Ogallala Water Conservation and Economic Analysis of Sorghum Silage Potential for Dairy Industry in Texas High Plains

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Motivation for Research

The continued growth in the dairy industry has increased the concern about scarce water resources.

Motivation for Research (cont.)

This study is important for stakeholders when considering water conservation methods.

Previous Literature

- Dairy cows in the Southern Ogallala Aquifer Region increased more than eleven-fold, from 41,500 head in 1990 to a high of 466,000 head in 2009.
- Analysis suggests the dairy industry has minimal impact on water resources while increasing economic activity and employment opportunities.

(Guerrero, Amosson, Jordan, 2013)

- Silage is one of the key components of dairy ration. Corn silage enhances quality milk production due to high digestibility, ease of handling, and palatability.

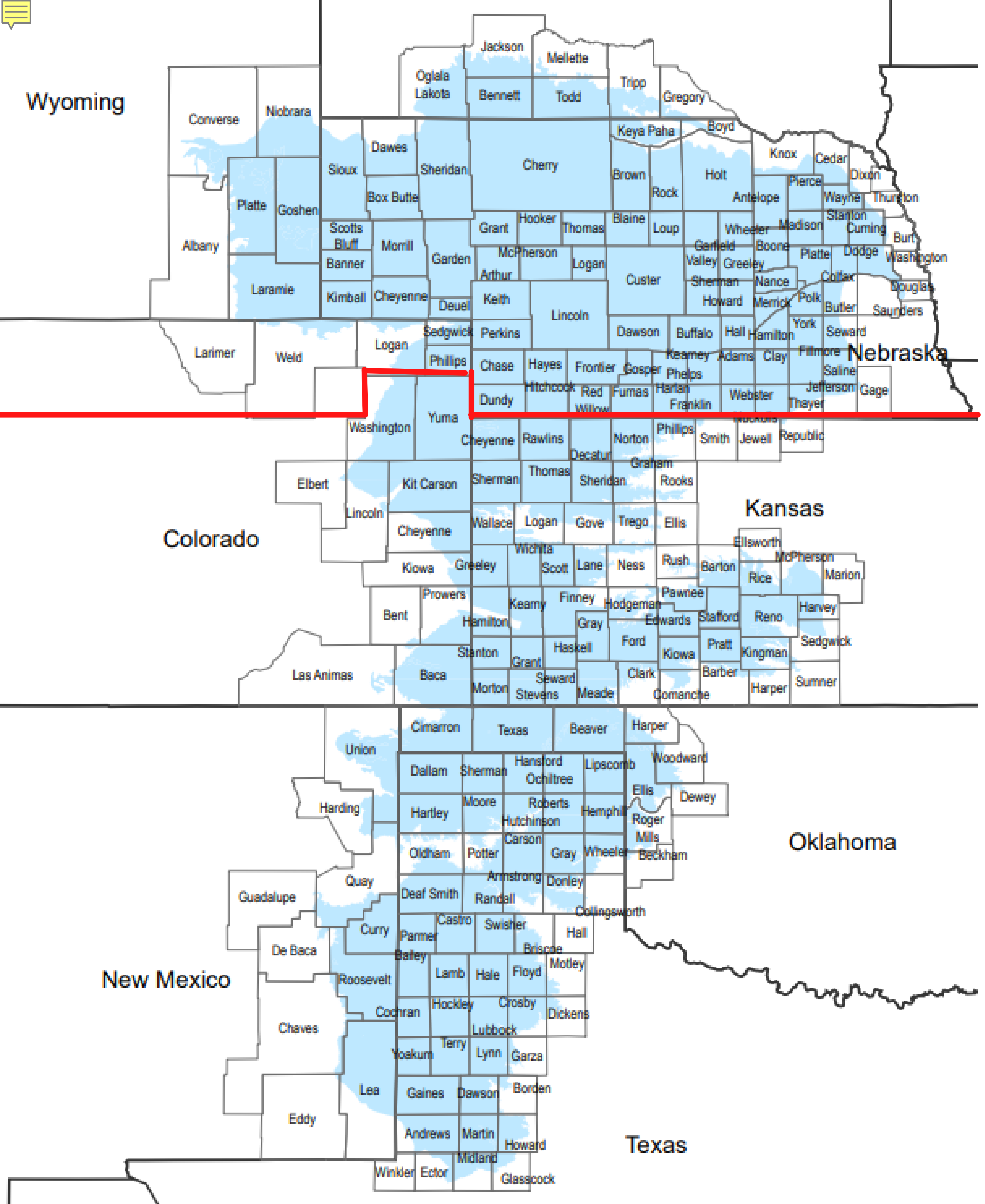
(Almas et al., 2017)

Thoughts about water use

- Silage crops utilize less irrigation water because they are harvested sooner.
- The direct water use of dairy cows is small in comparison to crop water use in the region.
- The total industry output generated by confined livestock operations is much larger ($2,500 vs $100,000+ per acre-foot of direct water use) than crop production.

