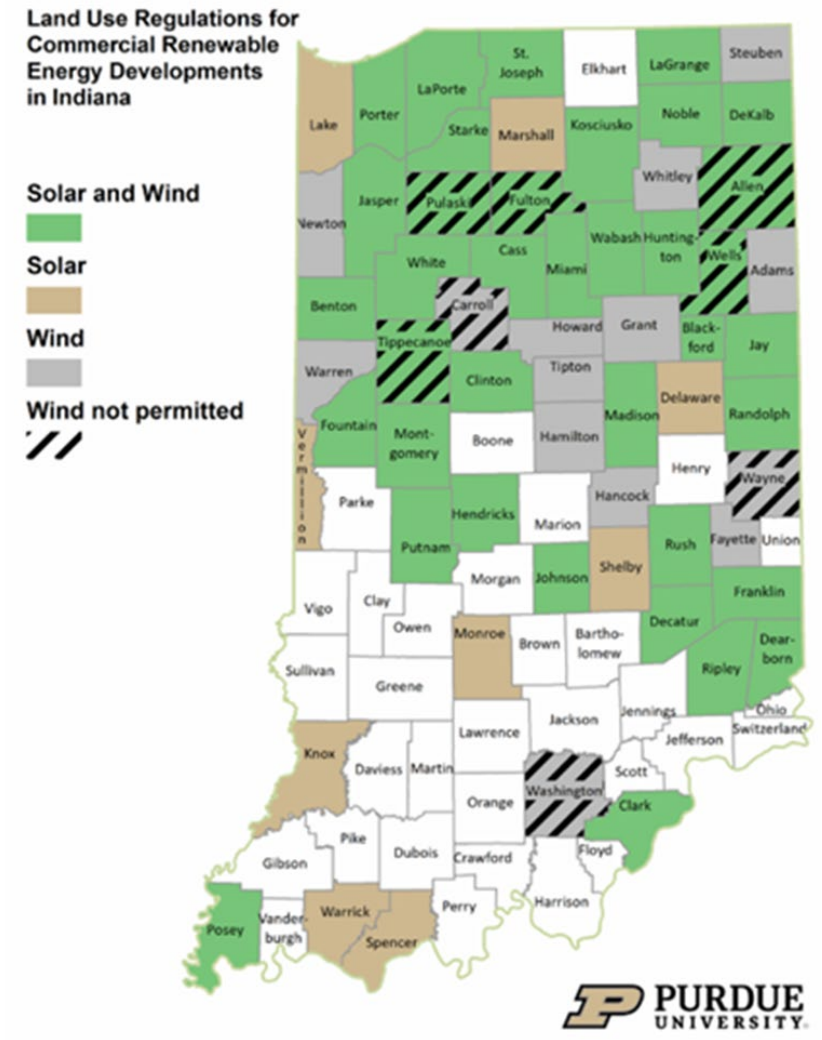
4. Solar Contracts and Associated Economics

Dr. Juan Sesmero, Professor in the Purdue Department of Agricultural Economics, discussed the rapid expansion of solar energy in the United States, particularly its growing presence on agricultural lands, and analyzed the economic and policy implications of this trend.

Dr. Sesmero showed that solar energy has become increasingly cost-competitive, with levelized costs of energy declining significantly over time. The presentation highlighted major utility-scale solar projects in Indiana, including the Mammoth Solar Project spanning 13,000 acres and capable of powering approximately 250,000 homes. This expansion has reignited debates about land use competition between energy production and agriculture, similar to previous food versus fuel discussions.

A number of Indiana counties have enacted local regulations related to renewable energy project, in part, to reduce loss of productive farmland (see figure below). Sixteen counties permit commercial solar energy systems (CSESs) by right in an agricultural district. Of these counties, Clark County is the only county that does not require additional use standards. Twenty-three counties permit CSESs by special exception in an agricultural district (plan commission, PC, or board of zoning appeals, BZA). Seven counties would require rezoning to permit a CSES (hearing with PC and 1. variance from BZA or 2. decision by legislative body). Five of these counties use overlay districts, and one would need a special exception after rezoning.

Figure 8: Map of land use regulations for commercial renewable energy developments in Indiana



The presentation examined various agrivoltaic configurations that attempt to balance solar generation with agricultural production. These include grazing systems where sheep maintain vegetation under panels, specialty crop cultivation beneath elevated panels, and dual-use row cropping with specially spaced arrays. Economic analysis reveals that full-density solar installations can generate approximately $2,500-3,000 per acre annually, significantly exceeding traditional corn-soybean rotation returns of about $240 per acre. However, quarter-density agrivoltaic systems, while less profitable at roughly $850 per acre, may offer a compromise solution.

Dr. Sesmero concludes by addressing policy implications, noting that many jurisdictions have implemented regulations to protect agricultural land. While agrivoltaic systems can help navigate these restrictions, their economic viability and impact on local agricultural economies vary significantly depending on configuration and implementation.

