Shading and Energy Impacts for Farmer-Friendly Agrivoltaics Array Installation

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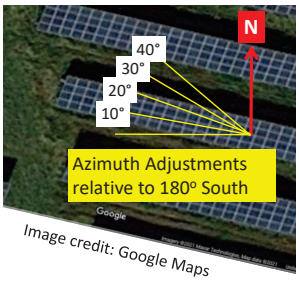
Introduction

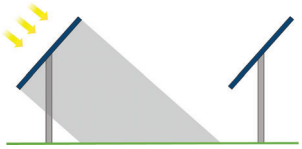
- We advocate for array installations compatible with convenient farming, considering other limitations that influence the direction that the field is plowed
- We simulated light for different panel designs and array rotations to assess how light would be affected, both direct and diffuse



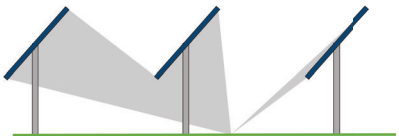
Rotating the array somewhat to fit the needs of the farmer may be necessary for AG arrays, but shouldn't have large negative impacts on electrical output.

Rotation of plowing on different fields in a local area. All different angles, none facing exactly north-south or east-west!

Direct Irradiance
(Comes directly from sun)

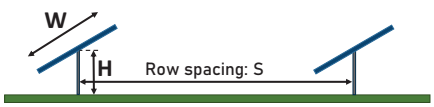


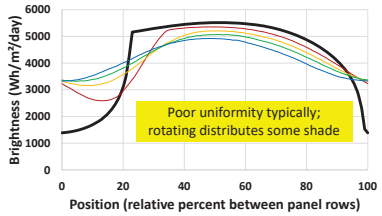
Diffuse Irradiance
(Comes from all angles)



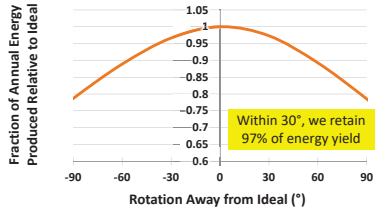
All shading calculations done in Python for New Brunswick, NJ using June data with W = 2m, H = 2m, and S = 6m.

Fixed Tilt
(Rows typically running East-West)

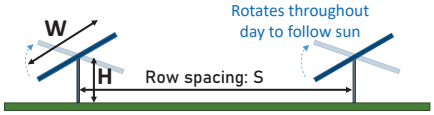


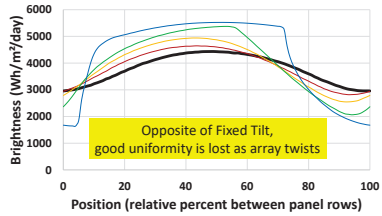


Uniformity =	65%	77%	83%	85%	86%
	0°	30°	45°	60°	90°

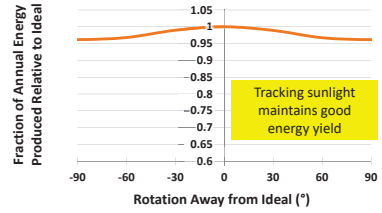


Single-Axis Tracker
(Rows typically running North-South)

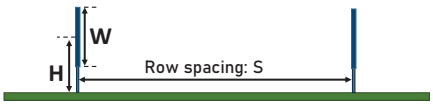


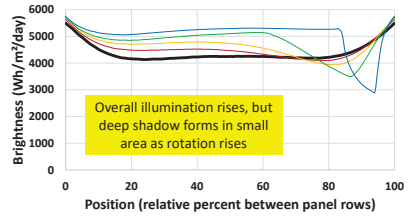


Uniformity =	86%	83%	78%	71%	65%
	0°	30°	45°	60°	90°

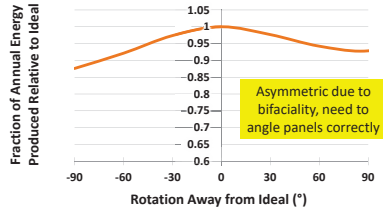


Vertical Bifacial
(Rows typically running North-South)





Uniformity =	92%	92%	91%	89%	88%
	0°	30°	45°	60°	90°



Energy calculations performed using PVWATTS; Fixed Tilt and Tracker used default parameters; VBF assumes bifaciality of 90%, and sums East-facing and West-facing output.

Conclusions

- Very little energy penalty for slight array rotations under 30° for all cases
- Fixed tilt arrays have lower ground light uniformity but it improves as array is rotated
- Single-axis tracking array light uniformity decreases as array is rotated, but maintains high energy
- Vertical bifacial arrays have good uniformity overall; rotation's effect on energy depends on bifaciality

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For updates on our agrivoltaics work, visit us at the Rutgers Agrivoltaic Project website using this QR code.

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By Ross Rucker and Dunbar P. Birnie, III

Poster presented at the Agrivoltaics World Conference 2024 in Denver, CO

Designing agrivoltaic installations on farmland needs strong input not only from the solar developers, but also from farmers who are already tilling the land and intend to keep working the land after array is installed. A source of possible conflict, however, is how the solar panels should be oriented, whether to maximize electrical output or conform to the way the farm has been operated. The existing farm tilling orientations might already be reasonable choices for array alignment which would be a convenient fit, but farms come in all shapes and rows can align with any direction. There may not be a desire to change the way the rows run, especially in cases where the tilling direction helps prevent soil erosion, or conforms to local geography. We examined the effects on light uniformity and electrical production when installing arrays at an angle, rotating away from the typical cardinal directions, for three array types: fixed-tilt, single-axis tracking, and vertical bifacial arrays.

All three array types showed different electricity production penalties as a function of array twist. On an annual electricity production basis, all three array types lose very little output when rotated away from their ideal. Rotating an array within 30° of the ideal angle still maintained at least 97% of the annual electricity production for all array types. This offers teams of farmers and solar developers a good amount of flexibility in system design, and attempting to align solar array rows with the farmer’s preferred tilling directions should not be a source of great conflict.