Objectives

- Calculate direct and indirect water usage for the region
- Estimate the impact of the utilization silage
  - Demand for silage by dairies
  - Acreage required for silage
  - Water use to provide silage
- Estimate the impact of converting from corn silage to sorghum silage



Study Region

- Data were collected for 120 counties in the Southern Ogallala Region
- All counties with an Ogallala Aquifer presence below the Northern Kansas state line

Map: Derived from USGS aquifer web service, developed by Mark Stewart

Study Region

Colorado (9)

Baca, Cheyenne, Kiowa, Kit Carson, Las Animas, Lincoln, Prowers, Washington, Yuma

New Mexico (6)

Curry, Harding, Lea, Quay, Roosevelt, Union

Oklahoma (7)

Beaver, Cimarron, Ellis, Harper, Roger Mills, Texas, Woodward

Kansas (52)

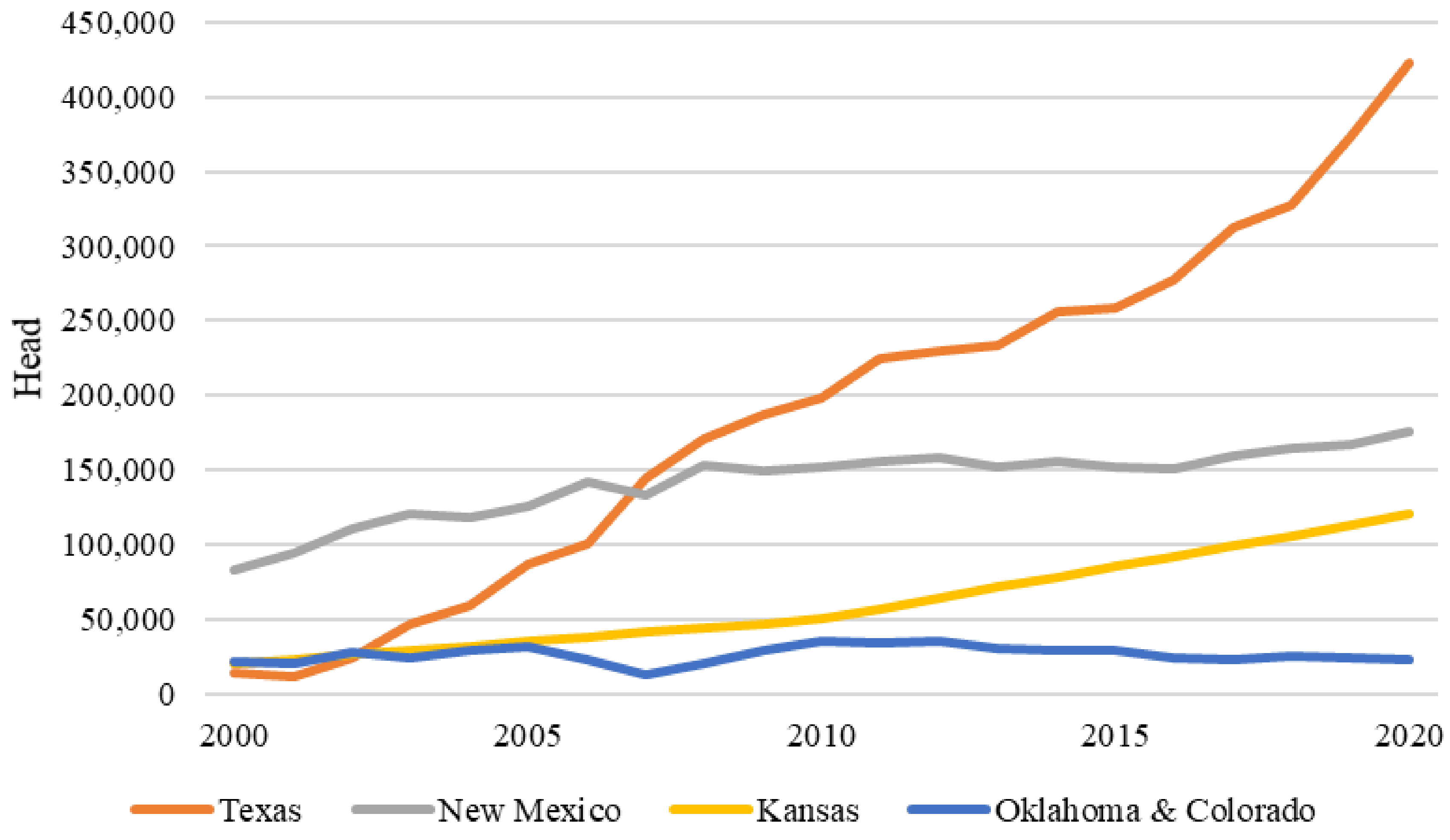
Barber, Barton, Cheyenne, Clark, Comanche, Decatur, Edwards, Ellis, Ellsworth, Finney, Ford, Gove, Graham, Grant, Gray, Greeley, Hamilton, Harper, Harvey, Haskell, Hodgeman, Kearny, Kingman, Kiowa, Lane, Logan, Marion, McPherson, Meade, Morton, Ness, Norton, Pawnee, Phillips, Pratt, Rawlins, Reno, Rice, Rooks, Rush, Scott, Sedgwick, Seward, Sheridan, Sherman, Stafford, Stanton, Stevens, Thomas, Trego, Wallace, Wichita

