

Economic Opportunities of Bioenergy Feedstock Production in the U.S. High Plains

Karthik Ramaswamy and Tyler Lark

University of Wisconsin-Madison, Nelson Institute Center for Sustainability and the Global Environment

Introduction

This project seeks to estimate the maximum long-term benefits and opportunities of producing alternative bioenergy feedstocks from agricultural lands overlying the Ogallala aquifer, emphasizing the importance of land use management, groundwater limitations, and market conditions.

Significance of the U.S. High Plains region:

Freshwater

- ❑ Ogallala is the largest freshwater aquifer in the U.S. linked to the High Plains system

Grain Production

- ❑ The region is dominated by 41% agriculture (~14% are irrigated for grain production) and 56% rangeland with high productive soils

Agricultural Industry

- ❑ \$35 billion in crop sales each year (Basso et al., 2013)

Problem Statement

There is a dual need to address dwindling groundwater supplies and increasing climate change. Drought tolerant bioenergy crops may offer a solution to both.

- Crop producers have experienced decreased well capacities, low crop yields, and higher extraction costs.
- These challenges have been forcing producers to either adopt alternative irrigated crops that give more returns per unit of water, transition to dryland production, or cease their farming operations.

Objective & Methods

OBJECTIVE: Evaluate the net returns of different agricultural production systems in the High Plains region and potential diversification of these systems with bioenergy feedstocks like biomass sorghum and switchgrass. The study area consists of 225 counties overlying the Ogallala aquifer.

SCOPE OF ANALYSIS

ENERGY SORGHUM

- Drought tolerant
- Familiar crop to the High Plains producers

SWITCHGRASS

- Fewer inputs
- High biomass

CORN

- Popular feedstock for ethanol production

PASTURE & CRP[†]

- Alternatives for crop production

Figure 1. Overview of the scope of bioenergy feedstocks and diversification of crops in the U.S. High Plains

[†]CRP - Conservation Reserve Program

SPECIFIC APPROACH

Step 1: Construct an economic analysis to estimate the net returns of growing different agricultural systems.

Step 2: Utilize remote sensing methods to identify irrigated and non-irrigated lands in the study area.

Step 3: Intersect the linearized crop budgets for seven agricultural systems with the remotely sensed data of irrigated and non-irrigated lands.

Step 4: Calculate maximum annual profits for non-irrigated crops using a recursive programming model.

Step 5: Determine the optimal irrigated crop choices for six major irrigated locations across the US High Plains, subject to groundwater constraint, using a 15-year multiperiod model.

