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Home on the Market Range: an evaluation of cultural and economic barriers to large-scale bison farming

Skylar Peyton
College of Saint Benedict/Saint John's University, SMPEYTON@CSBSJU.EDU

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an evaluation of cultural and economic barriers to large-scale bison farming

An All College Thesis

College of Saint Benedict/ St. John's University

In Partial Fulfillment of the Requirement for All College Honors

By: Skylar Peyton

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Abstract

Give me a home where the buffalo roam maybe a catchy tune from the 1800s, but it no longer represents the landscape of the American Midwest. As large-scale corporate farms invade the prairie with row crops and cattle yards, they are chasing away family practices as well as the antelope. Could bison, the original red meat, be a successful meat alternative? The argument that bison would be preferable to beef is based upon four premises: bison are better for the environment, healthier for human consumption, easier to manage, and similar in land needs. Based on these four premises, bison appears to be a positive choice yet there are few operations. This paper evaluates the cultural and economic barriers present in this industry. Through four site visits and numerous phone interviews, analysis reveals agriculture to be an unforgiving, risky, and unstable market. With farms going out of business and the market moving towards industrialization, families are walking a fine line between profit and failure which makes the initial leap to a new industry difficult. This could be mitigated with financial assurance or assistance such as a carbon cap-and-trade and programs working to improve niche markets.

Introduction

Beef: it's what's for dinner, but also a potential disaster. Producing almost 25.2 billion pounds of beef with an annual impact of 67 billion dollars and 3.6 billion kg of methane, the United States' cattle industry is one of the largest sectors of agriculture.[1] The consequences of corporate farming include high greenhouse gas emissions, destructive land practices, and a diminishing number of family farms. With looming threats of a quickly changing climate and more mouths to feed than ever, learning how to work with nature while keeping small operations profitable is vital. Bison seem to be a potential replacement to beef as the staple in meat production, but there are barriers both in the cultural context and the economic market. Although bison are profitable and offer numerous environmental benefits, the current transition from family-based to corporate farming makes a large-scale livestock change difficult without financial assurance or assistance.

[1] "Beef Industry Statistics," Beef USA, 2017, accessed September 10, 2017. http://www.beefusa.org/beefindustrystatistics.aspx; Jan Broucek, "Production of Methane Emissions from Ruminant Husbandry: A Review," *Journal of Environmental Protection* 05, no. 15 (2014).

Drive through the states of Iowa, Nebraska, and Kansas and look around. There are amber waves of grain, but not in the type mentioned in America the Beautiful. The prairie, the muse of that song lyric, has been all but eradicated by the handprint of corporate farms. Replaced by a heavily fertilized monoculture of corn that is used to feed the cattle industry, a total of 4% of farms now produce 66% of the food we eat.[2] This carbon-intensive process is compounded by the natural production of approximately 116 kg of methane per cow per year, making the beef industry a top greenhouse gas emitter.[3] However, the problem does not end with environmental consequences. Farmers across the nation are struggling as the demand for their products decrease (Figure 1).[4] Every year the number of farms get smaller while industrialization and factory-level farming increases.[5] The cost of machinery, slim profit margins, and control by the market creates an environment that is resistant to change yet desperately needs it. This, then, is the issue: the need for a more holistic, environmentally friendly source of meat must be balanced with a genuine consideration and concern for the farmer's livelihood and culture.

[2] Jay Bodner, interview by Skylar PeytonMar 20, 2017, Director of Natural Resources, Montana Stock-Growers Association; Michael Klamm, interview by Skylar PeytonMarch 23, 2017, Cattle on Feed expert at the U.S. Department of Agriculture; Roland Kroos, interview by Skylar PeytonMarch 29, 2017, Holistic Consultant and Vice President of the Montana Bison Association; Johnny Roe and John Roe, interview by Skylar PeytonMar 22, 2017, Farm and Feedlot Farmers in Eastern Nebraska; Tom Vilsack and Cynthia C.F Clark, "2012 Census of Agriculture: United States Summary and State Data," in *Geographic Area Series*(May 2014).

[3] Broucek, "Production of Methane Emissions from Ruminant Husbandry: A Review."; Karen Soeters and Gertjan Zwanikken, "Meat the Truth,"(Amsterdam: Alalena Production, 2008). Christopher Hyner, "A Leading Cause of Everything: One Industry That Is Destroying Our Planet and Our Ability to Thrive on It," *Stanford Environmental Law Journal* (2017).

[4] The Wall Street Journal, "Shifting Appetites: Change in the U.S. Consumption of Beef, Chicken, Pork & Seafood | Scatter Chart Made by Dreamshot | Plotly," in *plot.ly*(Dreamshot, 2017). "Per Capita Consumption of Poultry and Livestock, 1965 to Estimated 2018, in Pounds - the National Chicken Council," ed. United States Department of Agriculture(2017).

[5] National Agricultural Statistics Service, "Farms and Land in Farms 2016 Summary,"(United States Department of Agriculture, February 2017).

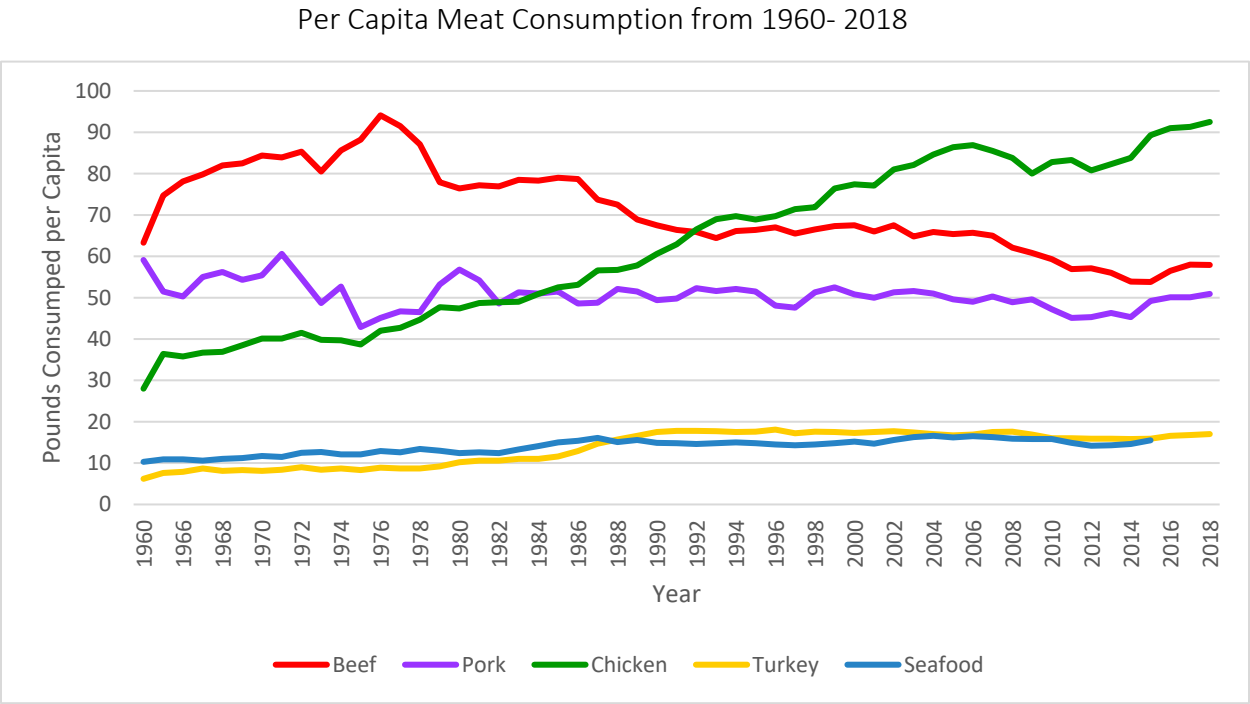

Figure 1. The changes in per capita meat consumption from 1960 until 2018. Beef production has been declining since 1975 as products like chicken increased. 2017was estimated and 2018 was projected levels of consumption. Seafood data was not available from 2016-2018. Bison data was not available. (Data adapted from Wall Street Journal "Shifting Appetites", 2017; USDA "Per Capita Consumption", 2017. Map was made by the author. See footnote 4 for full citations).

An answer may lie inside another classic American tune: *Give me a home where the buffalo roam; where the deer and the antelope play.* North American Bison (*Bison bison*) have been hunted for food as long as this continent has been inhabited. Plains Native Americans like the Sioux and Pawnee tribes followed herds of up to 30 million across the Midwest as they grazed.[6] After colonization and during the Western expansion of Manifest Destiny, bison were hunted almost to extinction. In more recent history, bison have made a slow rise out of endangerment through protection and conservation.[7] However, they have not made their way into mainstream American supermarkets and diets.

[6] "American Buffalo (Bison)," Wildlife Species Information, 1998, accessed March 19, 2017. https://www.fws.gov/species/species_accounts/bio_buff.html; W. T. Hornaday, *Map Illustrating the Extermination of the American Bison*(Julius Bien & Co. Lith., 1889). "Bison by the Numbers: Data and Statistics," ed. National Bison Association(2017).

[7] W. T. Hornaday, *Map Illustrating the Extermination of the American Bison*(Julius Bien & Co. Lith., 1889).

Besides their historical importance, there are four presumptive advantages to raising bison: (1) they are healthier for human consumption, (2) they have a smaller negative impact on the environment, (3) they are easier to manage, and (4) they require similar land capacity. If these four premises are true, bison may just be the answer to the previously stated environmental, cultural, and economic problem. However, even with these benefits, there are only 2,500 bison producers in the United States, with Turner Ranches accounting for 30% of all agricultural bison.[8] Many of these ranchers[9] claim that they could be raising two times their current herd size and still have more demand than supply, so it does not appear to be a market saturation issue.[10] This, again, begs the question why there are so few bison producers. Before answering, it is important to examine the before mentioned premises. Then culture and economics will be explored to find potential barriers to increase bison production. Finally, solutions will be offered for the impediments that currently prevent expansion of bison production.

The Four Premises

Claim 1: Bison are better for human consumption.

"Beef. It's what's for dinner!"
The Beef Industry Council
"We've Got the Meat."
Arby's
"Where's the Beef?"
Wendy's

[8] "Bison by the Numbers: Data and Statistics."; "Turner Ranches," 2017, accessed September 9, 2017. http://www.tedturner.com/turner-ranches/.
[9] For the use of this paper, "Ranchers" are individuals who raise livestock on large acreage while "Farmers" are individuals who grow row crops or follow corporate styles of farming i.e. feedlots.
[10] Moritz Epsy, interview by Skylar PeytonSeptember 29, 2017, Mortiz Epsy is the ranch manager for 777 Bison ranch in Western South Dakota; Dave Hutchinson, interview by Skylar PeytonSeptember 15, 2017, Owner and Rancher of Perfect 10 Bison and Hutchinson Family Organics; Dan O'Brien, interview by Skylar PeytonMar 17, 2017, Wild Idea Bison Ranch; Kristine Hansen, "Buffalo Meat Makes a Million," *CNN Money* Mar 13, 2012; Josephine Marcotty and Dave Hage, "Can We Save Bison by Eating Them?," *Star Tribune* Feb 28, 2015; Kelsey Blackwell, "Are Bison the Answer to Sustainable Meat?," *Health and Nutrition Research* (Jul 19, 2011).

Beef has continually been one of the most popular American dinners, but time has changed the style of consumption. Instead of steak and potatoes, a majority of beef now comes on a bun with fries.[11] McDonalds, the number one buyer of beef in the United States, now serves an average of 50 million customers a day.[12] Unsurprisingly with that many Big Macs finding their way into the bellies of consumers, health concerns have risen drastically.

Estimates for beef consumption in the U.S. range from 50-70 lbs per person per year, which is double most other industrialized countries.[13] High red meat consumption has been linked to an increase in cardiovascular disease, diabetes, hypertension, renal failure, and strokes.[14] Perhaps more importantly, red meat consumption has been directly correlated to cancers of the prostate, breast, and pancreatic regions.[15] New studies have shown that eating too much meat lowers life expectancy.[16] Along with cancer and mortality rates, meat is linked to the obesity crisis in the US. The CDC states that at least a third of the adult American population is obese, and that 67% are obese or overweight.[17] While lack of

[11] "The Efficient Steer: Fast, Fat, and Cheap," in *The Shadows of Consumption*, ed. Peter Dauvergne, *Consequences for the Global Environment* (MIT Press, 2008).
[12] Ibid.
[13]Blackwell, "Are Bison the Answer."; A. Wolk, "Potential Health Hazards of Eating Red Meat," *J Intern Med* 281, no. 2 (2017); "Beef Industry Statistics,"
[14] Blackwell, "Are Bison the Answer to Sustainable Meat?."; Gerald W. Deas, "To Beef or Not to Beef…Health Is the Question," *New York Amsterdam News* 102, no. 17 (2011); Marla B. Royne, Marian Levy, and Jennifer Martinez, "The Public Health Implications of Consumers' Environmental Concern and Their Willingness to Pay for an Eco-Friendly Product," *The Journal of Consumer Affairs* 45, no. 2 (2011);
[15] Blackwell, "Are Bison the Answer."; Gerald W. Deas, "To Beef or Not to Beef…Health Is the Question," *New York Amsterdam News* 102, no. 17 (2011); A. Pan et al., "Red Meat Consumption and Mortality: Results from 2 Prospective Cohort Studies," *Arch Intern Med* 172, no. 7 (2012); Marla B. Royne, Marian Levy, and Jennifer Martinez, "The Public Health Implications of Consumers' Environmental Concern and Their Willingness to Pay for an Eco-Friendly Product," *The Journal of Consumer Affairs* 45, no. 2 (2011); Rashmi Sinha et al., "Meat Intake and Mortality: A Prospective Study of over Half a Million People," *Archives of internal medicine* 169, no. 6 (2009); Wolk, "Potential Health Hazards of Eating Red Meat."
[16] Pan et al., "Red Meat Consumption and Mortality: Results from 2 Prospective Cohort Studies."; Sinha et al., "Meat Intake and Mortality: A Prospective Study of over Half a Million People."
[17] "The Efficient Steer: Fast, Fat, and Cheap."; "Adult Obesity Facts," ed. Center for Disease Control and Prevention(2017).

exercise and an increase in processed food are two major factors to this, a diet that includes large amounts of high fat, high cholesterol feedlot beef is also a contributor.

Ideally to solve these issues, individuals would simply stop eating beef. However, it would be very difficult, if not impossible, to convince Americans to give up their hamburgers and steaks so a better, healthier alternative is needed. As shown in Table 1, bison may be that choice.[18] Compared to both grass fed and grain-finished beef, grass fed bison meat is lower in cholesterol, fat, and calories, while containing more protein, iron, fatty acids, and omega-3.[19] Furthermore, it is unlikely to be found on an oily, fast food flattop any time soon. Also, because bison are considered exotic or "non-amenable"

Comparison of Nutritional Content of Bison and Beef

Nutrition	Feedlot Beef -Skylark Meats	Feedlot Bison - New Frontier	Grass Fed Beef - Strauss	Grass Fed Bison - Frontiere Natural Meats*
Energy (k cal)	274	169	230	179
Protein (g)	17.65	19.72	16.81	22.32
Fat (g)	22.06	10.56	16.81	9.82
Iron (mg)	1.85	1.9	1.59	6.43
Sodium (mg)	56	39	49	54
Saturdated Fatty Acids (g)	9.12	6.34	7.08	4.46
Cholesterol (mg)	68	39	75	71

Table 1. Nutritional content of feedlot beef, grass fed beef, feedlot bison, grass fed bison from the USDA Food Composition Database. All products were assessed on 100 g of a raw ribeye cut. (Data from the USDA "Food Composition Database" collected on 12/19/2017. Table made by the author. See footnote 18 for full citations.)