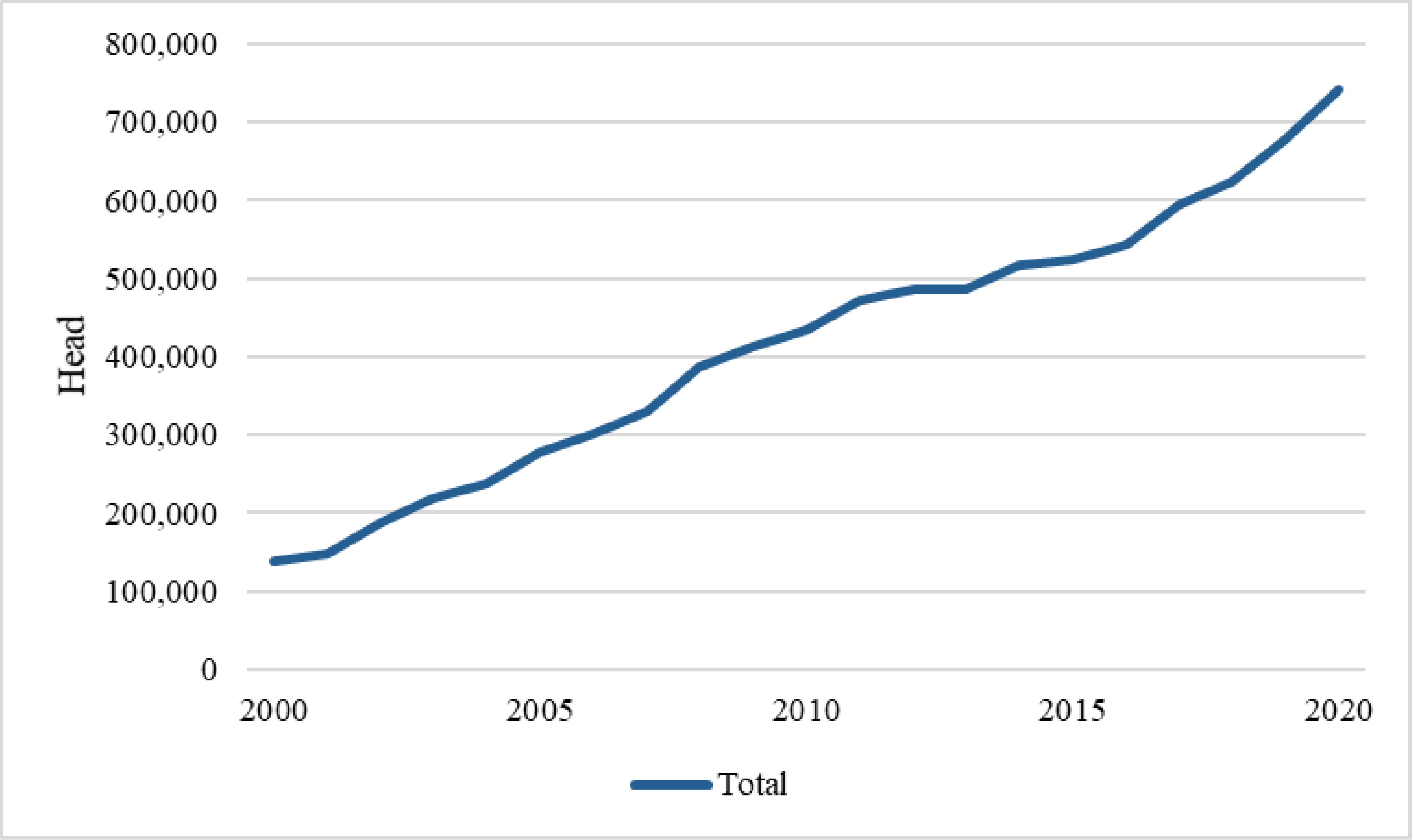
Texas (46)