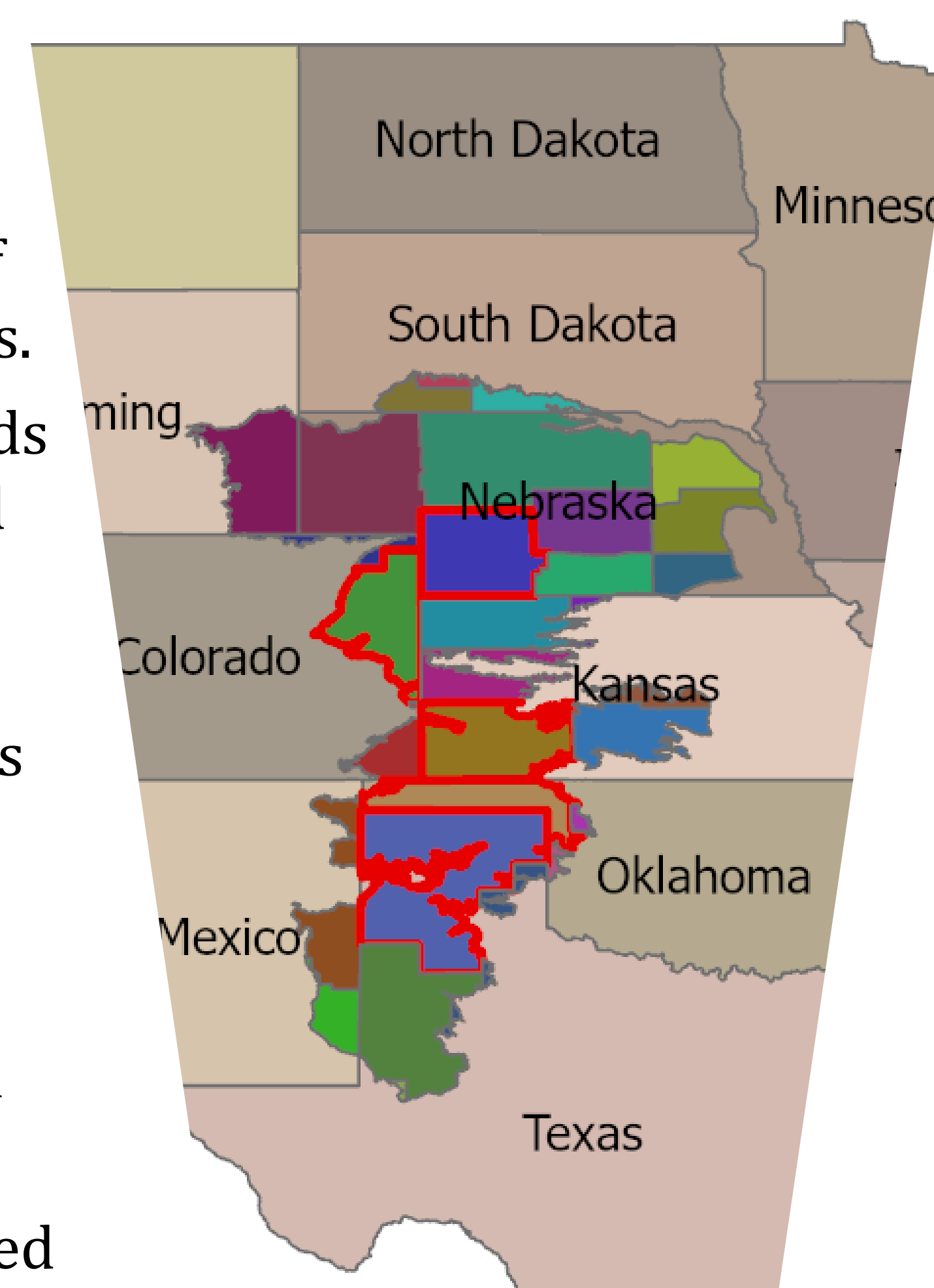


Figure 2. Agricultural Statistics Districts selected for the economic analysis are outline

Preliminary Results

Table 2. Crop budgets for producing non-irrigated corn in major agricultural districts in the U.S. High Plains

AG DISTRICTS (RANK)	Market Price (\$/bu.)	Crop Yield (bu./ac)	Net Revenue (\$/ac)	Direct Costs (\$/ac)	Net Returns (\$/ac)
SOUTHWEST, KS (5)	\$7.04	52.4	\$368.90	\$254.86	\$114.03
PANHANDLE, OK (3)	\$7.55	58.9	\$444.70	\$263.48	\$181.21
NORTHERN PLAINS, TX (1)	\$7.57	65.3	\$494.32	\$271.97	\$222.35
EAST CENTRAL, CO (4)	\$7.36	50.3	\$370.21	\$252.08	\$118.13
SOUTHWEST, NE (2)	\$6.77	71.6	\$484.73	\$280.33	\$204.40

Table 3. Crop budgets for producing non-irrigated sorghum in major agricultural districts in the U.S. High Plains

AG DISTRICTS (RANK)	Market Price (\$/bu.)	Crop Yield (bu./ac)	Net Revenue (\$/ac)	Direct Costs (\$/ac)	Net Returns (\$/ac)
SOUTHWEST, KS (2)	\$6.89	53.3	\$367.24	\$212.83	\$154.41
PANHANDLE, OK (4)	\$6.72	31.9	\$214.37	\$193.96	\$20.41
NORTHERN PLAINS, TX (3)	\$6.16	40.1	\$247.14	\$201.21	\$45.93
EAST CENTRAL, CO (5)	\$6.94	30.4	\$208.48	\$192.32	\$16.16
SOUTHWEST, NE (1)	\$6.50	61.7	\$484.73	\$220.23	\$180.82

Table 4. Annual maintenance budget for established switchgrass to be harvested for biomass in the U.S. High Plains over period of 10 years

Harvested Yield [†] (tons/ac)	Dry matter Yield (tons/ac)	Total Cash Costs (\$/ac)	Breakeven Price (\$/dry ton)
2.3	2	176	\$88
4.6	4	233	\$58
6.9	6	282	\$47
9.2	8	326	\$41

[†]Assumed as 15 percent moisture on the harvested switchgrass

Table 5. Estimated pasture revenue and average CRP rental rates in the U.S. High Plains

Ag Districts	Pasture Revenue ¹ (\$/ac)	2022 CRP rental rates ² (\$/ac)
SOUTHWEST, KS	\$21.98	\$41
PANHANDLE, OK	\$21.98	\$20
NORTHERN PLAINS, TX	\$23.28	\$29
EAST CENTRAL, CO	\$20.83	\$41
SOUTHWEST, NE	\$20.83	\$43

¹Deines et al., 2020; ²USDA Farm Service Agency

References

- Basso, B., A. Kendall, and D. W. Hyndman (2013), The future of agriculture over the Ogallala Aquifer: Solutions to grow crops more efficiently with limited water, *Earth's Future*, 1, 39–41
- Deines, J., M. Schipanski, B. Golden, S. Zipper, S. Nozari, C. Rottler, B. Guerrero, V. Sharda (2020), Transitions from irrigated to dryland agriculture in the Ogallala Aquifer: Land use suitability and regional economic impacts, *Agricultural Water Management*, Vol. 233, 106061