*Frontiere Natural Meats is assumed to be grass fed due to commentary on their website. However, this was never explicitly stated and cannot be guaranteed.

[18] Agricultural Research Services, "USDA Food Composition Databases," ed. United States Department of Agriculture(2017); Kim Severson, "As Bison Becomes More Popular, Two Views Emerge on How to Treat Them," *The New York Times*, 20160209 Feb 9 2016.

[19] Blackwell, "Are Bison the Answer."; Marcotty and Hage, "Can We Save Bison by Eating Them?."; Laura Neilson, "Grass-Fed Bison Meat for Conscious Carnivores," *Cool Hunting*, 2012-06-21 June 21, 2012; Shang-Ho Yang and Timothy A. Woods, "Assessing Consumer Willingness to Pay for Ground Bison Given Nutrition Information,"(Southern Agricultural Economics Association Annual Meeting: AgEcon Search, February 2013).

species, they are prohibited by law to be treated with growth hormones.[20] They are also rarely treated with antibiotics.[21] Many view this more natural approacch as a positive health decision.

Claim 2: Bison are easier to manage than beef.

As spoken by long time bison rancher Mortiz Espy, “Well, you ain’t babysitting like you do for cattle… [bison] are still wild.”[22] Raising cattle commercially is a full-time job. The animals demand attention, medication, and care from birth until slaughter. Starting with calving season, farmers need to monitor and assist a heifer giving birth. Issues with weight, genetics, over-feeding, timing, and weather can all lead to challenging birthing conditions.[23] Farmers mark their cattle 60 or so days before birth so they have an idea which heifers will need the most help. Even so, cattle farmers can experience between 5-7% death loss every year.[24] During calving season, commercial cattle are completely fed by the farmer. Once complete, it is time to move the cattle to pasture where fly-reduction programs and antibiotic schemes are followed to ensure health.[25] Come fall, heifers are rebred with bulls or by Artificial Insemination (AI), which can be a long, arduous process.[26] Mothers are separated from their calves, many of which are then shipped either to auction or by direct contract to a feedlot. Then the calf-cow process begins again. Feedlot farmers, after buying and shipping cattle, immediately push with grain

[20] "Bison by the Numbers: Data and Statistics." Food and Drug Administration, "Farm Animal Welfare: An Assessment of Product Labeling Claims, Industry Quality Assurance Guidelines, and Third Party Certification Standards," in *A Farm Sanctuary Report*(Department of Health and Human Services, 2005).
[21]Neilson, "Grass-Fed Bison Meat for Conscious Carnivores."; Marcotty and Hage, "Can We Save Bison by Eating Them?."; "Bison by the Numbers: Data and Statistics."; Blackwell, "Are Bison the Answer."
[22] Moritz Espy, March 29, 2017, Ranch Manager of 777 bison farms.
[23]"Raising Cattle for Beef Production & Beef Safety," Explore Beef, 2017, accessed March 26, 2017. http://www.explorebeef.org/raisingbeef.aspx; JR Jaeger, GJ Pirelli, and DW Weber, "Beef Cow-Calf Management Guide,"(Oregon State University, 2003); Tom R Troxel and Kenny Simon, "Best Management Practices for Small Beef Cow-Calf Herds,"(Division of Agriculture- University of Arkansas); "Beef Production Calendar," 2017, http://beef.unl.edu/beefprodcal.shtml.
[24] Veterinary Services, "Mortality of Calves and Cattle on U.S. Beef Cow-Calf Operations," ed. United States Department of Agriculture(Animal and Plant Health Inspection Service, May 2010).
[25] Jaeger, Pirelli, and Weber, "Beef Cow-Calf Management Guide."; "Beef Production Calendar,"
[26] "Beef Production Calendar," ; Jaeger, Pirelli, and Weber, "Beef Cow-Calf Management Guide."; Steve Sutera, interview by Skylar PeytonSeptember 16, 2017, Eastern South Dakota Small Calf Cow Farmer, Former South Dakota Extension Agent.

(and grain products), enzymes, and growth additives, and they prepare for diseases with antibiotics.[27] The lots themselves need to be maintained and cleaned at least once a week. The corn used for feed either needs to be bought or grown, which takes numerous hours and strong bank accounts.[28] This all adds up to 14 hour workdays and multi-million-dollar budgets. As John Roe, a feed lot farmer, said "it's an expensive, lifelong gamble."[29]

In the words of one producer, bison are "stupidly simple… You build a fence, manage your grass, and let bison be bison."[30] They require a hands-off management style and can be kept in a single herd, with the only major labor costs occurring during sorting and slaughter days. Bison cows cannot and will not be helped with calving. They understand what they are doing and are incredibly dangerous if a rancher does try to help. "I know it might sound crass, but the best thing you can give a bison in trouble is a bullet."[31] Epsy of 777 Bison Ranch is not alone, since many bison websites, producers, and associations often advertise calving season as the perfect time to take vacation.[32] Beyond the minimal labor involved in calving, rates of death loss are often between 1-3%.[33] Some, like Nebraska bison rancher Dave Hutchinson who in 40 years has never lost a calf, would argue that it is even lower.[34]

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[27] "Beef Production Calendar," ; "Basic Beef Production Guidelines (Beef Cattle)," 2017, accessed March 26, 2017. http://extension.psu.edu/animals/beef/production/articles/basic-beef-production-guidelines.

[28] "Modern Beef Production: Fact Sheet," ed. Cattlemen's Beef Board and National Cattlemen's Beef Association(Explore Beef, 2009); "Raising Cattle for Beef Production," ; "The Beef Lifecycle: From Farm to Fork," last modified 2014-08-27, August 27, 2014, accessed March 26, 2017. https://factsaboutbeef.com/2014/08/27/the-beef-lifecycle-from-farm-to-fork/; "Basic Beef Production Guidelines (Beef Cattle)," ; Lee I. Chiba, "Beef Cattle Nutrition and Feeding," *Animal Nutrition Handbook* (2014); "Beef Production Calendar," ; "Commodities: Latest Corn Price," (Nasdaq, 2017).

[29] Roe and Roe.

[30] Hutchinson.

[31] Espy; O'Brien; Kroos; Jim Matheson, interview by Skylar PeytonMarch 28, 2017, Assistant Director of the National Bison Association.

[32] Espy; O'Brien; Kroos; Matheson.

[33] "Raising Bison: Starting Your Bison Operation," 2017, 2017. https://bisoncentral.com/raising-bison/; Thomas Foulke et al., "Enterprise Budget: Bison Cow-Calf,"(University of Wyoming College of Agriculture, January 2001); Steve Metzger and Vern Anderson, "Commercial Bison Production: Economic Analysis and Budget Projections," *Carrington Area Farm Business Management Program (1993-1996)* (1998).

[34] Hutchinson.

Beyond the hands-off management, bison are adapted to the prairie and will not calve during storms, a trait any beef farmer can tell you is not shared by their cousins.[35]

Bison cannot be fed growth supplements, chemicals given to livestock to increase the number of pounds put on in a day, and can only be given therapeutic antibiotics, which are meant to save the animal's life.[36] Even then, this does not happen often since most ranchers would rather lose one animal than risk the entire herd.[37] This cuts out the entire schedule that many corporate beef farmers follow post-calving. Bison, when managed properly, have the labor cost of moving pastures, but even that can be easy and less time consuming. "They know," says Hutchinson, "that when I open a gate they are headed to a better place."[38] Bison do not need to be corralled, chased, or coerced into moving to the next paddock as long as the management style allows for this kind of rotation. Bison also have a bear-like metabolism that drops by 30% in the winter.[39] This causes the animal to eat less during the winter months, allowing it to remain self-sufficient. Even in remarkably bad years, bison do not need additional feed during the winter months. Their instincts and bodily adaptations allow them to dig through the snow to eat prairie grass.[40] Both Epsy and Hutchinson described using supplemental feed mostly as a mechanism to keep the bison in the right pasture when the compact snow would have allowed the livestock to leave the property.[41] Bison also need no protection from winter storms. They have evolved to tolerate extreme cold and will face storms head on. That way drifts form behind them and they will

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[35] Kroos.
[36] "Bison by the Numbers: Data and Statistics."
[37] Epsy.
[38] Hutchinson.
[39] "Raising Bison: Starting Your Bison Operation," ; Hutchinson; Kroos; R.J. Christopherson, R.J. Hudson, and R.J. Richmond, "Comparative Winter Bioenergetics of American Bison, Yak, Scottish Highland and Hereford Calves," *ACTA Theriologica* 23, no. 2 (1978).
[40] Hutchinson; Christopherson, Hudson, and Richmond, "Comparative Winter Bioenergetics of American Bison, Yak, Scottish Highland and Hereford Calves."; "How Bison Survive Winter in the Northern Great Plains," 2017, accessed September 18, 2017. https://www.worldwildlife.org/stories/how-bison-survive-winter-in-the-northern-great-plains.
[41] Epsy; Hutchinson.

not suffocate.[42] Overall, a bison rancher manages the pasture, checks water sources, maintains fences, and lets them be.

Slaughter is the only real management-heavy time, and this differs between farms. It does take time and energy to sort out the herd, but again ranchers have adapted to this. Some producers, like Dan O'Brien, have become their own packagers so they can shoot the bison from a distance and avoid stressing themselves and the animal.[43] Others use a corral system to transport the animals to the select processing facilities that accept live bison.[44] This is when most injuries happen, and the goal of all slaughters is to ensure the safety of both people and livestock.

Claim 3: Bison are better for the environment.

Bison are the emblem of the Great American Plains. It is hard to imagine the movement of settlers across the Midwest or Manifest Destiny without picturing the spirited and free roaming North American Bison. This is because they evolved on the prairie and have specific adaptations for the ecosystem. Some of these have already been discussed: a lower metabolism, storm tolerance, and hardiness for winter. Yet there are more environmental factors that distinguish bison as an environmental choice.

Greenhouse gases are widely recognized as one of the main cause of climate change. What is not publicized enough is that agriculture, especially corporate-level production, is a large producer of

[42] Hutchinson; "How Bison Survive Winter in the Northern Great Plains,"
[43] O'Brien.
[44] Epsy.

these greenhouse gases (Figure 2).[45] Beef cattle, and all ruminants, produce high levels of methane because of their unique chambered digestive system. Cattle, on average, produce about 116 kg of methane a year.[46] Surprisingly, corn-fed cattle produce about 1% less of enteric, or internal, methane than grass fed since the grain is easier to process, but other factors such as manure and feed production increase the greenhouse gas comparison.[47] Bison, on the other hand, produce only 72 kg. [48] If this is taken into consideration, switching all 66,200,000 beef cattle in the United States to bison would reduce emissions by 2.9 billion kg of methane each year.[49] This would be the equivalent removing 15.5 million cars from the roads. [50]

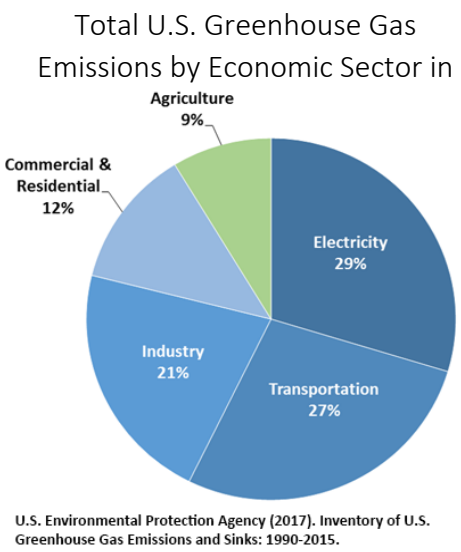

Figure 2. Breakdown of the nation's greenhouse gas emissions by economic category in 2015. (Image from the EPA's website "Sources of Greenhouse Gas Emissions" accessed 11/22/2017. See footnote 45 for full citation.)

Scientists agree that the climate is warming at an alarming rate due to human contributions to these greenhouse gases.[51] Some even say that temperatures could rise as much as 10°F in the Great

[45] Hyner, "A Leading Cause of Everything: One Industry That Is Destroying Our Planet and Our Ability to Thrive on It." Soeters and Zwanikken, "Meat the Truth." "Sources of Greenhouse Gas Emissions," last modified 2018-04-14, 2017, accessed November 22, 2017. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.
[46]"The Ecology of Big Beef: The Shadows of Consumption," ed. Peter Dauvergne, *Consequences for the Global Environment* (MIT Press, 2008); Broucek, "Production of Methane Emissions from Ruminant Husbandry: A Review."; Veerasamy Sejian et al., "Measurement and Prediction of Enteric Methane Emission," *International Journal of Biometeorology* 55, no. 1 (Jan 2011).
[47] Nathan Pelletier, Rich Pirog, and Rebecca Rasmussen, "Comparative Life Cycle Environmental Impacts of Three Beef Production Strategies in the Upper Midwestern United States," *Agricultural Systems* 103, no. 6 (2010).
[48] "The Ecology of Big Beef: The Shadows of Consumption."; Broucek, "Production of Methane Emissions from Ruminant Husbandry: A Review."; Sejian et al., "Measurement and Prediction of Enteric Methane Emission."
[49] "Beef Industry Statistics," ; "Cattle Inventory Vs Human Population by State," September 24, 2017, accessed September 25, 2017. http://beef2live.com/story-cattle-inventory-vs-human-population-state-0-114255; "Quick Stats National Agricultural Statistics Service," 2017, 2017. https://quickstats.nass.usda.gov/#F5F5719A-D65A-307E-8A11-22013E5AE7EF.
[50] "Cattle Inventory Vs Human Population by State," ; "Greenhouse Gas Equivalencies Calculator," ed. Environmental Protection Agency(2018); US Census Bureau, "Population by State," ed. United States Department of Commerce and Labor(2010).
[51]"Scientific Consensus: Earth's Climate Is Warming," *NASA Global Climate Change* (2017).

Plains by the end of the century.[52] No one knows for sure the effects that this warming will have, but it is important to mention some of the current predictions in light of how they may impact this industry. Climate is one of the most important factors of farming. Hotter years bring less rainfall and more damage to ecosystems. A recent estimate said that for every 1.5°F the temperature rises, cattle producers will lose 1 billion dollars.[53] While bison are better adapted for these harsh conditions, recent studies show that they will have similar results.[54] Both cattle and bison will be smaller and less able to hit weights the current markets rely on, which is why finding adaptation and mitigation abilities is vital to our current society.