Andrews, Armstrong, Bailey, Borden, Briscoe, Carson, Castro, Cochran, Crosby, Dallam, Dawson, Deaf, Smith, Dickens, Donley, Ector, Floyd, Gaines, Garza, Glasscock, Gray, Hale, Hansford, Hartley, Hemphill, Hockley, Howard, Hutchinson, Lamb, Lipscomb, Lubbock, Lynn, Martin, Midland, Moore, Motley, Ochiltree, Oldham, Parmer, Potter, Randall, Roberts, Sherman, Swisher, Terry, Wheeler, Yoakum

Data Collection (cont.)

Dairy Cow Inventory





Data Collection

Data Sources

- Milk Market Administrator
  - Pounds of milk
  - Converted to head
- Direct Water Use
  - Average of 65 gallons of water per day per cow
- Indirect Water Use
  - Dairy Rations
- Texas A&M AgriLife Extension
  - Crop budget data
    - Water use by crop
    - Yield

Results

Ingredient	Dairy Cow Unit: Daily Ration as fed (lbs)	Dairy Cow Unit: Annual Ration as fed (tons) [a]	Study Region: Feed Requirements (tons) [b]
Alfalfa	4.00	0.73	622,574
Grass hay	1.82	0.33	282,988
Crop residues	1.11	0.20	172,937
Corn Silage	50.57	9.23	7,871,114
Sorghum Silage	3.43	0.63	533,635
Small Grains Silage	17.14	3.13	2,668,174
Concentrates	38.86	7.09	6,048,872
Total	116.94	21.34	18,200,294

[a]Assumes dry matter content of 90%, 88%, 90%, 35%, 88% for alfalfa, grass hay, crop residues, silages, and concentrates, respectively.

[b]Based on an estimated dairy cow inventory of 852,841 in 2020

Results

- Approximately 62,000 acre-feet of water for direct usage.

	Feed Requirements (tons)	Yield/Acre (tons)	Acreage	Irrigated Applied (ac-in per acre)	Indirect Water (ac-ft)
Alfalfa	622,574	5.50	113,195	24.00	226,391
Grass	282,988	2.56	110,542	9.00	82,907
Corn Silage	7,871,114	27.00	291,523	20.00	485,871
Small Grain Silage	2,668,174	10.00	266,817	10.00	222,348
Sorghum Silage	533,635	21.00	25,411	14.00	29,646
Corn Grain	2,699,041	6.30	428,419	22.00	785,435
Total	14,677,526		1,235,907		1,832,598

[a] Yield and irrigation was obtained from Texas A&M AgriLife Extension, 2020

Corn Silage vs. Sorghum Silage

	Yield	Irrigation (ac-in)	Price ($)	RAVC ($/ac)
Gorn Silage	27 ton	20	$53	$311.42
Sorghum Silage	20 ton	14	$46	$235.53
Grain Sorghum	62 cwt	10	$7.35	$18.10

