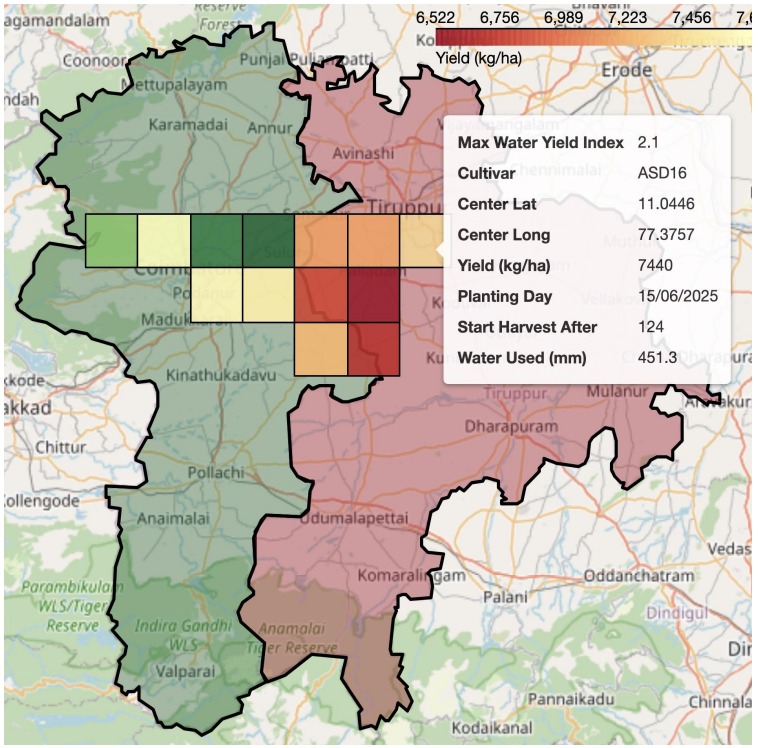


Crop Science Guided AI to Improve Farm Profits and Enhance Sustainability

Powered by Holos

A Holistic Hybrid Agricultural DSS

- Problem: Profits of US grain farmers are constrained by increasing input costs.

- Our approach - Holistic Solutions:
  a. Planning & operations are *optimization* problems spanning complex, intertwined domains.
  b. Farm profits can be increased through efficient usage of inputs.
  c. Grounded on research through partnerships with academia.

- Solution: Holos, a *Hybrid* Agricultural decision support system, assists in identifying and executing *efficient, sustainable resource management solutions*, from landscape to parcel, over multiple zones and seasons*

- Current focus: Efficient *water* management solutions for water agencies, growers/farming organizations, sustainability agencies.

*: current for single; planned for multiple

Efficient Water Management for Alfalfa

Case Study Definition & Parcel Level Recommendation

Irrigation is 47% of operating cost (UCANR)

Question: For alfalfa growers in Kern County ($89M revenue), what is an optimal variety and irrigation schedule to increase water efficiency, and farm profit?

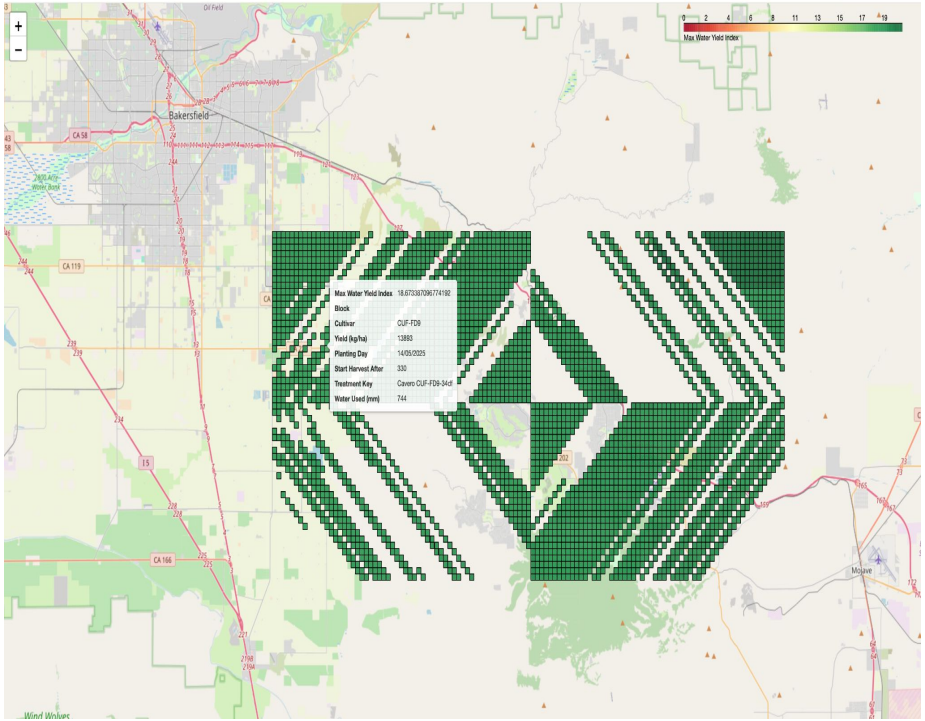
Recommended Treatment + Irrigation Schedule

