From Optimization to Adoption: A Decision-Support Tool for Groundwater-Constrained Bioenergy Crop Transitions

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Why it matters

1. The High Plains Aquifer supports major irrigated corn production, but groundwater decline is reducing well capacity and increasing pumping costs.
2. Lower-water crops such as sorghum and switchgrass may help support transitions from irrigated agriculture.
3. Producers and stakeholders need location-specific guidance.

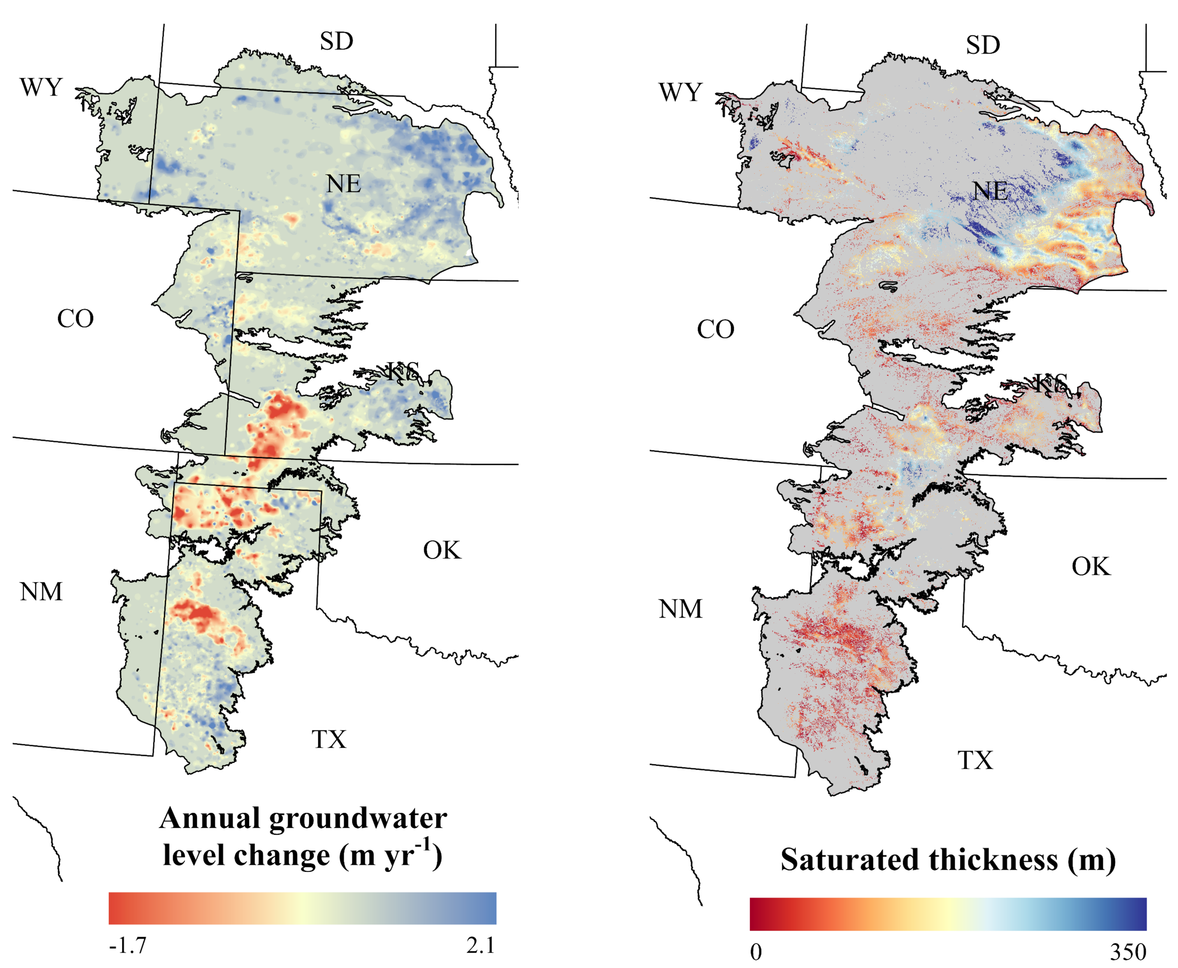


Fig. 1. Spatial variation in groundwater conditions across the U.S. High Plains Aquifer