Bison and the prairie evolved together. Summers can be hot and humid in this ecosystem with few trees for shade so finding a way to cool off is necessary. For many cattle, rivers and streams are the means to this end. Fecal matter and runoff can enter the waterway because of this behavior, spreading disease and contamination downstream.[55] Like cattle, bison release some heat by shedding their winter coats in the spring, but instead of sitting in waterways they take dust baths. This action not only cools the animal, but also helps with flies.[56] They leave behind wallows which fill up with rainwater, providing drinking water and habitat for other species such as tadpoles and birds. Cattle and bison also graze slightly differently, with bison increasing the biodiversity of the prairie lands by eating more quick-growing grasses and less wildflowers and forbs.[57] This does have a biological role, though as many

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[52] Joe Craine, "Climate Change and the Future of Bison," *Climate Change* (blog), November 11, June 2013, https://blog.nature.org/science/2013/06/24/climate-change-bison-cattle-grassland/.
[53] Ibid.
[54] Joseph M. Craine, "Long-Term Climate Sensitivity of Grazer Performance: A Cross-Site Study," *PLOS ONE* 8, no. 6 (2013).
[55] "The Ecology of Big Beef: The Shadows of Consumption."; E. Conroy et al., "The Impact of Cattle Access on Ecological Water Quality in Streams: Examples from Agricultural Catchments within Ireland," *Science of The Total Environment* 547, no. Supplement C (2016); Kroos; Sutera.
[56] O'Brien; Hutchinson; "Basic Facts About Bison," last modified Feb 15, 2012, 2012, accessed March 19, 2017. http://www.defenders.org/bison/basic-facts; Dave Arthun and John L. Holechek, "The North American Bison," *Rangelands* 4, no. 3 (1982).
[57] Conroy et al., "The Impact of Cattle Access on Ecological Water Quality in Streams: Examples from Agricultural Catchments within Ireland."; Glenn E. Plumb and Jerrold L. Dodd, "Foraging Ecology of Bison and Cattle on a Mixed

articles have pointed out a better management style in cattle could increase similar impacts. [58] Finally, bison are keystone species and encourage the natural, holistic ecosystem for a variety of wildlife including 42 species of birds and over 200 others.[59]

Claim 4: Bison are similar in land demand

The big question when discussing livelihood-based bison farming is if it is possible. There are benefits, but if the average cattle farmer could not easily switch to bison and maintain herd size (referred to as 'production levels'), it would not matter. Ignoring the cost factor (which will be addressed later), bison are equal in carcass weights and calving frequency (bred percentage+ death loss) so grazing land must be evaluated.[60] To calculate the land demand for bison and beef, a study area was selected from historical documentation and ecological similarity of the Northern Great American Bison Herd shown in appendix A.[61] These states, North Dakota, South Dakota, Montana, Nebraska, and Wyoming, were all analyzed using the three stages of a commercial beef cows life: calf-cow, weaning, and finishing (feedlot). Data was collected through interviews and government databases to consider whether the average farmer could switch to bison. It was discovered that farms in Wyoming needed the most land at 18 acres per animal, and the lowest was 13 acres per animal in South Dakota. These results were

Prairie: Implications for Natural Area Management," *Ecological Applications* 3, no. 4 (1993); E. Gene Towne, David C. Hartnett, and Robert C. Cochran, "Vegetation Trends in Tallgrass Prairie from Bison and Cattle Grazing," *Ecological Applications* 15, no. 5 (2005).

[58] S Damhoureyeh and D Hartnett, "Effects of Bison and Cattle on Growth, Reproduction, and Abundances of Five Tallgrass Prairie Forbs," *American Journal of Botany* 84, no. 12 (1997); Plumb and Dodd, "Foraging Ecology of Bison and Cattle on a Mixed Prairie: Implications for Natural Area Management."

[59] Alan K. Knapp et al., "The Keystone Role of Bison in North American Tallgrass Prairie
Bison Increase Habitat Heterogeneity and Alter a Broad Array of Plant, Community, and Ecosystem Processes," *BioScience* 49, no. 1 (1999); "Grassland Birds," 2017, accessed September 26, 2017. https://programs.wcs.org/northamerica/wildlife/grassland-birds.aspx; Black-Tailed Prairie Dog," 2017, accessed September 26, 2017. http://www.conservenature.org/learn_about_wildlife/prairie/prairie_dog.htm.;

[60] "Basic Facts About Bison," ; "Raising Bison: Starting Your Bison Operation,"

[61] Hornaday, *Map Illustrating the Extermination of the American Bison*; N.S. Shaler, "Map of North America,"(Kentucky Geological Survey, 1876); National Gap Analysis Program, "Ecological Data Gis,"(2017).

congruent with the assertion of Animal Unit Measurements (AUMs) that claim grazing animals of the same size – which bison and cattle are – need the same amount of land.[62]

Because the regulations, farming styles, climate, and forage are different across the five states, each needed a unique calculation for acreage. To do this for cattle, the lifecycle of a feedlot animal was assessed on a per month basis with the result being the acreage one feedlot animal uses from birth to slaughter. The three stages in a lifecycle were considered for both the land grazed as well as feed produced to create a holistic number for animal acreage. Acreage for grass-fed cattle was not calculated because it was not possible to separate acreage from calf-cow operations and grass-fed operations with the data available. Due to the small number of bison farmers and lack of data on the USDA website, bison acreage was only calculated from interviews. The full calculations for these assessments are shown in appendix B.

[62] Dan Ogle and Brendan Brazee, "Estimating Initial Stocking Rates," in *Technical Note*(USDA- National Resources Conservation Services, June 2009).

Once the calculations were completed, the numbers were compared with current beef production data from the National Agricultural Statistics Service (NASS). By comparing the number of head to the number of operations, an average farm acreage per county was created. This average farm acreage was then transitioned from cattle acreage to bison acreage to see if production levels could be maintained. Results found that 69% of the study area could successfully switch to bison based on the average farm acreage, with the highest success rates in South Dakota (88%), parts of North Dakota (81%) and Montana (62%). These results are shown by Figures 3 and 4.

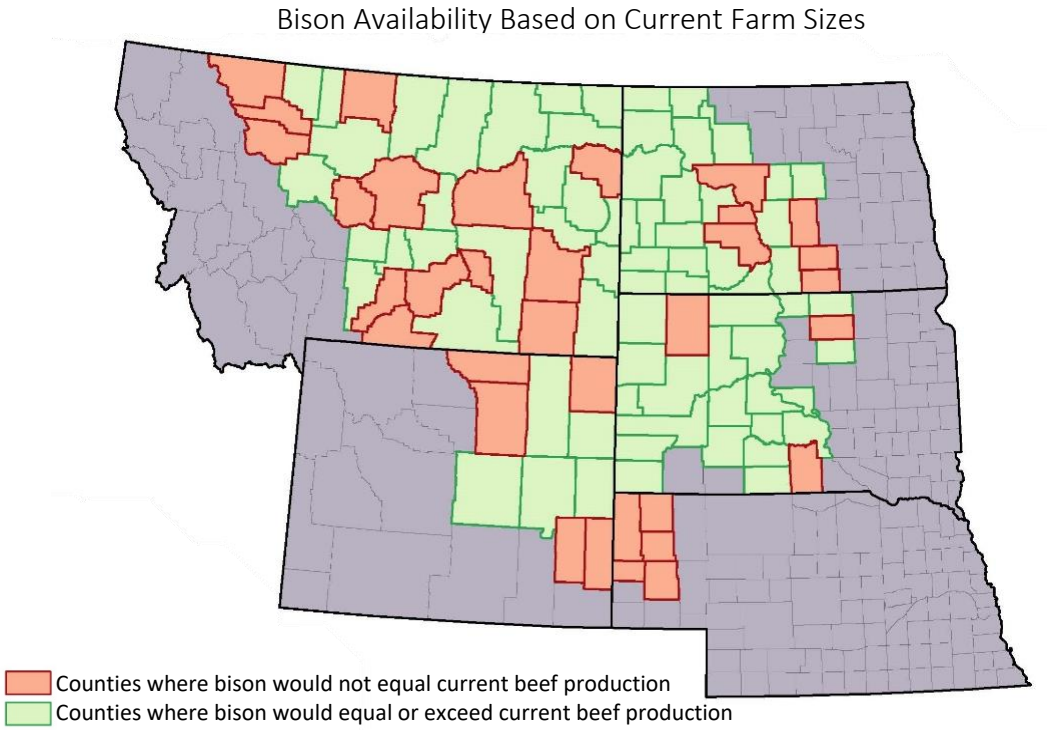

Figure 3. The study area showing the counties that could maintain or increase productivity by switching to bison. The study area was chosen from historical and ecological documents shown in Appendix A. The calculations for this data are shown in Appendix B and then compared to cattle data from the National Agriculture Statistics Service. (Data was collected by the author in the spring of 2017. Map was made by the author in ArcGIS.)

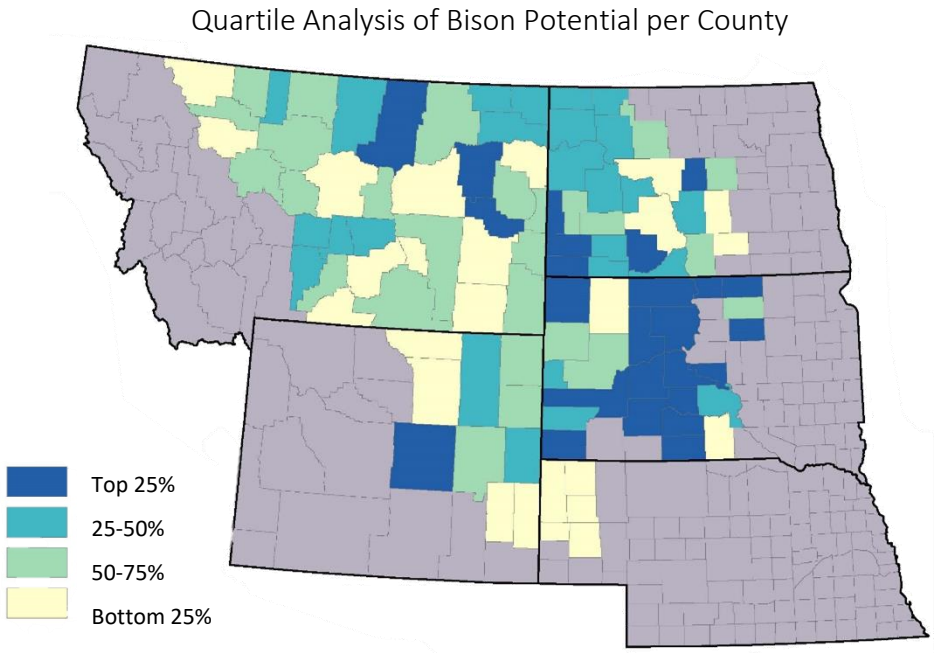

Figure 4. the study area broken up into quantiles based upon positive transition acreage. South Dakota is the most productive, with pockets of productivity in North Dakota and Montana. The study area was chosen from historical and ecological documents shown in Appendix A. The calculations for this data is shown in Appendix B and then compared to cattle data from the National Agriculture Statistics Service. (Data was collected by the author in the spring of 2017. Map was made by the author in ArcGIS.)

If it was possible to switch every acre in the study area over to bison, over an additional half a million head could be added to current production levels. However, as shown in the data, not every average farm could transition to bison without losing some productivity. This is important to note because it is unlikely that a farmer would shift his or her practice to bison if they could not maintain their production levels. Table 2 looks at the NASS census data for number of beef animals and converts them to bison using the previously mentioned calculations. The third column shows the total number of bison that could be in each state if every acre transitioned to bison. Columns four, five, and six only consider the percentage of farms that could transition to bison and maintain production levels ("Positive Transition Rate"). These columns aim to show the potential number of bison per state based upon the assumption that only farmers that could maintain production levels would transition. It is important to reiterate that these are broad estimations and are only meant to show a potential for bison farming in

the Midwest. They cannot account for site-specific management practices, forage, or landscape and should be treated as only approximations.

Estimated Potential Bison Numbers from Cattle Acreage

State	Current Number of Beef Animals	Current Acreage Used by Beef Animals	Number of Potential Bison from Cattle Acreage	Positive Transition Rate (Percentage per State that Could Transition to Bison)	Number of Potential Acres using Positive Transition Rate	Number of Potential Bison using Positive Transition Acreage
Montana	1,994,350	30,230,810	2,015,387	62%	18,743,102	1,249,540
Nebraska	494,400	2,134,519	125,560	0%	0	0
North Dakota	1,166,617	24,941,733	1,385,652	81%	20,202,804	1,122,378
South Dakota	1,523,185	23,758,326	1,979,860	88%	20,907,327	1,742,277
Wyoming	679,897	11,094,488	616,360	50%	5,547,244	308,180
Focus Area	5,858,449	92,159,875	6,122,819	69%	63,590,314	3,349,395

Table 2. Provides an estimate for the potential total number of bison in each state based upon currently used cattle acreage. It also estimates the number of potential bison available if only positive transition acres were considered. (Data was collected by the author and the National Agriculture Statistics Service (NASS) in the spring of 2017. Table was made by the author. See Appendix B and footnote 63 for full citations."

Nebraska was a clear outlier in this study, which is expected since it is one of the top feedlot states.[63] This means that most of the acreage in Nebraska is used for the feedlot stage rather than the calf-cow or weaning stage. Feedlots provide the largest barrier to land feasibility because they produce an inflated carrying capacity. Instead of the cow being put into an environment where the animal moves around, eats what is available, and contributes to other facets of the ecosystem, feedlots make the animal sedentary and move all necessities to them, increasing the efficiency. Figure 5 shows the

[63] National Agricultural Statistics Service, "Cattle on Feed February Report,"(U.S. Department of Agriculture, Feb 24, 2017).

correlation between high feedlot counties and the inability to successfully transition to bison. Besides the environmental degradation involved in these feedlot-finishing acres, there are also increased health risks, higher labor cost, and a large push for industrialization associated with this practice.[64] Nevertheless, finishing beef in this state increases the amount of meat on an animal and decrease the time needed to be on feed. Cattle that are finished in a feedlot typically are ready for slaughter 6 months to a year before a grass-fed bison would be.[65]

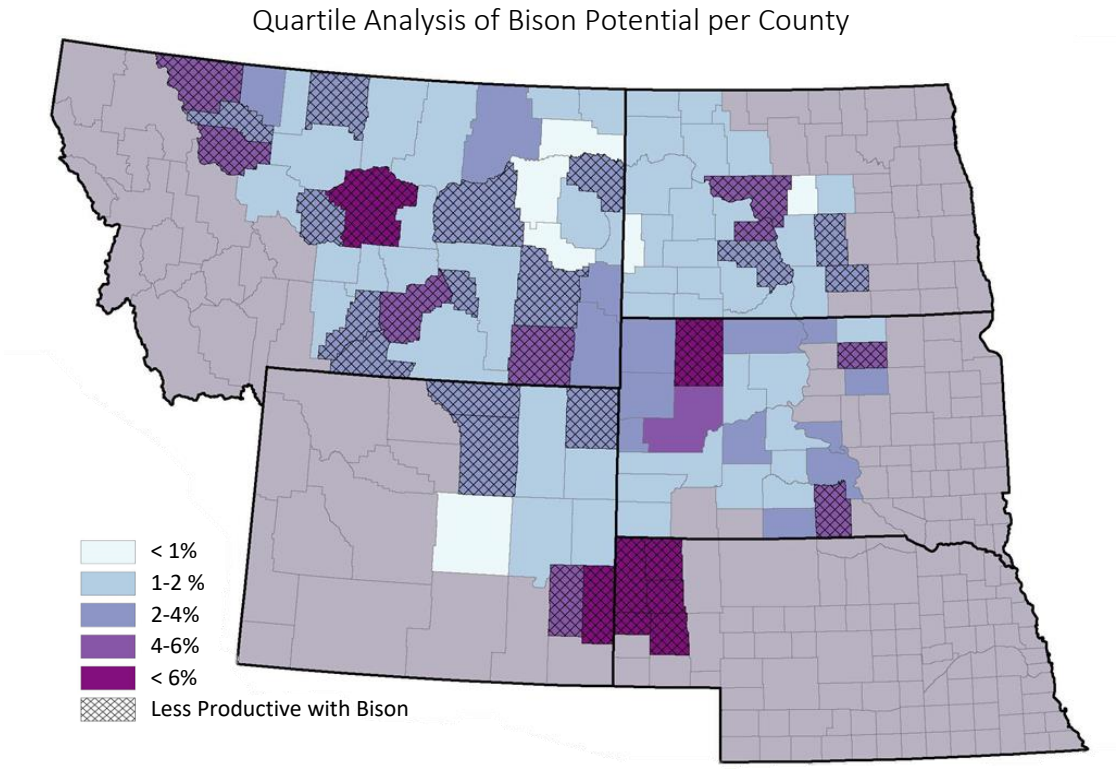

Figure 5. The study area broken into percentages based on number of feedlot farms. The crosshatch counties are those shown in red in Figure 3, which means they are the counties that would lose productivity with bison. This shows the correlation between feedlots and inability to transition to bison. The average acreage used by feedlots per county is between 2-4% so any county higher than that would have an increased feedlot acreage use. (Data was collected by the author and the NASS in the spring of 2017. See appendix B for full citations. Area was decided by Hornaday 1889, N.S. Shaler, 1876, and the USGS Eco-Region guide. See appendix A for full citations. The map was made by the author in ArcGIS.)