Treatment Name of Cavero CUF-FD9-34df is recommended to (maximize) Yield/App Irrigation Prod(kg/ha/mm) at 17

Irrigation Schedule
Apply 25.0 mm of water/furrow 31 days after planting date
Apply 24.0 mm of water/furrow 33 days after planting date
Apply 29.0 mm of water/furrow 51 days after planting date
<More>

Day/day schedule specific to a parcel

Large Scale ROI: Modeled at 25ha resolution



Efficient Water Management for Alfalfa

Water Savings, Impact on Return, Methodology at Parcel Level

Projected 27% water savings*

Data is for year #3 in 4 year stand.

Target yield 7 ton/ac

Practices	Water applied (in)	Pct Water Saved	Net Return/Ton	Pct Increase Net Return
Current	49	N/A	-$8.57	N/A
Holos Recommended Cavero CUF-FD9-34df	36	27%	$11.40	233%

Methodology: Model yield response to water

- *CSM models evaluate water productivity index* for 14 generic treatments; recommend one with highest index
- Three cultivars with varying fall dormancies: CFIA-FD4, Ara-FD7, CUF-FD9
- Irrigation procedures considered: Dry, 31", 16" (extrapolated to meet target yield)
- Phosphorous application procedures considered: 0 lb/ac, 107 lb/ac split twice, 56 lb/ac, 232 lb/ac split thrice
- *AI Models "fine tune" CSM recommendation.*

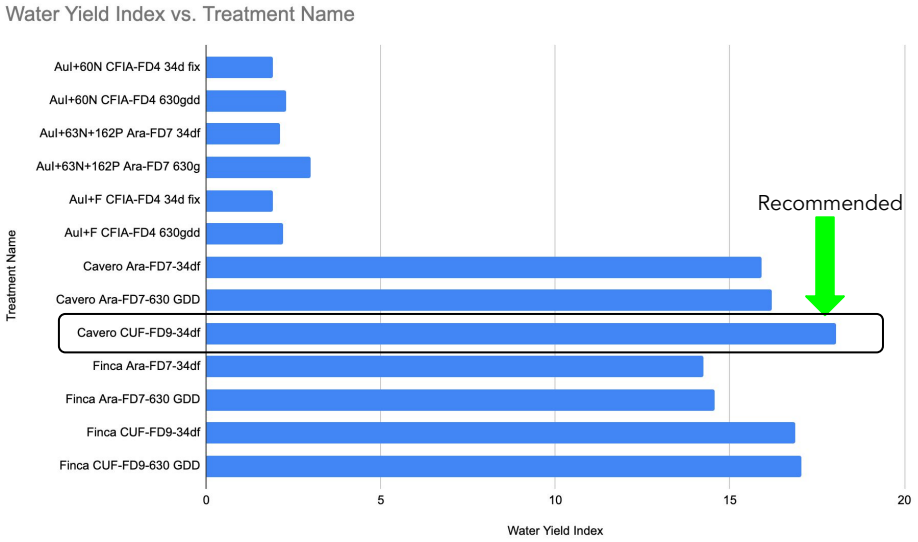
- Sources: Alfalfa Water Use, UCANR, 2023 Kern County Crop Report
- Monetary values are preliminary projections (based on ~$12.50 to irrigate 1 In, alfalfa price of $255/ton)
- *Trading of excess (saved) water would add to farm profit*
- AI models will narrow the water quantities, possibly increasing savings to meet policies and increase profit.