Obtained from Texas A&M AgriLife Extension, 2025

	Tons	Acreage	Water (ac-ft)	Dairy Cost	Producer Returns
Baseline					
Corn Silage	7,871,114	291,523	485,871	$417,169,042	$90,786,012
Sorghum Silage	533,635	26,682	31,129	$24,547,210	$6,284,353
	8,404,749	318,204	517,000	$441,716,252	$97,070,364
Replace 50% CS with SS					
Corn Silage	3,935,557	145,761	242,936	$208,584,521	$45,393,006
Sorghum Silage	4,469,192	223,460	260,703	$205,582,832	$52,631,440
	8,404,749	369,221	503,638	$414,167,353	$98,024,446
Difference	**-**	**51,016**	**(13,361)**	**$(27,548,899)**	**$954,081**
Irr GS Acreage Conversion		51,016	42,513		$923,390
Overall Difference			**(55,875)**		**$30,691**

Conclusions

- The dairy industry in the region continues to grow.
- Conversion of corn silage to sorghum silage has the potential to save water and reduce costs for dairies.
- Crop Alternatives should be further evaluated to save water.

Future Research

- Capacity of the region to support CAFOs with projected water levels.
- Shift from grain production to silage.

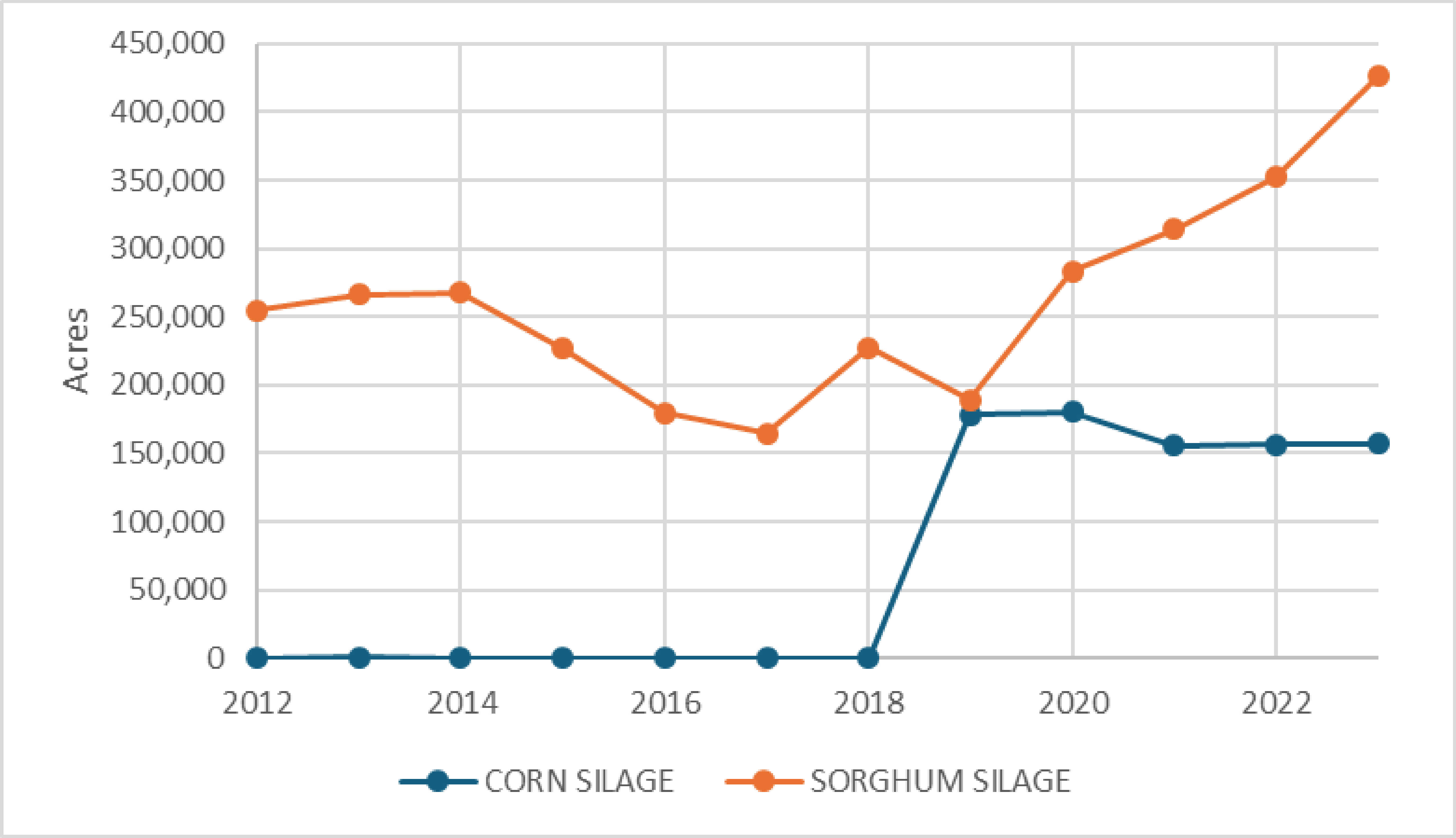
Acknowledgements

Ogallala Aquifer Program

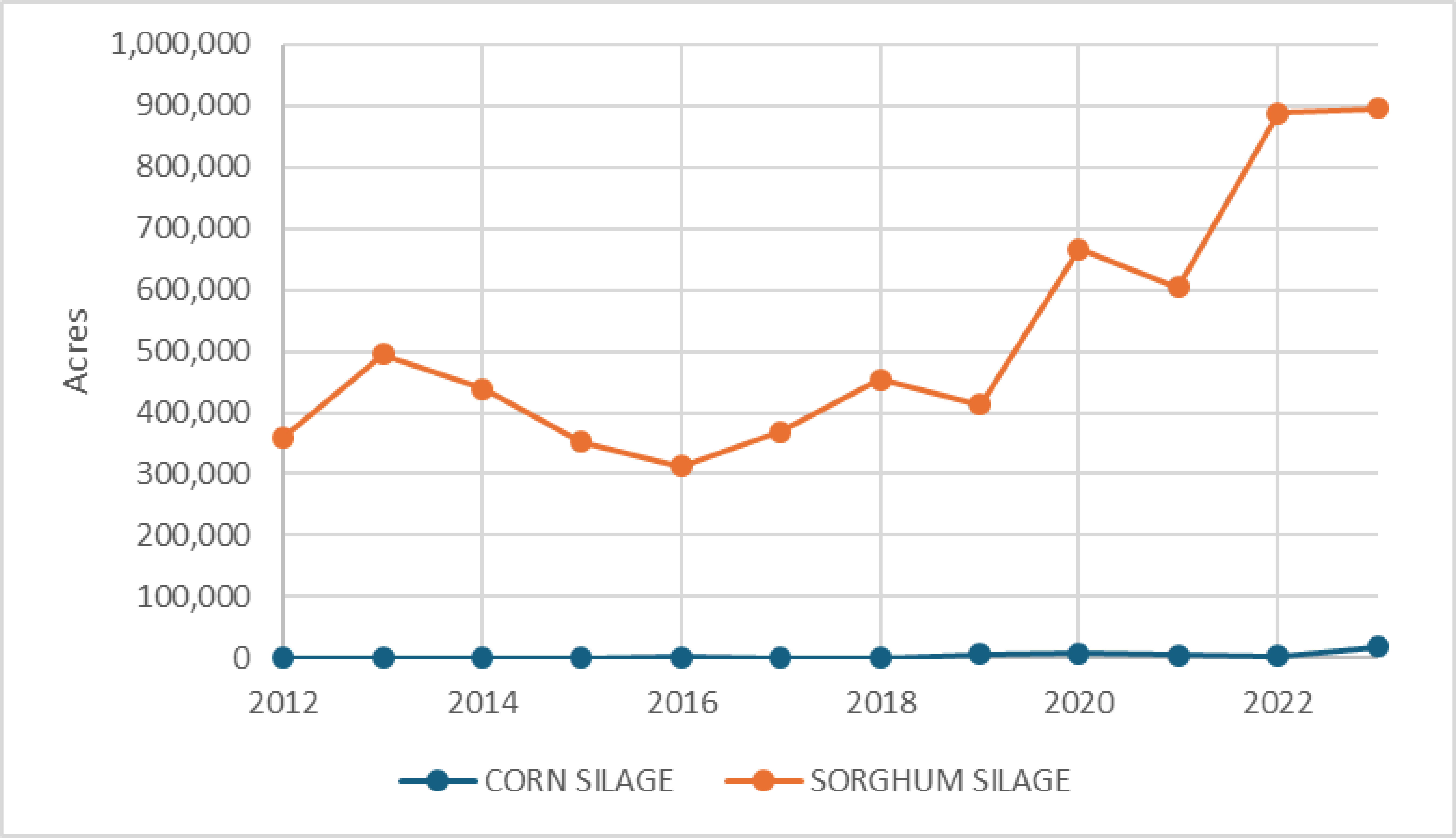
Questions?