[64] C. B. Gilbertson et al., "Runoff, Solid Wastes, and Nitrate Movement on Beef Feedlots," *Journal (Water Pollution Control Federation)* 43, no. 3 (1971); J. T. Vasconcelos et al., "Review: Feeding Nitrogen and Phosphorus in Beef Cattle Feedlot Production to Mitigate Environmental Impacts," *The Professional Animal Scientist* 23, no. 1; Lisa MB Harrington and Max Lu, "Beef Feedlots in Southwestern Kansas: Local Change, Perceptions, and the Global Change Context," *Global Environmental Change* 12, no. 4 (2002).

[65] O'Brien; Espy; Hutchinson; Klamm; Kroos; Stan Boltz, interview by Skylar PeytonMarch 28, 2017, State Range Management and Drought Specialist, Natural Resource Conservation Service; "Beef Industry Statistics," ; "Raising Cattle for Beef Production & Beef Safety,"

Because of the acreage efficiency possible by feedlot practices, it is not feasible to consider bison as similar in productivity. However, the segregated aspects of the current agricultural system points to a potential domino effect: if there were an increase in bison farming, there would inherently be a decrease in feedlot number. Fewer calf-cow operations, specifically those on prairie land which has the most potential to switch, means fewer cattle to send to the feedlots. If more producers switched to bison, the previously used feedlot land would also be available to allow even more farms to switch to bison in a positive feedback cycle. These new lands that have typically been feedlot operations would then be able to raise bison or other crops, balancing out the time deficiency mentioned above. For more information, refer to the previously completed project "Home on the Market Range: A Land Feasibility Study for Large-Scale Bison Farming."

Finally, there are reasons to believe that this study goes beyond the area specifically chosen. Using the National Resource Conservation Service Acreage Predictor, which uses animal units per months or AUMs, grass-fed bison and beef weigh similar amounts, so they have similar AUMs.[66] This means they would need similar acreage. This was confirmed by many of the interviews conducted.[67] Overall, the conclusion is that grass-fed birth-to-slaughter and calf-cow operations could switch to bison while maintaining their herd numbers, but feedlots would need a longer transition period with decreases in farm-specific production levels. This means current production levels should not fluctuate in the Great Plains if farmers decided to switch to bison.

Methods

Bison seem better in terms of environmental impact, health considerations, time management, and feasibility. This leads back to the original question of why are there not more bison farmers? Initial curiosity and research would say that economically it might not be profitable to purchase a herd of

[66] Ogle and Brazee, "Estimating Initial Stocking Rates."
[67] O'Brien; Espy; Hutchinson; Bodner; Klamm; Kroos; Matheson; Boltz; Sutera.

bison, since they are significantly more expensive. Another barrier is that farming culture is incompatible with large-scale changes due to the high risks on investments and strong roots in tradition. This rest of this paper aims to evaluate the cultural aspects of farming as well as look at the economic considerations. To do this, two different sections will follow.

Culture Methods

First is a look into beliefs and systems present in modern day agriculture. To do this, four on-site interviews were conducted in South Dakota and Nebraska during the month of September, 2017. Figure 6 shows the map of where the farms were located. Along with opportunistic questions, there were 12 prepared questions (found in appendix C) that covered potential barriers of risk management, farming style, and family values that were asked during the interview process. Answers were recorded and transcribed, along with notes taken by the author. Pooled together and evaluated, these four interviews provide the basis of the analysis.

Figure 6. Shows the counties where onsite interviews were conducted in September of 2017. (The image was created in ArcGIS by the author.)

Each interviewee provided a unique perspective on the beef and bison industry. Dave Hutchinson from Rose, Nebraska, is both a bison and beef farmer. He lives in the unique ecosystem of the Sandhills in Western Nebraska, and has a large focus on grass-finished, organic products. Hutchinson's farm spans 5,000 acres which housed 200 bison and an undisclosed amount of cattle. Steve Sutera is a conventional beef calf-cow farmer from the Yankton, South Dakota area. Conventional calf-cow farmers have their pasture separated into four distinct areas: summer pasture, winter pasture,

weaning pasture, and calving pasture. Sutera is in business with his brother who lives 7.5 miles down the road and therefore has the smallest herd with only 80 cattle. Sutera is also a retired extension agent of 30 years and was able to provide perspective as both a producer of feed cattle and show cattle, which are bred to be examples of different species. Dan Rasmussen is the last beef farmer from the White River/ Badlands area of South Dakota. Rasmussen's farm has been intact for over 100 years and follows a holistic resource management (HRM) style of intense grazing and long periods of rest. He and his family are very proud of the 1,200 organic, grass-fed animals they produce on their 20,000-acre ranch. Finally, Moritz Epsy is the manager at 777 Bison Ranch in Hermosa, South Dakota. Epsy, like Rasmussen, follows holistic resource management for their 2,000 bison. Being the largest ranch interviewed, the 777 ranch spans 26,000 rolling acres. Both Rasmussen and Epsy focused mostly in calf-cow pairs but did finish some animals.

These four perspectives – conventional calf-cow beef, HRM beef, HRM bison, grass-finished bison/beef – were supplemented by thirteen phone interviews conducted in March of 2017. These interviews provide a secondary source from a wealth of perspectives including feedlot producers, conventional agriculture farmers, holistic resource management consultants, grass finished bison farmers, the vice president of the National Bison Association, extension agents, and others. Along with these, other individuals were contacted for an interview. While the exact numbers were not tracked, approximately twelve beef farmers and two bison farmers declined the invitation to be interviewed. Some beef farmers explained they were not comfortable having a stranger on their property, did not like the environmental focus, were uninterested in being interviewed, or were out of town during the interview dates. For the bison farmers, one was out of town during the interview date and the other had to cancel for medical reasons. This is worth noting since it adds to the cultural lens of these industries.

Finally, it is imperative to discuss the feasibility of this study. Given that this is an undergraduate research project with limited funds and short timeline, the focus of this project has to be on the four site

interviews. This limits the scope to only the livestock industry. While there are many important externalities, including the issues of consumer income inequality, capitalism, and social justice, these cannot be discussed thoroughly given the restrictions. That is not to undermine the importance these matters have in today's society. Furthermore, it is important to stress that this paper uses a very idealistic, simplified model of agriculture. Because it is not possible to calculate every possible situation that may be found in the numerous ranches and farms across the Midwest, this research relies on the data available. While not as accurate as an in-depth study, the goal is to identify barriers that may exist in the industry which further studies could expand upon.

Economic Methods

Money makes the world go 'round, and farming is no different. If a business or company does not make economic sense, there is no industry. Considering a transition to bison without first looking at the economic values, market, and profits would be impossible. To examine the role of viability in the economic sector, a cost comparison between bison and beef calf-cow operators was created.

For the cost analysis, a few things were taken into consideration. First was the type of operation. Calf-cow operations were the most common of those interviewed as well as most prevalent in the study area mentioned in the Four Premises. Calf-cow operations are run similarly in bison and beef, and they arguably have the most potential to switch. Predominately using pastures and supplemental feeding, calf-cow operations are less complicated and more stable than the volatile feedlot industry that relies not only on beef sales, but those of grains as well. Because of these reasons, the comparison was completed between a bison calf-cow operation and a beef calf-cow operation.

To discover barriers in the calf-cow market, two economic budgets were evaluated against one another. Bison costs were obtained from Pennsylvania State Extension Office's Document "Sample Bison

Cow-Calf Breeder Budget (One Cow)".[68] Published in April of 2017, it was the most recent document that contained cost information. The current sale price for yearling bison was obtained from a mean sale price from a December 2016 Auction released by the National Bison Association's Auction Numbers.[69] This market is still considered very new and so variations in price are extreme. The replacement heifer price was from the USDA's Monthly Bison Report.[70]

For the calf-cow beef operation, the costs were gathered from the University of Wisconsin's Calf-Cow Economic Spreadsheet.[71] This document contained data such as type of feed, types of machinery, and opportunity cost that the Bison operation did not have. Because of this, certain values were not added into the calculations which is explained further. Like the bison spreadsheet, this document was released in January of 2017 so it reflects recent values, though with changing markets that does not necessarily mean it is perfect. Because cattle are a staple of the American diet, the weights and prices for calves were found easily in the USDA's Livestock Report.[72] Current sale prices came from the October 25, 2017, closing prices.[73]

This cost analysis looked at four main sectors: replacement heifers, feed costs, variable costs, and fixed costs. The replacement heifer prices were calculated based on the price of animal over its lifetime assuming no injury or death. Feed costs were calculated by the spreadsheets and feed, supplemental feed, and minerals. Variable costs were those that changed every year with different decisions and market factors. These included: health, transportation, marketing, interest, and

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[68] George L Greaser, Melissa Morrow, and Jayson K Harper, "Sample Bison Cow-Calf Budget," ed. Pennsylvania State University Extension(August 2017).
[69] "Trading Board Listings," October 2017, accessed October 25, 2017. https://bisoncentral.com/trading-board-listings/.
[70] Breanna Saso, "September Monthly Bison Report,"(United States Department of Agriculture, Oct 11 2017).
[71] Bill Halfman, Kory Stalsberg, and Ryan Sterry, "UW Extension Cow-Calf Operation Enterprise Budget," ed. University of Wisconsin- Extension(Jan 2017).
[72] National Agricultural Statistics Service, "Livestock Slaughter 2015 Summary,"(U.S. Department of Agriculture, April, 2016); Veterinary Services, "Mortality of Calves and Cattle on U.S. Beef Cow-Calf Operations."
[73] "Latest Feeder Cattle Price & Chart," Oct 25 2017, http://www.nasdaq.com/markets/feeder-cattle.aspx.

miscellaneous costs. Fixed costs are those that can be expected to stay stable year after year. Fixed costs included: breeding, building and facility expenses, machinery costs, and interests including depreciation costs. The costs were calculated by the two University sources and compiled by the author. Time was not considered a variable in the comparison. This was due to the economic comparison being a calf-cow operation rather than a finishing operation like feedlots. Since both bison and beef cattle would only breed once a year, thus producing only one calf, time should be considered insignificant. However, it is estimated that it takes two times as long to finish grass-fed beef or bison as it does grain fed.[74] This should be remembered in future studies or when discussing the economics of finishing operations.

The goal of this section was to evaluate the potential for bison in an economic sense. The generalization of this industry is meant only to illuminate conflicts that may or may not exist in the marketplace. This is a broad oversimplification of an incredibly complex system and is not meant to provide an in-depth analysis. The goal was not to discover something new in the economic field, but to address a key concern of those who may be considering bison. This concern is simply whether the bison industry is profitable. As a disclaimer it should be noted, the cattle industry was at a three-year decline with poor future projections at the time of this study (Figures 7 and 8).[75] The bison industry, on the other hand was facing a continued boom over the past four years that does not seem to be subsiding (Figure 9).[76] These trends should be considered when evaluating the results. Finally, limitations on the resources available due to bison being a relatively new industry and on the author's ability to complete a detailed economic analysis are key factors in this discussion.

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[74]"Raising Cattle for Beef Production & Beef Safety," ; "Beef Industry Statistics," ; "Bison by the Numbers: Data and Statistics."

[75] Chicago Board of Trade, "Live Cattle Prices," *Market Insider* November 23 2017. William Hahn, "Beef and Pork Values and Price Spreads Explained," in *Electronic Outlook Report from the Economic Research Service*(United States Department of Agriculture- Economic Research Service, May 2004); "Meat Price Spreads," 2017, accessed Dec 20, 2017. https://www.ers.usda.gov/data-products/meat-price-spreads/.

[76] "Monthly Bison Report Summary January 2017 Vs December 2016 and Vs Previous Five Years," ed. United States Department of Agriculture(2017).

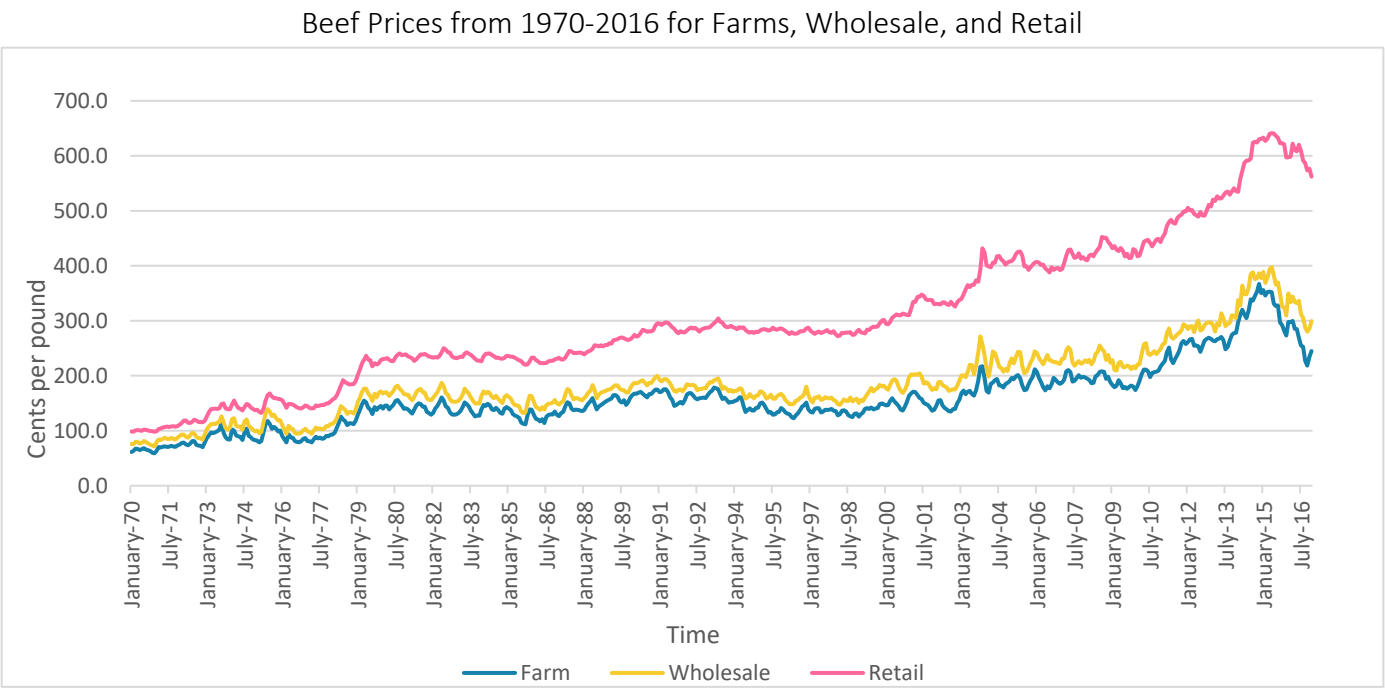

Figure 7. Monthly Changes in price for beef in different sectors of the livestock process from 1970 - 2016. The farm category corresponds with the selling price at auction, wholesale is the price the processing plant receives, and retail is a grocery store price that consumers pay. Retail shows the most drastic change with a major increase in price across all sectors in 2014. (Data from the USDA Economic Research Service "Meat Price Spreads", 2004; "Beef and Pork Values", 2017. The graph was made by the author. See footnote 75 for full citations.)