How we modeled it

1. Groundwater data + Crop economics
2. 30-year optimization model
3. Crop transition pathways
4. Tool-ready outputs

Key Insights

#1: Irrigated corn declines unevenly

23% of currently irrigated corn area is likely to transitions to dryland systems over 30 years

#2: Regional differences matter

Region	Transition pattern
Northern HPA (NE, SD, WY)	Irrigation remains more resilient
Central HPA (CO, KS)	Mixed transition corridor
Southern HPA (NM, OK, TX)	Earlier shift to dryland pathways

#3: Bioenergy opportunities are place-based

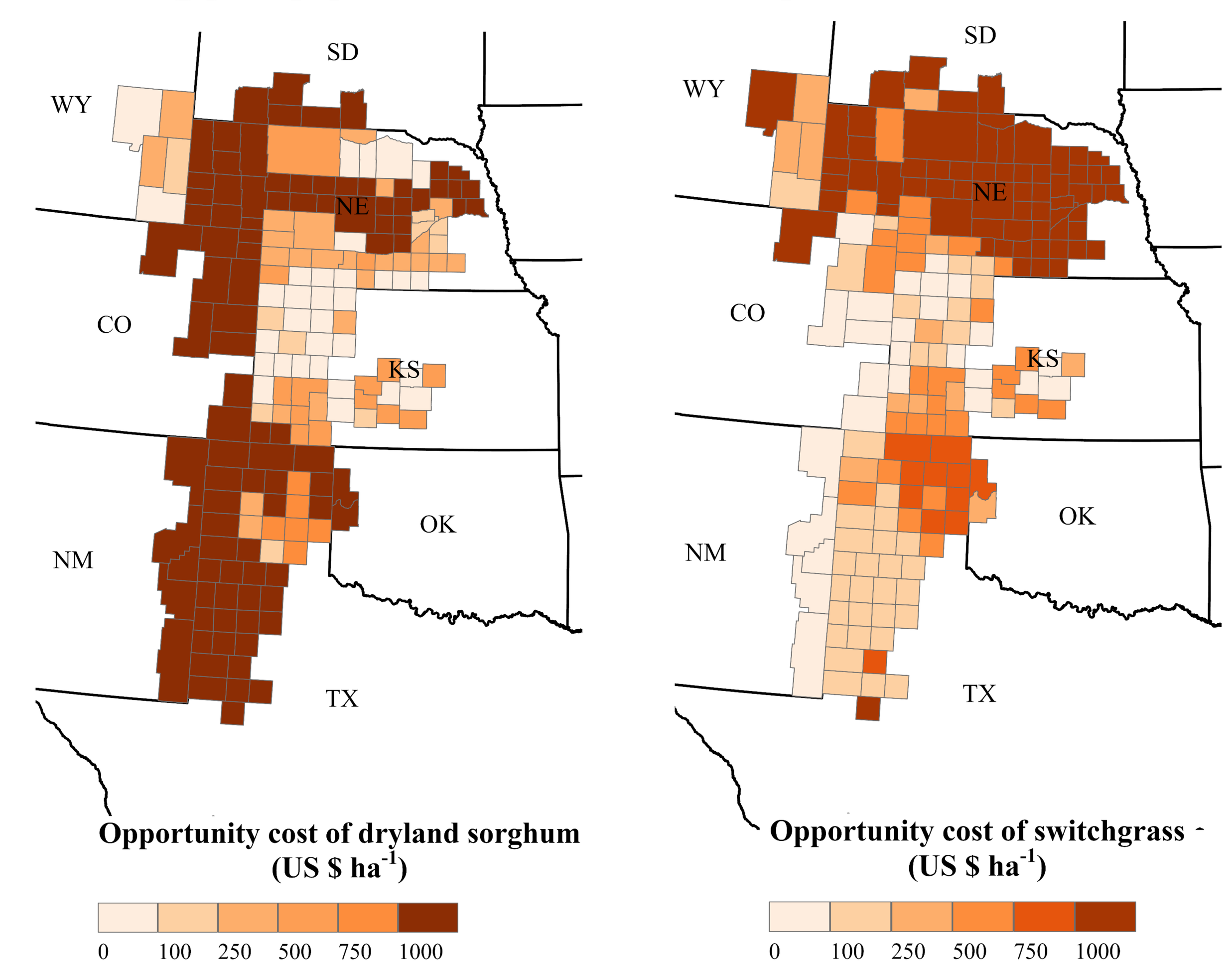


Fig. 2. Opportunity costs for non-irrigated bioenergy feedstocks across the U.S. High Plains Aquifer