THANK YOU!

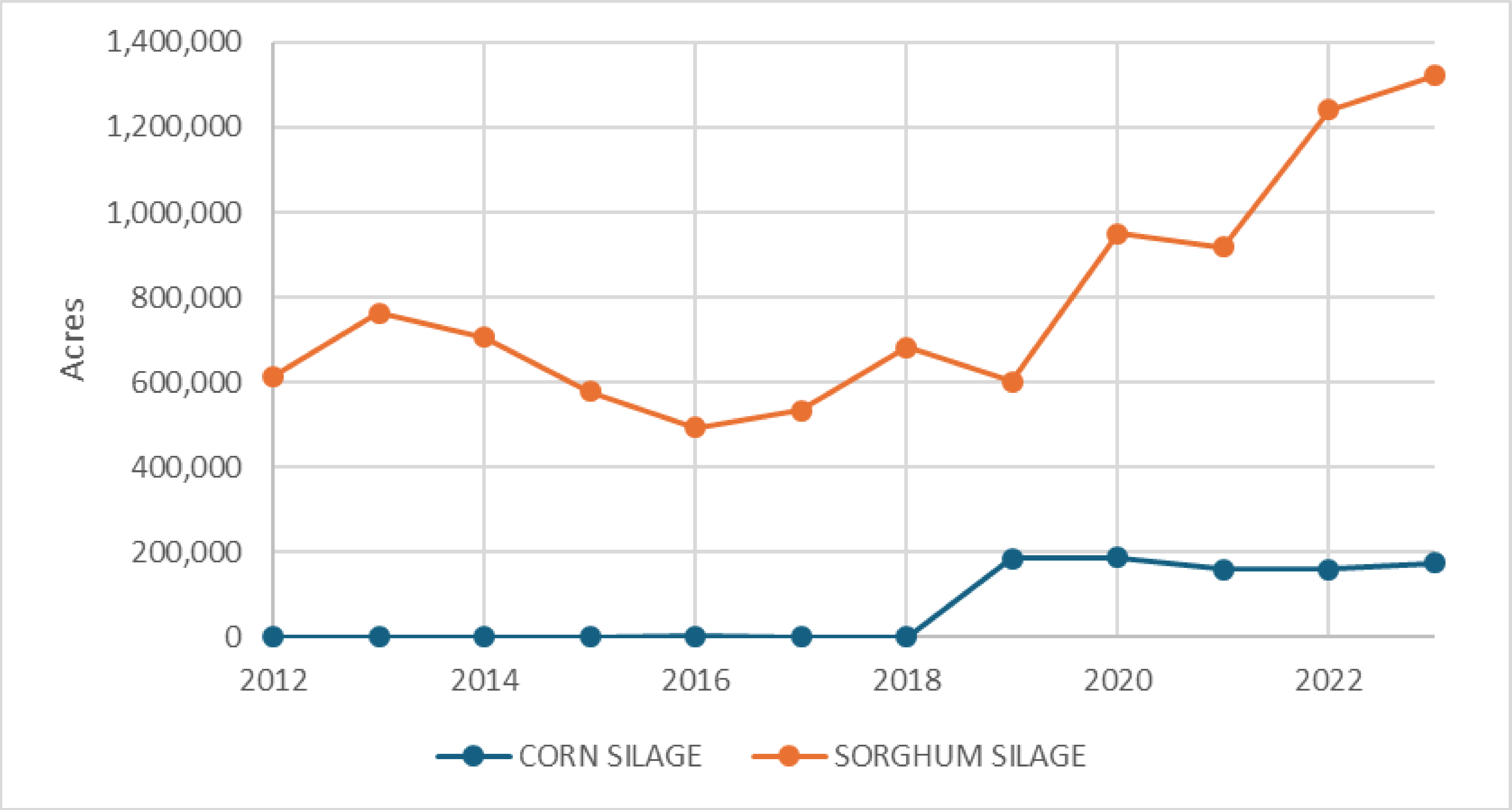
Irrigated Acres



Non-Irrigated Acres



Total Acres



1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Acres
2012
2014
2016
2018
2020
2022
CORN SILAGE
SORGHUM SILAGE