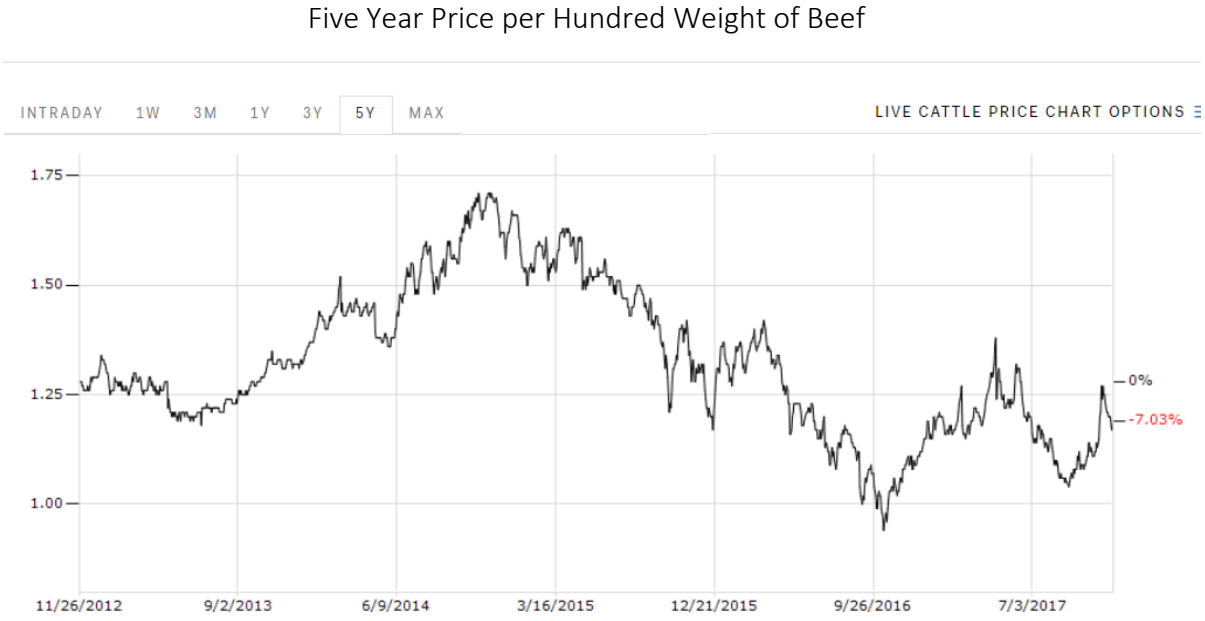

Figure 8. The daily prices per hundred weight of finished beef (live cattle) from November of 2012 until November of 2017. Beef has been declining since 2014. (Image comes from the Chicago Board of Trade "Live Cattle Prices", 2017. See footnote 75 for full citation.)

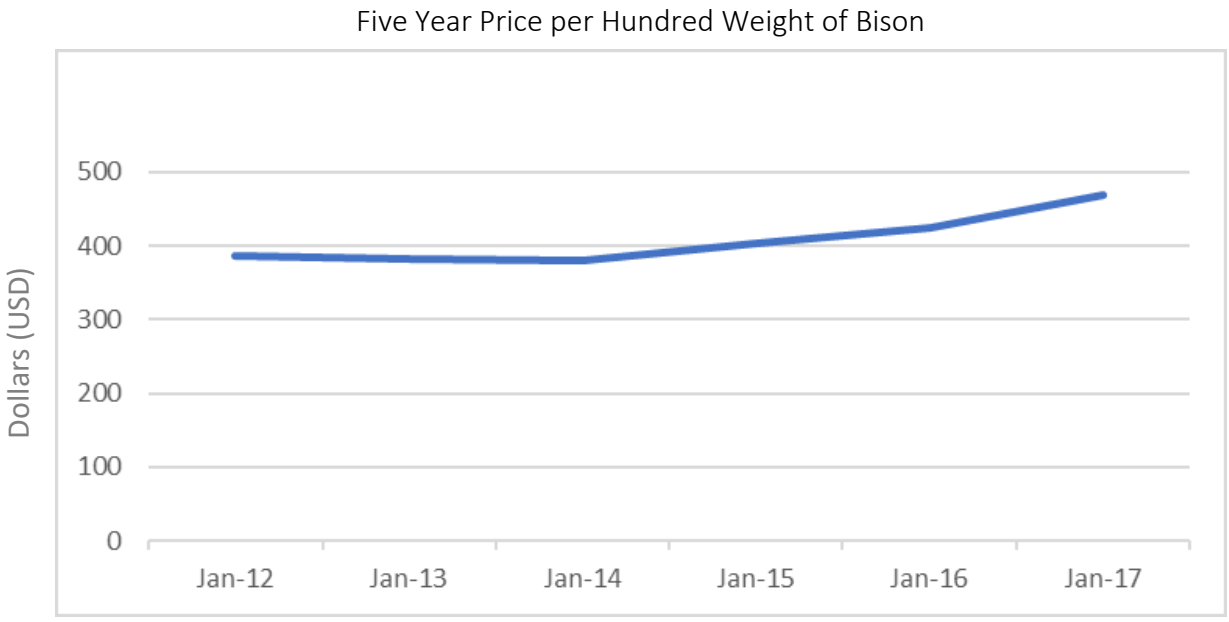

Figure 9. The annual prices per hundred weight of bison from January of 2012 until January of 2017. The data was collected from the five-year analysis released by the USDA, but little information besides values was available. Daily prices were not found, but this graph does show the increase in bison prices from 2012. (Data collected from USDA "Monthly Bison Report", 2017. Graph was made by the author. See footnote 76 for full citation.)

Current Cultural Trends

The formation of what is classified today as a "beef cow" was a long process spanning centuries, continents, and species. Cows, of some kind, exist in artwork from over 30,000 years ago. Cattle restructured the dietary balance of modern humans, and, according to some, affected the colonization of Europe and the New World. [77] Without cattle, present day diets would look drastically different.

Of all these important effects, two of the most profound influences by cattle in the United States have been in landscape and culture. The first group of a cows were brought to the colonies in 1607; however, they were all eaten due to a famine in 1610.[78] In 1620 another shipment arrived, and, less than a decade later, the numbers totaled over 1,500.[79] So began the cultural revolution in the

[77] Denis Hayes and Gail Boyer Hayes, *Cowed: The Hidden Impact of 93 Million Cows on America's Health, Economy, Politics, Culture, and Environment*, First Edition ed.(New York: W.W. Norton & Company, 2015).
[78] Ibid.
[79] Ibid.

United States of pilgrims being conquerors and farmers. From manifest destiny to post-civil war cowboys, cattle and the culture of the U.S. have been deeply integrated.[80] Cattle have also shifted the landscape of the US physically. One of the first tasks for colonists in New England was to clear forests and construct fences to keep the cattle in.[81] This opened the landscape to be grazed which changed the type of grass grown. The rough and repetitive clipping by cattle's teeth discourage the growth of some prominent New World species while paving the way for English grasses to infiltrate.[82] Predators, like the wolf, were also hunted to near extinction to protect these fenced cattle.[83] While the landscape and utility of cattle changed, one theme remained the same: cattle were born, raised, and slaughtered in one area until the early 20th century.[84] This is not true of the industrial system found today.

At the turn of the 1900s, agriculture employed over a third (41%) of all Americans, and IT impacted 7.7% of the GDP by the 1930s.[85] By 2000, less than 2% of the American labor force was employed by agriculture and the GDP impact was less than 1%.[86] As the number of farmers has decreased, the productivity per acre has increased (Figure 10).[87] With the help of irrigation, fertilizer, improved technology, GMO's and other advancements, the same amount of food can be grown in less

[80] Ibid.
[81] William Cronon, *Changes in the Land : Indians, Colonists, and the Ecology of New England*(First edition. New York : Hill and Wang, 1983., 1983).
[82] Ibid.
[83] Ibid.
[84] Hayes and Hayes, *Cowed: The Hidden Impact of 93 Million Cows on America's Health, Economy, Politics, Culture, and Environment*. L.R. Corah, "Development of a Corn-Based Beef Industry," *American Society of Animal Science* (2008).
[85] Carolyn Dimitri, Anne Effland, and Neilson Conklin, "The 20th Century Transformation of U.S. Agriculture and Farm Policy," in *Economic Information*(United States Department of Agriculture, June 2005).
[86] Ibid.
[87] Sun Ling Wang, Richard Nehring, and Roberto Mosheim, "Indices of Farm Output, Input, and Total Factor Productivity for the United States, 1948-2015," in *Agricultural Productivity in the U.S.*, ed. USDA ERS(Oct 2017).

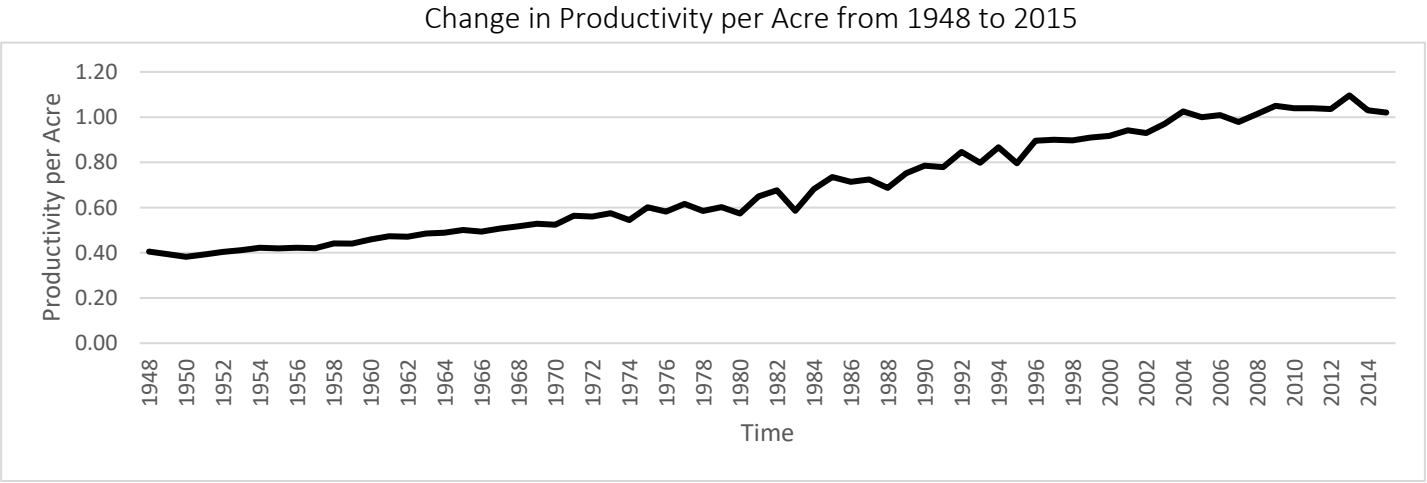

Figure 10. The change in total factor productivity (the ratio of total outputs to total inputs) from 1948-2015. The graph shows that acres in 2015 were over twice as productive as acres in 1948. (Data from the Wang, Nehring, and Mosheim "Indices of Farm Output", 2017. The graph was made by the author. See footnote 87 for a full citation."

than half the space by fewer individuals (Figures 11 and 12).[88] Perhaps most shockingly, in 1930 only 30% farmers worked a second position in a non-agricultural field, while today, that number is 93%.[89]

This agricultural transition, defined by sociologists Linda Lobao and Katherine Meyer as "the abandonment of farming as a household livelihood strategy" is profound in the data as well as the change in social structure.[90] While the goal of their paper was to give an overview on the literature in the field and highlight research gaps, the authors also accentuated the different levels of change found in the current agricultural system. Things such as household inequality, lack of diversity, and a changing production complex have affected the economic, political, and social wellbeing of farming.[91] One of the largest changes has been in the development of a dualistic system. According to the journal, farms now

[88] "U.S. Cropland Is Consolidating into Larger Farms," Farm Size and Organization of U.S. Crop Farming, December 2017, accessed Dec 20, 2017. https://www.ers.usda.gov/amber-waves/2017/december/us-cropland-is-consolidating-into-larger-farms/; "Recent Trends in GE Adoption," Adoption of Genetically Engineered Crops in the U.S., July 2017, accessed Dec 20, 2017. https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx; Elizabeth Bechdol, Allan Gray, and Brent Gloy, "Choices," *Agricultural & Applied Economics Association* (2010). "Farm and Ranch Irrigation Survey," ed. USDA Census of Agriculture Historical Archive(1910-2002).

[89] Dimitri, Effland, and Conklin, "The 20th Century Transformation of U.S. Agriculture and Farm Policy."

[90] Linda Lobao and Katherine Meyer, "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming," *Annual Review of Sociology* 27, no. 1 (2001).

[91] Ibid.

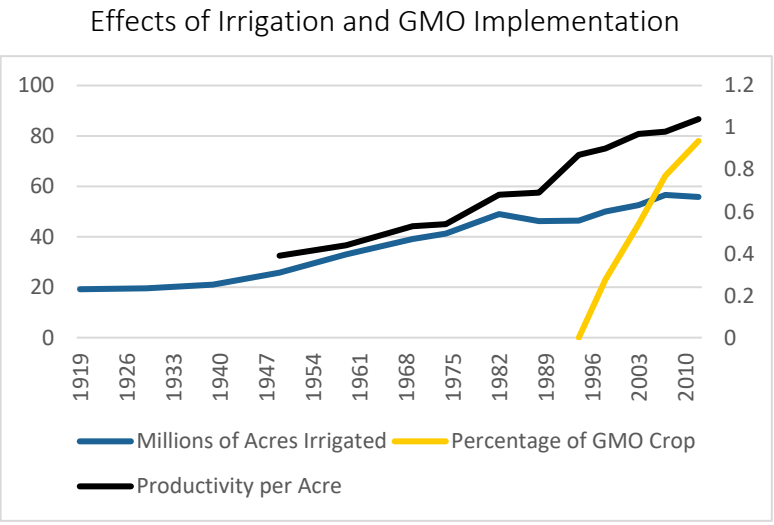

Figure 11. Shows two adaptations that allowed land to become more productive over time. The blue line shows acres (in millions) that were irrigated, and the yellow line shows the average percentage of crops (corn, cotton, and soybeans) that were genetically modified starting in 1996. (Data from the USDA "Recent Trends in GE Adoption", 2017; "Farm and Ranch Irrigation Survey", accessed 2017; and "US Cropland is Consolidating", 2017. Graph was made by the author. See footnote 88 for full citations.