Sorghum: competitive in selected dryland transition zones

Switchgrass: stronger opportunity in Colorado, New Mexico, and parts of the southern High Plains

From Model to Tool

Next step: BE-SMART (BioEnergy Sustainable Management and Resilient Transition Tool)

BE-SMART, BIOENERGY CROP TOOL

YOUR INPUTS

Location: Finney County, KS

Well Capacity (ac-ft/yr): 300

Available Land (acres): 1,000

Planning Period (years): 30

RUN ANALYSIS

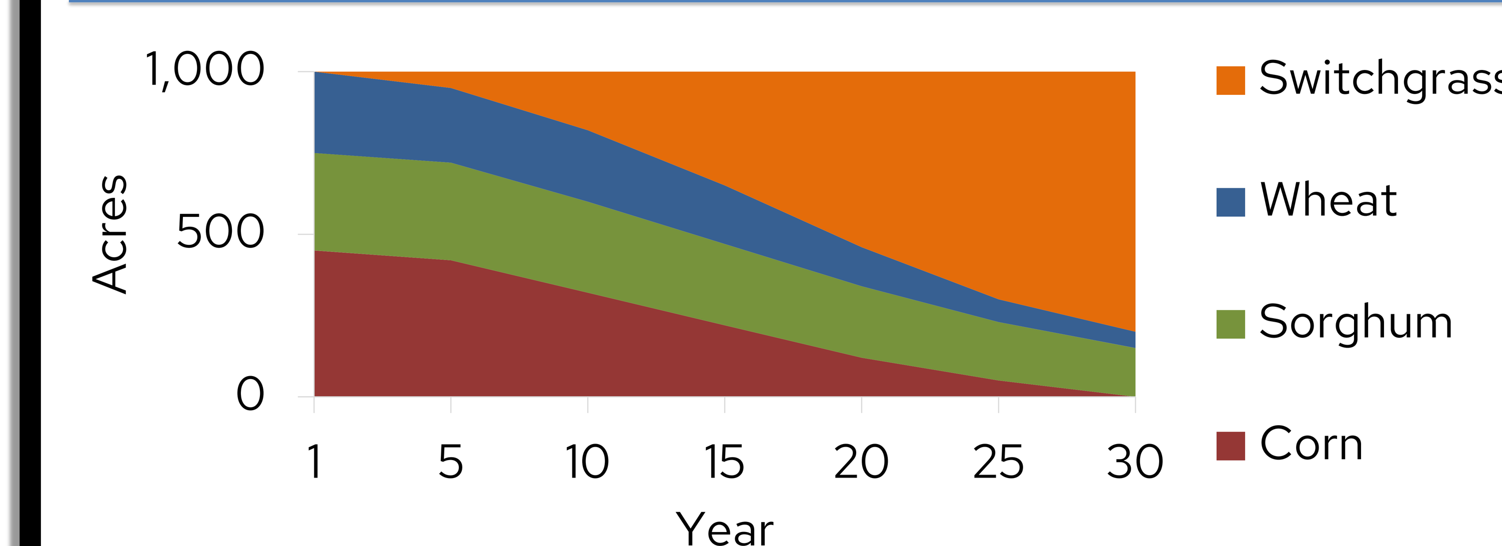
RESULTS (OUTPUTS)

Optimal Strategy: In year 6 switch to **Switchgrass**

Total Profit (30 year): **$2.3M**

Water use .vs current system: **-28%**

Water Availability Extended: **+12 Years**



Why this tool matters

- Makes complex optimization results accessible
- Helps compare crop, water, and profit tradeoffs
- Supports producer adaptation and bioenergy planning

Groundwater-constrained agriculture requires place-based decisions. Our model identifies economically favorable crop transitions, and our tool translates them into practical crop and bioenergy planning recommendations.

Ramaswamy, K., Lark, T., Aragon, N. 2026. Opportunities for Bioenergy Crops to Support Transitions from Irrigated Agriculture and Conserve the U.S. High Plains Aquifer. *Agricultural Water Management (forthcoming)*. Preprint available: http://dx.doi.org/10.2139/ssrn.5638491

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