*: validation will be through observed yield/practices and field trials

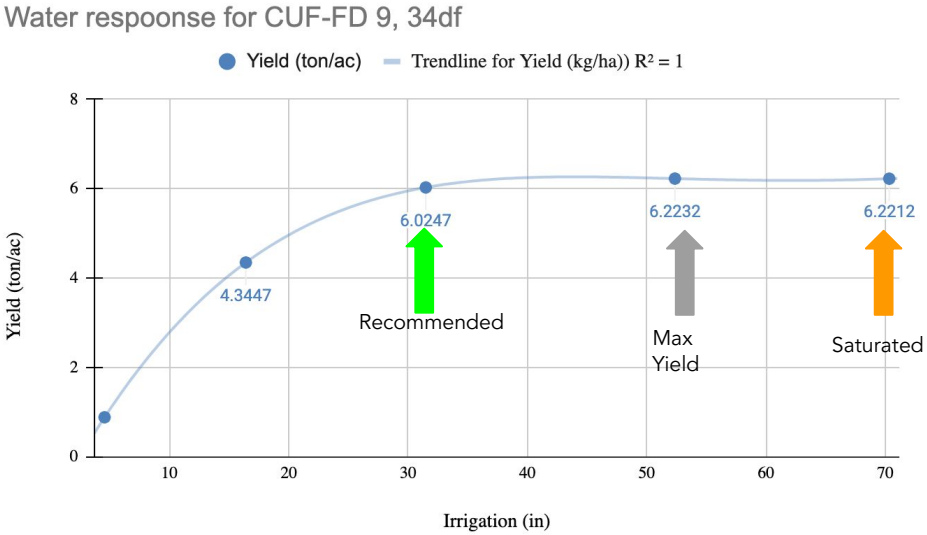
Efficient Water Management for Alfalfa

Parcel Level Water Response for Multiple Treatments & Recommended Treatment

CSM Recommendation - Broad



Fine tune of CSM Recommendation



Efficient Water Management for Alfalfa

Impact on Profit and Ground Water Storage at Landscape

Kern: Impact on Alfalfa farming: water savings => profit

- 7 ton/ac production
- Assumption: 100% irrigation @ 49 In @ $12.50/In

Harvested acreage	Seasonal Total water used (Ft)	Holos: Water saved (Ft)	Holos: Water Cost Reduction (USD)
47k	193K	52K	$6.6M

Holos numbers *under verification*; obtained by applying 27% savings/parcel
CA state alfalfa water savings projection: 10.2M In
Sources: Alfalfa Water Use, Kern GSP

Kern: Impact on groundwater sustainability (SGMA):

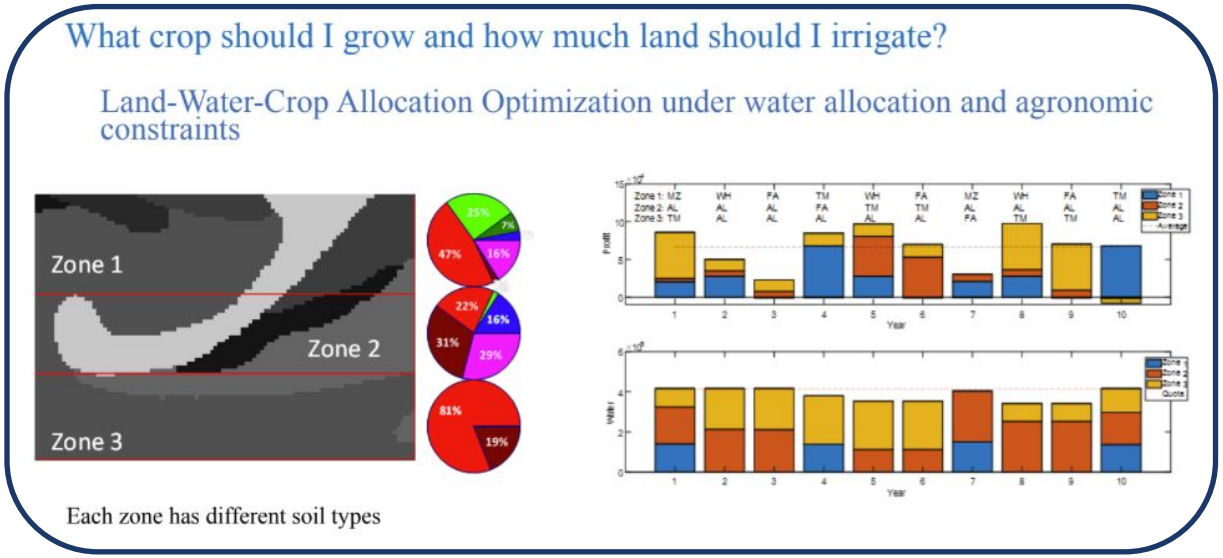
- Improved storage levels: add saved water to pre-Holos level
- Assumption: 100% alfalfa irrigation through groundwater

Period	Change in GW storage (AcFt/yr)	Projected storage change using Holos (AcFt/yr)
2015-2023 (Dry)	-344K	-291K
Projected (WYs 2041-2070) Baseline	85.6K	137.8K
Projected (WYs 2041-2070) 2030 Climate Change with Projects	46.8K	99K

Planned Efficient Water Management Solutions

Multi zonal, multi season & In Season Risk Mitigation

- Multi Season Planning: Identify optimal lower rotations, planting date, and irrigation schedule to increase water use efficiency,
- In Season Risk Mitigation: Use Remote Sensing to identify water stress and communicate mitigation strategies.



Seeking from Grower Community

Engage to:

- Better understand your resource management needs: your crops, problems, goals, etc.,.
- Applying Holos to meet your needs
- Validate your specific treatments through localized historical data
- Conduct field trials for ground truth validation
- Develop responsive AI models to solve your problems and meet your goals
- Scale up