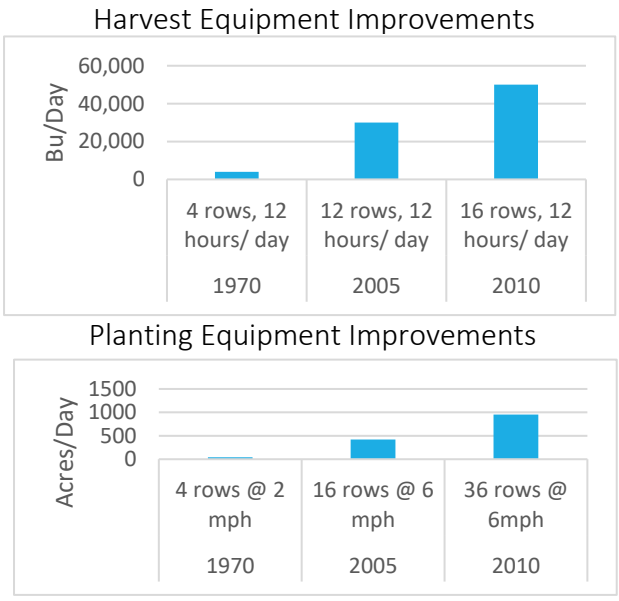

Figure 12 (A&B). Changes in equipment technology and efficiency from 1970-2010. (Data from the USDA "Farm Size and Organization", 2017. Graph made by the author. See footnote 88 for full citations.)

come in two distinct sets: small units unable to support a family and extraordinarily large organizations mostly using hired labor.[92] The later description consists of 3.6% of current farms in the US but amasses over 50% of the sales nationally.[93] Essentially this means that over 96% of farms cannot sustain the average family.

These 96% of farms are in competition for the other 50% of the nation's income. This increases the levels of competition, innovation, and technology. To receive enough to stay afloat, farmers must invest heavily in machinery and fertilizers, switch production into a niche market, or contract to a large

[92] Ibid; Dimitri, Effland, and Conklin, "The 20th Century Transformation of U.S. Agriculture and Farm Policy."; Thomas A. Lyson and Amy Guptill, "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming," *Rural Sociology* 69, no. 3 (2004).
[93] Lobao and Meyer, "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming."

corporation.[94] All three of these options take away personal freedom, degrade the environment, and eradicate historical farming practices.[95] Contracting to corporations is a relatively new concept only employed by 3% of all farmers, but this practice "produces nearly all poultry, half of all hogs, and a quarter of cattle."[96] While it may not be widespread, this notion is clearly very productive and as markets grow smaller, more and more individuals may look to it as an attempt to save their land.

Three main concerns were brought up as representative of sociological research: decreasing populations, industrialization of farmland, and increasing polarization between small and large farms. [97] While the articles and studies varied, most agree that the overarching influence of these three factors have decreased the quality, livelihoods, and mental health of farmers in the U.S.[98]

According to Lyson and Guptill, the above-mentioned changes in land sizes, number of farms, decreasing profits, mindset of farmers, and overall industrialization have led to a breakdown of agriculture into two distinct groups: commodity agriculture and civic agriculture. [99] The United States is moving towards regionalization, which means that food products are isolated to the area in which they grow the best and are combined in a national and global market.[100] Essentially, the food grown in one part of the country does not end up on the family tables in that area but goes to a processing plant or larger corporation to be shipped. This has created economic, social, and culinary gaps in the food system.

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[94] Ibid; "Industrial Agriculture: The Outdated, Unsustainable System That Dominates U.S. Food Production," Food and Agriculture, 2017, accessed November 12, 2017. http://www.ucsusa.org/our-work/food-agriculture/our-failing-food-system/industrial-agriculture; "Recent Trends in Ge Adoption,"
[95] Lobao and Meyer, "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming."
[96] Ibid; Hayes and Hayes, *Cowed: The Hidden Impact of 93 Million Cows on America's Health, Economy, Politics, Culture, and Environment*.
[97] Lobao and Meyer, "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming."
[98] Ibid; Walter Goldschmidt, "Large-Scale Farming and the Rural Social Structure," *Rural Sociology* 43, no. 3 (1978).
[99] Lyson and Guptill, "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming."
[100] Ibid.

Commodity agriculture is an essential piece of this industrialized structure. With deep-seeded roots in capitalism and consolidation, it is fueled by new sciences and technologies like GMOs, encouraged mostly by universities and governmental organizations, and works based on standards of productivity and efficiency.[101] Someone who is following this paradigm would specialize in a sector such as grains or beef and typically associate themselves with a larger organization. It permeates so many facets of the industry that "farmers are often reduced to workers whose primary tasks are to follow production procedures… and farms are simply places where production occurs."[102] This style of agriculture takes away freedom of choice from the farmer.

Civic agriculture is the alternative to the commodity approach. It's derived from consumer demands and inefficiencies in the industrialized system capitalizing on local, small niches like farmer's markets, community gardens, and community supported agriculture (CSAs).[103] The goal of this paradigm is to bring local and regional food to the consumer directly, cutting out the middleman and fostering an artisan approach.[104] Direct marketing – when the producer and the consumer meet face to face – is vital to this industry.[105] Arguably this practice is more sustainable and often derives a higher price.

Goldschmidt from 1978 is a commonly reference article in Rural Sociology journals. This is because the study done by Goldschmidt and his team found out that the smaller, more local food systems produced a higher standard of living socially, economically, and politically compared to the industrialized model.[106] He states "'a community surrounded by large-scale farm operations offered the

[101] Ibid.
[102] Ibid.
[103] Ibid; "USDA Census of Agriculture Historical Archive," ed. Albert R. Mann Library - Information Technology Services(2017); "Farmers' Markets and Local Food Systems," June 2007, accessed February 9, 2018. https://crcresearch.org/case-studies/crc-case-studies/farmers-markets-and-local-food-systems.
[104] Lyson and Guptill, "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming."
[105] Ibid.
[106] Walter Goldschmidt, "Large-Scale Farming and the Rural Social Structure," Ibid.43(1978); Lyson and Guptill, "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming."; Lobao and Meyer, "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming."

poorer social environment according to every test made.''[107] The reason this insight continues to play a role in modern discussions is because the agricultural industry is in a time of transition. While the number of civic-based food systems are increasing, commodity-based is as well.[108] These two models are in tension with each other and medium sized practices are either transitioning towards one or disappearing.[109] In looking at future projections, Goldschmidt's findings become even more important. If larger, commodity agriculture becomes the norm for most of these medium-sized operations, it could significantly negatively impact the livelihoods of farmers. However, if the trend continues for civic agriculture to rise, family farmers could see an increase in independence, happiness, and finances. While the future is unknown, it is important that these considerations are brought to light and debated.

Cultural Barriers

Culture is an elusive concept. It is derived from an individual's upbringing, traditions, beliefs, habits, assumptions, and norms.[110] Similar to an accent, culture is often unobserved from the individual's perspective, but very present to an outsider's point of view. Understanding that culture is a palpable, persuasive, and persistent member of the decision-making process, it is vital to evaluate its role when discussing choices in the agricultural community.[111]

With this in mind, these interviews aimed to highlight areas of concern and draw out potential cultural context that would make large-scale change, like bison production, potentially difficult. Some of these areas of concern are the declining population of farmers, the high risk of the enterprise, specificity in management style, and strong traditional or family values. The next portion of this paper will flush out some important quotes and similarities among the interviewees along these lines.

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[107] Goldschmidt, "Large-Scale Farming and the Rural Social Structure."
[108] Thomas A. Lyson and Amy Guptill, "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming," Ibid.69(2004).
[109] Ibid.
[110] "What Is Culture," 2018, accessed March 31, 2018. http://www.asanet.org/topics/culture.
[111] Ibid.

Declining Population and Increased Industrialization

It has been reported multiple times and is considered common knowledge in farm communities that small, family-sized farms are a thing of the past.[112] Sutera, who worked as an extension agent for 30 years, commented on the change: "So the big guys are safe… it's the small guys … who are in trouble."[113] The farmers who are cropping thousands of acres, working directly under a large corporation, and have specific contracts have mitigated some of the financial difficulties found in today's agriculture. This move towards company-control and contracts is the current trajectory of farming, but that is not how agriculture was done in the past. It was common to have small, family farms that were providing a living, not an income.[114] "What was considered a farm in the past would only be considered a hobby today… you'd have to have another income somewhere."[115] This statement from an individual who grew up on a small dairy farm was reinforced by Sutera, "To be competitive, you have to be really big."[116] Figure 13 shows this new trend toward fewer, larger farms.[117]

This transformation towards industrialization is a fear found in many of those who were interviewed. All four of the site-interviews mentioned industrialization with hesitation:

- "Industrialization is hard on the resource."[118]

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[112] National Agricultural Statistics Service, "Farms and Land in Farms 2016 Summary."; "Quick Stats National Agricultural Statistics Service," ; "Land Values 2017 Summary,"(August 2017); Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."; George Wuerthner, "The Truth About Land Use in the United States," *Watersheds Messenger* 9, no. 2 (2002); Verlyn Klinkenborg, "Death of a Farm," *The New York Times*, 20100731 2010; Rebecca Sananes, "As Big Milk Moves in, Family-Owned U.S. Dairy Farms Rapidly Fold," *National Public Radio* January 11, 2017.

[113] Sutera.

[114] Jane Doe, interview by Skylar PeytonOctober 15, 2017, Jane Doe grew up on a dairy farm during the 1970s but no longer is a part of agriculture; John Doe, interview by Skylar PeytonMar 21, 2017, Feedlot Farmer in South Central South Dakota; Epsy; Hutchinson; Roe and Roe; Sutera; Sananes, "As Big Milk Moves in, Family-Owned U.S. Dairy Farms Rapidly Fold."

[115] Doe.

[116] Sutera.

[117] National Agricultural Statistics Service, "Farms and Land in Farms 2016 Summary." "USDA Census of Agriculture Historical Archive."

[118] Dan Rasmussen, interview by Skylar PeytonSeptember 30, 2017, Dave Rasmussen is the owner of 33 Ranch, an organic, holistically managed calf cow and slaughter farm.

- "… and now we are stuck in a paradigm [of industrialization] that we can't get out of."[119]
- "You know, we don't need industry…. we have agriculture."[120]
- "I really loved it [extension], but it's taking a backseat as farmers rely more on their fertilizer or seed companies… they've lost that one-on-one contact."[121]

Beyond the site interviews, over 60% of the phone interviews mentioned either industrialization or the industrial production paradigm.[122] This is a concern for many because when control moves from the farmer to a company, the ecosystem, family, and product suffers since the decisions are made by foreign management that are not connected with the land. The uncontracted or small farmer is then put in a difficult position where he or she needs to compete against industry, move to a niche market, or adapt to the paradigm.

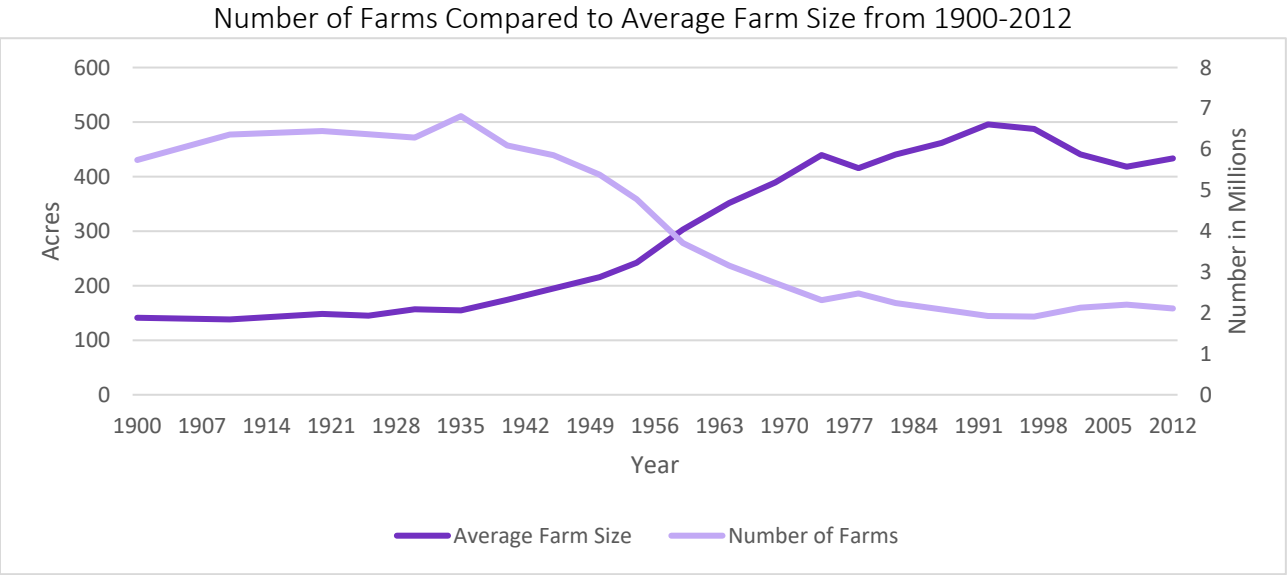

Figure 13. The corresponding increase in farm size and decrease in number of farms from 1900-2012. High expenses, urbanization, increased productivity, and other factors have pushed many farms to sell and consolidate, creating fewer but larger farms. (Data from the USDA Census Historical Archives "Farms and Land in Farms", accessed 2017. The graph was made by the author. See footnote 117 for full citations.)

[119] Epsy.
[120] Hutchinson.
[121] Sutera.
[122] O'Brien; Doe; ; Espy; Kroos; Matheson; Roe and Roe; Boltz.

Along with this, the number of young individuals coming into agriculture is significantly smaller than the aging population that is leaving.[123] This is, again, a common theme acknowledged in the agricultural community. While most remain positive and believe "someone will do it", the decrease in young individuals leads to increase in farm sales, consolidation, and loss of heritage.[124]

> You know, out of the five of us, no one went back… which is why we had to sell the farm. It had been a family farm since my father's family immigrated to this country – three generations – and selling to a urban individual…was the end of it being a true farm. It's a hobby now.

What this means is that as the population declines and farm sales increase, they are moved to either corporate control, hobby farms, or development property. These farmers who are older in age and still function on a small scale are basically like an animal species with only one sex. They cannot reproduce, they cannot grow, so the only option is to live out their life and watch the species go extinct. "Farmers are looking for choices … but industrial farming is killing their options."[125] There are some mitigation practices being implemented where older farmers without an heir will take on an apprentice and train them into the industry and an increase in non-agricultural or individuals who left agriculture returning at an older age.[126] Overall, however, this dispersion of the small farmer minimizes the creativity, options, and style of farming that is practiced and profitable. This means implementing a large-scale change, like bison, would need to be started at a corporate level and work down the supply chain, which is unlikely.