5. Agrivoltaic Farming Systems

Dr. Mitch Tuinstra, Professor of Plant Breeding and Genetics, Wickersham Chair of Excellence in Agricultural Research, and Scientific Director of the Institute for Plant Sciences at Purdue University, presented concerning alternative agrivoltaic systems for crop production in the corn belt. These systems under research are specifically designed to be less dense and more elevated than traditional solar farm installations.

As the global population accelerates toward a full earth scenario, food, energy, and water demands will increase dramatically. The first order constraints that face resource generation technologies, such as static land availability, compound into second order challenges such as direct competition for the same land and solar photons. Within the contiguous United States, both agriculture and energy production such as solar have turned to densification schemes to increase yields and power per land area, respectively. These technologies, coupled with water generation capabilities or management strategies, remain widely separated in their implementation or experience loss in combination.

To address these challenges, the Purdue team established an Agrivoltaic research platform in 2019 with support from the National Science Foundation and Purdue University. The interdisciplinary research team includes experts from multiple fields: Rakesh Agrawal (Chemical Engineering), Peter Bermel (Electrical and Computer Engineering), Sylvie Brouder (Agronomy), Margaret Gitau (Agricultural and Biological Engineering), Juan Sesmero (Agricultural Economics), and Mitch Tuinstra (Agronomy).

The team employs a comprehensive research approach utilizing an Agrivoltaic Array, on-site micrometeorological condition analyses, and on-site experimentally validated ray-tracing and irradiance modeling simulation software. They collect detailed crop physiological stage, ear, and height data, using sophisticated equipment including pyranometers and shadow-ring assemblies to measure direct and diffused light intensities at plant levels. The research also incorporates an ear photometry system for analyzing yield components such as kernels per ear, kernel fill, and ear dimensions.

A significant finding of their research identified critical time frames in which the relationship between irradiance and yield is highly significant ($p < 0.00005$). This discovery enabled the implementation of ideal anti-tracking during those growth periods and solar tracking during all non-critical periods, collectively called critical-time anti-tracking. While this approach reduces power generation to 13.68% during a six-week ideal anti-tracking time frame compared to solar tracking, it still achieves 86.71% power generation over a year when compared to solar tracking. The reduction in power offsets yield loss, effectively increasing overall land productivity.

The research revealed that crop photosynthesis rates dropped to near-zero when plants were shaded by PV modules, primarily due to decreased stomatal conductance. However, these rates quickly returned to normal after the shading period ended. This understanding helped inform their optical simulation analyses, which assume minimal photosynthetic activity during near-zero irradiance states and rapid normalization within minutes after transitioning to different irradiance conditions.

An unanticipated insight gleaned from the research showed that soil moisture was significantly higher under the solar panels and contributed positively to yield. Statistical analyses further revealed that both cumulative irradiance and soil moisture conditions drive variation in crop performance in AgPV systems.

Looking toward future implementations, the team is exploring new AgPV prototypes with reduced height requirements based on plant height rather than machinery clearance. These systems feature a lower edge panel height of 1.7m in tracking mode and incorporate conservation strips with diverse plant species to increase biodiversity and reduce soil erosion. Additionally, Mitch envisions that short corn varieties, based on genetic discoveries from Purdue researchers and others, may play a crucial role in balancing the need for renewable energy with the preservation of productive crop land. The integration of cover crops into these regenerative AgPV systems shows promise for improving overall soil health.

This research proposes a technology for near-neutral coproduction of food and energy, leveraging existing hardware to create a viable pathway for widespread solar implementation throughout the contiguous United States. The comprehensive approach, combining advanced modeling with practical agricultural considerations, demonstrates the potential for successful integration of agricultural and energy production systems.

6. Future meeting dates

Barring unforeseen circumstances, the following will be the dates for the group's next two meetings: July 8, 2025 and December 9, 2025. **Please note that the Indiana Prairie Farmer Master Farmer Awards Program will be held following our July 8th meeting. Both events will take place at the Purdue Beck Ag Center. To accommodate attendance at both events, we will shorten the Purdue Farm Policy Study Group meeting beginning at 11:45am and ending at approximately 3:30pm. The Master Farmer Awards Program will begin at approximately 4pm.**

7. Future Topics
The following topics were suggested for future meetings:
- Agricultural Trade, Trade Policy, non-GMO markets
- Future of Higher Education
- Conservation Stewardship Program in the Inflation Reduction Act
- Orange corn development and commercialization (Torbert Rocheford)
- Affordable rural housing

If you have thoughts on these or other topics of interest, then please forward those to Ken Foster (kfoster@purdue.edu).

5. Adjournment at 3 pm

Respectfully Submitted,

Ken Foster

Ken Foster
Professor – Agricultural Economics
Director – Purdue Farm Policy Study Group