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[123] Epsy; Kroos; Rasmussen; Sutera; Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."; "Beef Industry Statistics," ; Doe; Roe and Roe.
[124] Sutera; Doe; Tesla Mitchell, "Aging Farmers, Fewer Farmers: Trends in Agriculture Bring Sweeping Changes in Winona County, Countrywide," *Winona Daily Mail* Feburary 8, 2015; Sananes, "As Big Milk Moves in, Family-Owned U.S. Dairy Farms Rapidly Fold."; Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."; Correspondents, "If Nc Wants to Feed Itself – and the World – It Needs to Save Its Farms," *The News and Observer* March 24, 2017,.
[125] O'Brien.
[126] Epsy; Kroos; Sutera.

High Financial, Industrial, and Profit Risks

The decrease in young adults and smaller farms is pronounced and widely recognized, but there is a question of why. What is happening in the livestock industry that is turning off young producers? Quite simply, agriculture is a hard life. "I mean yes, I would like to see a bunch of young people get into it, but property costs and realistic return on investment through agriculture is… a tough business."[127] Risks are inherent in every market and every interaction, but when looking at the costs and markets of agricultural risks, it is higher than average. There are so many things that could inhibit initial involvement, stunt growth, and keep change at bay. Not to mention, one bad move could cause a farmer to lose their livelihood. As Epsy explains:

> Everything is risky… the market is controlled by someone who's daily trading a piece of paper. It's highly subsidized and competitive on a global scale. Your company could be used as a bargaining chip someplace for political purposes. Then you have to sign over everything you got… and you could lose it to mother nature, the market, disease. Then you are going to make negative half a percent when it's all said and done, maybe 3%.[128]

Breaking some of those considerations down, one of the first major costs is land. Land costs hundreds to thousands of dollars per acre depending on the use – for crops or for grazing – and the location.[129] Not to mention, these costs are continually increasing as show in Figure 14 and Figure 15. [130] Even in some of the cheapest pasture lands, as shown in Figure 16, the overall capital investment means someone who wants to enter agriculture but has no land could easily be over a million dollars in debt

[127] Epsy.
[128] Ibid.
[129]National Agricultural Statistics Service, "Farms and Land in Farms 2016 Summary."; "Land Values 2017 Summary."; Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."
[130] National Agricultural Statistics Service, "Land Values 2017 Summary."; Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."

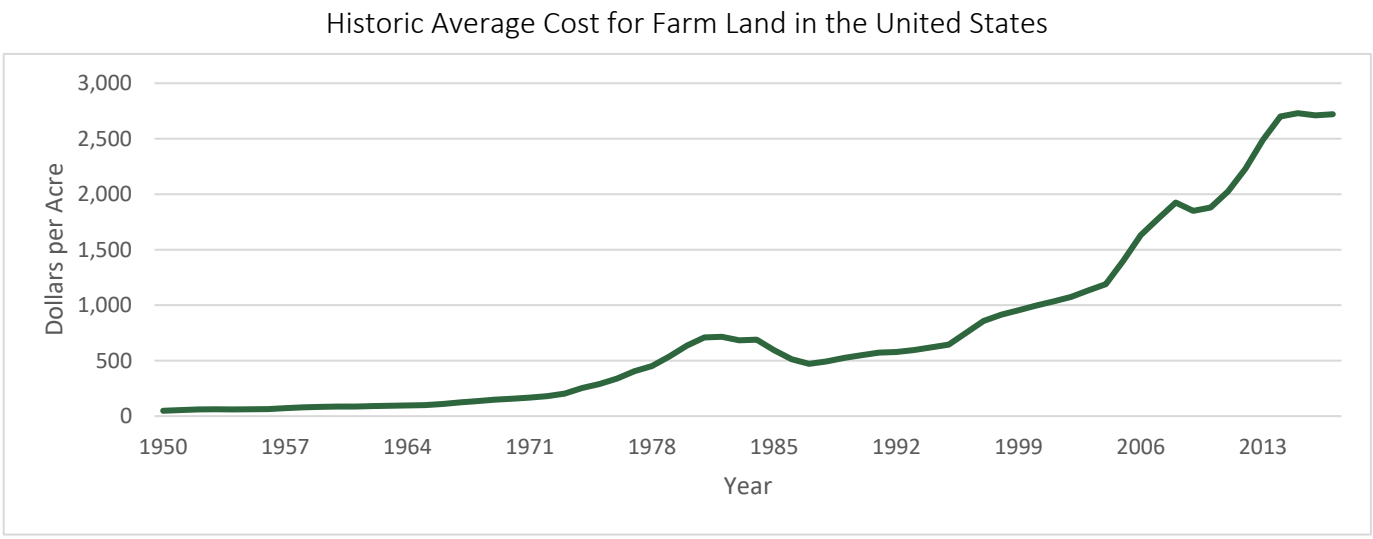

Figure 14. The increasing average cost of land across the United States since 1950. The numbers were calculated by taking the average of crop and pasture land. All information was found except for the year 1996 which was estimated based on the average from 1995 and 1997. (Data from the USDA "Summary on Land Values", 2017; "National Agriculture Statistics Service", Vilsack and Clark, "2012 Census of Agriculture", 2013. Graph was made by the author. See footnote 130 for full citations.)

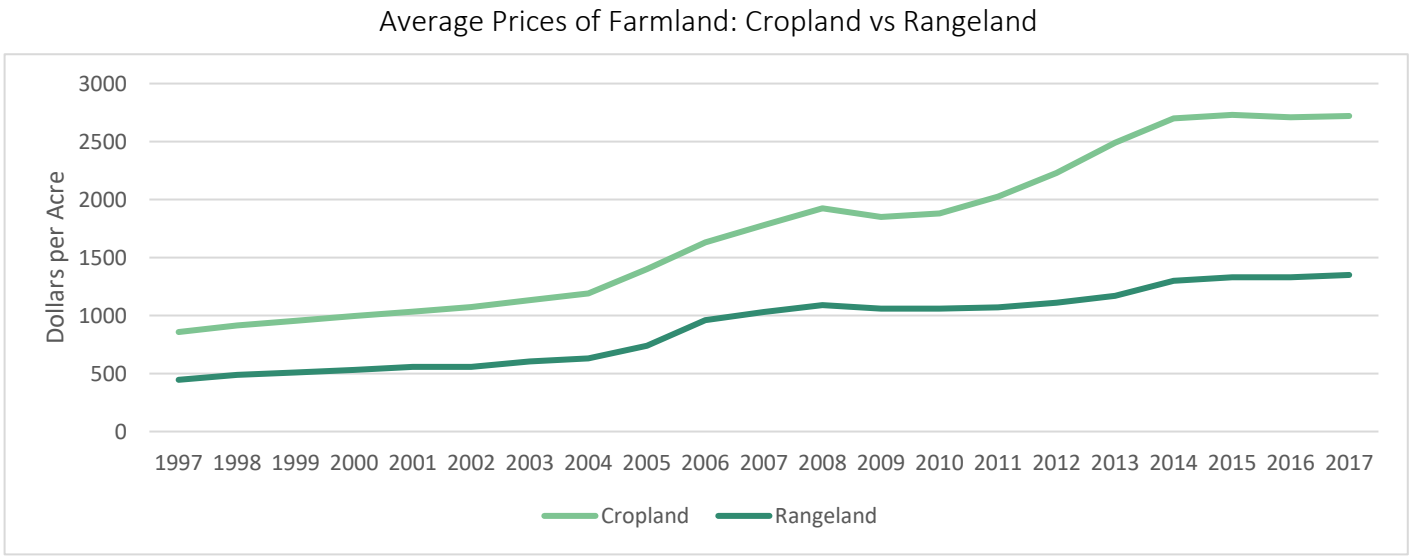

Figure 15. The difference in dollars per acre of rangeland and crop land across the United States. Range land is consistently lower and rising at a slower rate than crop land. (Data from the USDA "Summary on Land Values", 2017. The graph was made by the author. See footnote 130 for full citations.)

before buying a herd or machinery or fencing. "For someone young, the only place for them to start is if they had an in with a neighbor or in-law or their own family because land is just too expensive."[131] Then you add in machinery, which has been updated to farm, as John Doe said, "the face of the earth" and can, again, cost half a million to a million dollars. [132] Then you have herds, feed, veterinary bills, and so on. Figure 17 shows the declining net income for farmers since the turning of the century considering these inputs.[133]

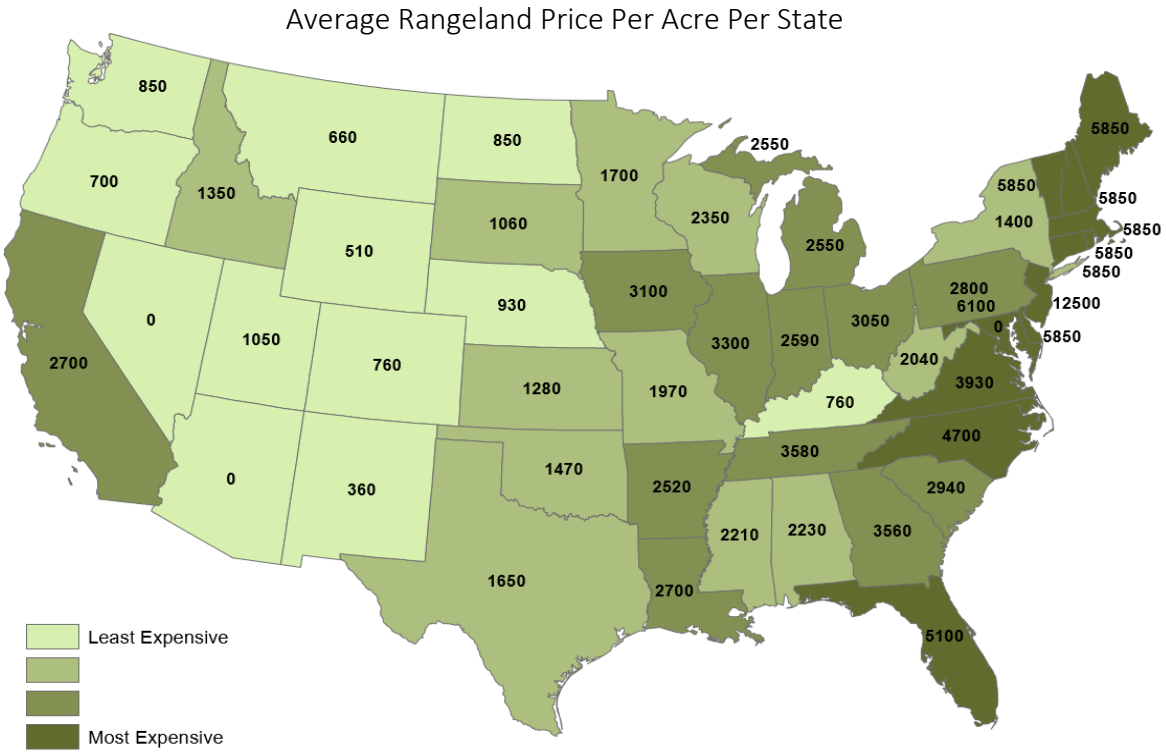

Figure 16. The 2017 average state price for rangeland across the United States. The study area of South Dakota, North Dakota, Nebraska, Montana, and Wyoming held some of the lowest prices for rangeland in the nation. (Data from the USDA "Summary on Land Values", 2017. The map was made by the author in ArcGIS. See footnote 130 for full citations.)

[131]Sutera.

1. [132]Doe; Espy; Rasmussen; Sutera; Sam Ro, "Here's a Price List for a Whole Bunch of Cool, Brand New Farm Equipment," *Business Insider*, 2014-05-08 May 8 2014.

[133] "U.S. Net Farm Income Is Forecast to Rise in 2017 after Declining in the Prior 3 Years," August 2017, accessed November 23, 2017. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=76952.

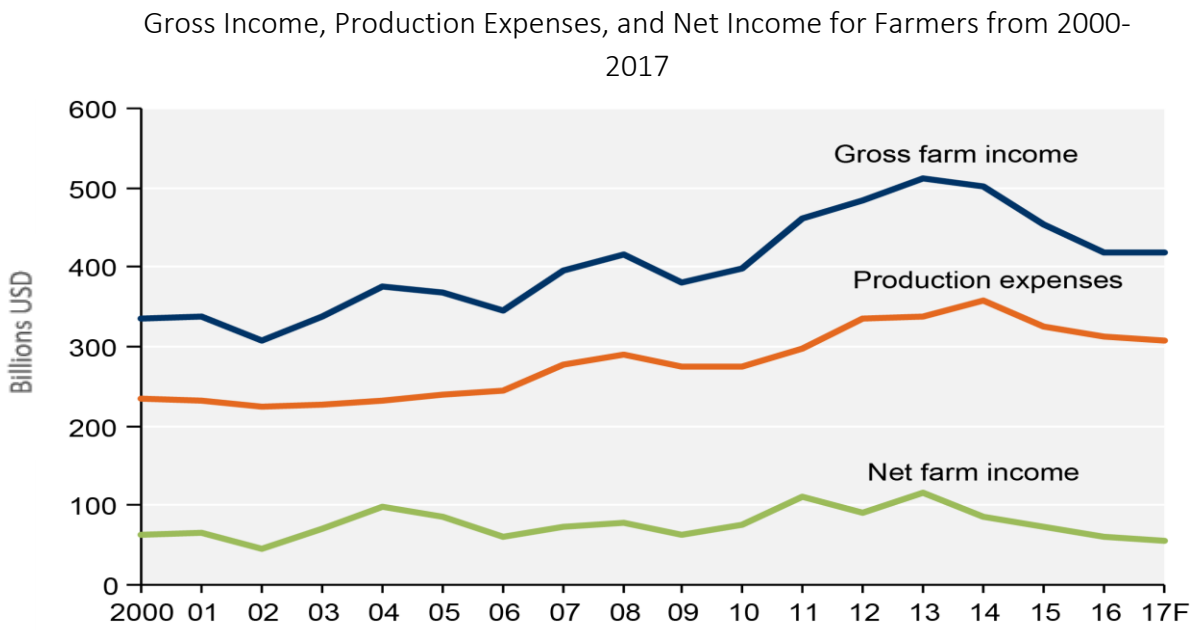

Figure 17. Change in income from 2000 until 2017. There was a rise during 2010-2013, but that was coupled by the higher production expenses. Over all, Net Farm Income has been steady or declining since 2000 as Production Expenses and Gross Income grow closer to one another. (Graph is from the Economic Research Service "US Net Farm Income", 2017.)

The initial capital needed to begin farming is enough to cripple many, and that is without any external forces. Prices for commodities, like wheat, are set by the Chicago Board of Trade, but there is a general distrust and anger around that system. As the two conventional feedlot producers said: "You have better chances in playing the lottery than you do of playing the market."[134] And "We [farmers] are the only production company where we don't set our own prices."[135] Epsy, who was raised on a CA farm, commented in similar spirits, "The commodities are no longer linked to the market... so therefore it's a trading game now. And that trading game sets the price for the whole world."[136] He also mentions another major change, which is the role of globalization. Farmers no longer are just feeding their families or communities but have expanded into a world market.[137] This produces positives and

[134] Doe.
[135] Roe and Roe.
[136] Epsy.
[137] Tom Vilsack, "United States Summary and State Data,"(United States Department of Agriculture, 2012); Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."

negatives, but in general, increases risk. "[In the expanding market] we are just a really little part of the picture... so a bad crop year here does not necessarily mean an increase in price" said Sutera, discussing changes he saw during his time as an extension agent. [138] This global supply and demand can affect prices, decisions, and reliability through imports. As Rasmussen described, "If grass-fed beef had a higher return that the marginal corn fed… there's a better chance they would plant it back to grass… but the imports are shutting that down."[139] Then there are also the considerations of weather, disease, and accidents which lower a farmer's control of products. All of these external factors increase the risk and decrease individual choice.

Finally, the issues of profit need to be addressed:

- "The margins in agriculture are so slim and they are getting slimmer and slimmer every year. Every year it gets a little bit harder to do what you did last year."[140]
- "One, financially, it's not good enough margins. Two its risky."[141]
- "With the cost of everything… you have got to know where you are so you can fulfill your lease."[142]

Cost and profit are two vital portions to this industry. It is a hard to invest millions and millions of dollars on a 1-2% profit gain. Not to mention, smaller gains hold back innovation and encourage individuals to cut corners. It is hard on the land and on the family, which can then affect a child's interest in the farm and possibly lead to corporate control. While this is a culture and a lifestyle, farming is also a business. Without making money, the business fails.

Initial cost, external control, and slim profit margins all contribute to an enterprise of extremely high risk. The risk factor dominates all decisions from what to plant, when to calf, and where to sell.

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[138] Sutera.
[139] Rasmussen.
[140] Ibid.
[141] Epsy.
[142] Sutera.

"Risk management is probably the most important thing … [because] in this industry… you get to make one big mistake financially, but very few survive two."[143] This is vital to understanding the culture because if the farmer makes decision knowing he or she gets one, maybe two, mistakes, any change made must be well thought out on numerous levels. If the change procures a minimal benefit and has a high level of uncertainty, it may not be worth the risk.

New concepts and new ideas are also perceived with skepticism, not because farmers think they are bad ideas but because of the different factors affecting their mindset. The lack of innovation is not due to a lack of creativity or insight, it is due to a lack of power. Rasmussen explained this when he said,

> There's a lot of great ideas and things that would be fun to do and make sense and they may even be the right thing to do, but can you survive the risk… because that's our goal at the end of the day… survive the risk.[144]

Since this industry is teetered so precariously on the edge of financial ruin and the product, which is food, is necessary to society, change is slow and frightening. When asked how to mitigate risk, responses differed from starting small so mistakes are flushed out early on, make changes when the market is good so the financing comes from surplus, and to update machinery or practices only as needed so that you do not get caught up in debt.[145] None of the interviewees stated they would be willing to try an idea without some sort of model, case study, financial assurance, or unbiased science.

Specificity in Management Style

All of the previous cultural considerations, while specific to the livestock industry due to the nature of the interviews, paint an image of agriculture as a whole. On a more specific level, there may be cultural differences and even incompatibility between bison and beef farmers. Before diving into this

[143] Rasmussen.
[144] Ibid.
[145] Epsy; Rasmussen; Sutera.

concept, it is important recognize that no two pieces of land are the same and therefore cannot be managed exactly alike. There will never be a cookie-cutter concept that fits all the farms across the Midwest, but there are different models that offer places for farmers to begin, which is what is always done. Two of these that were highlighted during the interview process are Conventional Agriculture (CA) and Holistic Resource Management (HRM). CA is a four-pasture rotation based on the lifecycle of the livestock which means pastures for summer, winter, calving, and weaning. HRM is more focused on the proper management of the grass (the resource) and using the livestock as a tool for that management.

These styles represent more than just a mindset about how to farm. Each management style comes with its own paradigm of thoughts and tools. For example, when asked about bison farming, Sutera, a CA beef farmer, said that "they're just different animals" while Rasmussen argued "I just don't see any difference [between bison and beef], they are out there eating the same forage and they're both ruminants."[146] The contradictory sentences are extremely important when looking at the variety of opinions in the culture, but they also point to a bigger consideration. For a CA farmer, bison are a totally different animals because they cannot calve early, cannot be over-handled, do not need supplemental feed, and occasionally have a temperament not found in domesticated animals.[147] However, because in HRM the focus in on the resource (grass) and not the livestock, bison and beef are the same: they are large, cloven-hooved animals that push the litter (dead grass) into the soil so the microbes can decompose it and turn it back into new plant growth.[148] Even Epsy, the other HRM interviewee, agreed

[146] Rasmussen; Sutera.
[147] O'Brien; Epsy; Espy; Klamm; Kroos; Boltz; "Basic Facts About Bison," ; "Raising Bison: Starting Your Bison Operation," ; "How Bison Survive Winter in the Northern Great Plains," ; Erin Patrick Lyons, "Give Me a Home Where the Buffalo Roam: The Case in Favor of the Management-Function Transfer of the National Bison Range to the Confederated Salish and Kootenai Tribes of the Flathead Nation Student Note," *Journal of Gender, Race & Justice* 8(2004); Marcotty and Hage, "Can We Save Bison by Eating Them?."; United States Department of Agriculture, "Bison 2014: Health and Management Practices on U.S. Ranched-Bison Operations," ed. USDA–APHIS–VS–CEAH–NAHMS.(Fort Collins, CODec 2016).
[148] Epsy; Rasmussen.

saying “Cattle are just cattle. Bison are just bison. Animals are just animals… we manage grass.”[149] While the biological differences mentioned in the four principals stay the same, the overall change between bison and beef under HRM is minimal.

What this means in terms of culture is that one group is may be very skeptical and need to learn an entirely new management style if they switch to bison. For the other group, the evidence that bison’s inherent benefits are worth the risk of entering a newly developed, niche market will have to be strong and proven before HRM beef managers would switch. This creates two different cultural lenses with needs for different research based upon different questions. In a simple way, it makes communication of why bison would be the better option difficult yet imperative.

Rooted in Tradition and Family Values

Farming is a passed down tradition. Examining those who provided a bit of their background during the interview process, 100% grew up either in or around agriculture.[150] It is important to remember that this sample is not a scientifically chosen group of individuals, but that percentage is still remarkable. To get a national perspective, the 2012 Census of Agriculture reported that 1 out 5 farmers were first-time producers, meaning they had not been on a farm longer than 10 years.[151] This was a major decline of 19.6% for a ten-year window and 23.3% for a five-year window.[152] This is drastically important because it highlights the role of tradition and family in the culture.

Rasmussen is one of many whose family is still farming the same piece of land that was homesteaded upon immigration. When asked what he hoped for the future of the land his family had been managing since 1914, he said:

[149] Epsy.
[150] O'Brien; Doe; ; Epsy; Espy; Hutchinson; Bodner; Rasmussen; Roe and Roe; Boltz; Sutera.
[151] Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."
[152] Ibid.

> Well, I hope that our … natural resources will be managed in a way that is sustainable and that our kids can come back and live here, have a business that provides a living where they can raise kids and keep going.[153]

And he is not alone. John Doe's remarks about hope for his land were similar in that "it is really nice that there is still interest in my livelihood from the kids…. so it will continue"[154] Johnny and John Roe are a father and son pair who want nothing more than "to keep their grandfather's land in the family and create a livelihood on it."[155] Even the bison farmers have the same focus on family tradition. Epsy, who was raised on a CA cattle farm in Montana, said that "It [farming] works. It worked for over a hundred years. It has raised families and contributed to the local economies… and I wouldn't be where I am today without it."[156] O'Brien is a bison rancher who grew up on a dairy farm, and his decision to switch livestock was influenced by the legacy he would leave his kids. "My land," he said, "will look the same for my kids and my grandkids and my great grandkids."[157] There is a large emphasis on continuing the legacy and family.

For farmers and ranchers, their culture is not just stories or legends from the past, but the place and the land they are working. Every morning when they sit down to put their boots on, they are sitting down next to the memory of their father or grandfather doing the same thing. Every change that is made has a perspective of longevity – how will this affect the land for me, for my daughter, for her kids? This is not true for every single farmer. Some of the large, corporate level farms are owned by individuals who live in different states and make an annual visit. They do not have similar ties to the land and tradition. However, this plays a role in culture and in the passing down of knowledge. Those who

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[153] Rasmussen.
[154] Doe.
[155] Roe and Roe.
[156] Epsy.
[157] O'Brien.

grew up on the same land they manage are making very minimal changes to the way it was done.[158] Thinking of places that practice CA or row crops, it is likely that their fathers or their grandfathers also practiced CA and row crops. Following the tradition of previous generations provides a sense of comfort and reliability in an extremely volatile market. While this may limit adaptation of change, it provides a sense of security and continuity.

Unfortunately, not all of the historical practices are based in sound environmental knowledge, but this is accidental and unintended.[159] No farmer has gone out with the mindset of degrading the land he wants his children to inherit. The misinformation and economics of the time pushed these types of agriculture which are now being passed down through the generations.[160] This is a difficult mindset to change, which is why a majority of bison farmers are either new to system or those who have been away for a long time and want back in.[161] Change is slow, but that is because anything that affects the land or the style of farming affects individual and family identity.

Unexpected Themes

While industrialization, risk management, incompatible farming styles, and family values were concepts the interviews were conducted with, there were also themes that developed organically across the interviews worth noting. The first was that it was incredibly difficult to find individuals who would allow a stranger onto their property. While some had legitimate issues with the dates or illness, many stated they were not comfortable speaking with an environmentalist. This alone is interesting because it gives the culture a secretive air. By not speaking with someone who, presumptively, supports different ideas or values, stigmas and stereotypes may be continued.

[158] Epsy; Hutchinson; Rasmussen; Sutera.
[159] Epsy.
[160] Ibid.
[161] Ibid; Matheson.

What makes this worth noting is that in multiple interviews, there were many comments of distrust.[162] This doubt was evident in comments about the author's intention, science's agenda, uneducated consumers, incompetent politicians, and so on. This friction between the farmers and the "outsiders" was clear and potent in many situations. As one rancher explained, "research is a wonderful thing when it is [correct]…. Otherwise it is an agenda. There is a lot of research that gone on over the last sixty years that was tainted."[163] There were multiple interviewees who asked for references and articles about the views considered in this paper, and others who did not wish to hear them at all. What this suggests is that the agricultural community feels they have been misrepresented to the public through these different avenues and therefore does not trust outside sources or opinions readily. It creates a culture of fear, mistrust, and misrepresentation.

A great example can be found in the consumer/ producer relationship. Three of the four site interviews listed the miscommunication between consumers and producers as a major issue in the industry: "You know, ranchers don't sell beef to ranchers, they sell them to urban people… but you need to have a little bit of communication between the products we produce and the consumer's response."[164] "We should eat smarter… we should quit subsidizing cheap proteins and let that true cost float out and maybe educate people about the true cost of things."[165] "How that all plays out for the future of farming, balancing what the consumer wants, is really my biggest concern."[166] While these quotes are all taken from different topics and different perspectives on the current state of agriculture, they all hit the same subject: farmers and ranchers feel that most consumers do not know what they are eating. This adds to a culture where many feel that their livelihoods, products, or even they are

[162] Doe; Hutchinson; Rasmussen; Sutera.
[163] Rasmussen.
[164] Ibid.
[165] Epsy.
[166] Sutera.

misunderstood or misrepresented. This further isolates the agriculture community from the "outside" world.

Summary of Culture Sections

To summarize simply, small, family-farm based agriculture is dying. There is continual pressure, either by the market or by profit margins, to increase productivity and move towards industrialization. This pressure acts as a restraint on new ideas and concepts because as the profits get smaller and smaller, farmers have less capital to invest in new ideas and technology. The community is built upon the notion that every year is a risk, and, because of that, the industry does not change easily. Agriculture demands high costs, including million-dollar machinery, land, insurance, and other mitigation items. Farmers are so weighed down in this debt that attempting to make significant changes could mean losing their practice. There is also a lack of choice due to the disconnected markets and external variables. Family and tradition play enormous roles in the decision-making and practices found on farms across the country. These handed-down history lessons work to create a safety net in an incredibly insecure market. There is also a healthy dose of skepticism of outside sources and individual's due to being misconstrued in the past. Finally, many farmers feel cut off and misunderstood by their consumers.

In regards to cultural barriers for large-scale bison operations, there are many. With the challenges of industrialization, there is little room to step outside of the current norms. In general, there are so many constraints on the average farmer that considering changing markets, processing styles, and, potentially, management is out of the question. Most medium to small sized farmers are trying to keep up with the current industry and find a way to adapt so they can keep the land in their family. They do not have the financial or social freedom to try something new and be wrong. Costs could potentially include their income, property, history, and future, which is too much to risk on profits that may or may not be realized. While it is true that bison have numerous benefits, there are simply larger issues at play

which take precedence. It is unfortunate, but agriculture is an unforgiving, difficult industry which seems to be in a period of shifting tides. There is the potential that this push from industrialization will force new, niche markets to expand in order to keep farmers employed. If that is the route history takes, bison farming would be an excellent choice, but it can only be a speculation at this point.

Although there are clearly a lot of challenges, it is necessary to highlight that all of the individuals interviewed loved what they were doing. While the market is not open to significant change and many family farms are looking at an end of an era, these farmers absolutely love what they do. They feel they are contributing to society, building a better future, working with their hands, and making a difference. There is both connection to place and to each other that is stronger than many other cultures. While family values may hinder the ability to switch livestock, it also produces tight-knit groups that have seen the land change and work hard to preserve many of the Great Plains natural resources. There is a grit and a cynicism, but there is also a desire to work for others, a love for the land, and genuine hope for future. While these conclusions may be austere, most of the farmers are very positive about the beef and bison industries. They have concerns, many of which have been laid out in this section of the paper, but many expressed their belief that it will all work out whether that be in form of consumers demanding family-raised produce, Co-ops, CSAs, or other solutions. While this paper is focused on the issue of barriers to large-scale bison, it felt essential to mention these positive cultural considerations.

Current Economic Trends

As discussed previously, the United States' development, culture, and identity is intertwined with the cattle industry. However, it is important to remember with industrialization that agriculture is

highly influenced by markets and corporations. The Hoover's Report[167] for cattle and livestock addresses issues relating to "ranches and farms that raise cattle, including those intended for dairy herd replacements, and feedlots that fatten cattle in preparation for slaughter."[168] It showed an overall increase by 4% from 2018-2022 which follows years of volatile change.[169] As part of this optimistic view, two major indictors for beef – the US spending on non-durable goods and consumer price index – rose by 1.9% and 1.6% respectively.[170] What this shows is the potential for a consistent market after decades of unrest. This report, however, is not a guarantee for stability and it is possible the market will continue to shift.

Agricultural economics has been integral into the movement from small, isolated farms to large supply chains found across the nation. It originally focused on farm management issues and had close links with the agricultural and biological sciences.[171] However, like the markets themselves, the farm economic sector has continually changed and found new areas in profitability and production.[172] This development is leading into a more unified vision of economics which includes other fields like psychology. Areas of future projections include risks, uncertainty, and behavioral farm decisions.[173]

The economics of agriculture is directly tied to the same spilt in farming discussed in the cultural changes section. For past 30 years, the US has maintained about 2 million farms labeled by the USDA.[174] This consideration means that there are over 2 million farms that produce more than $1,000 in revenue,

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[167] Hoover Company Reports are in-depth company reports used to improve an organization, encourage investment, and relay current business information. It is associated with Dun and Bradstreet. For more information, visit: http://www.hoovers.com/about-us.html
[168] "Cattle Ranching Industry Overview," (2018).
[169] Ibid; "Quick Stats National Agricultural Statistics Service," ; Vilsack and Clark, "2012 Census of Agriculture: United States Summary and State Data."
[170] "Cattle Ranching Industry Overview."
[171] Jean-Paul Chavas, Robert G. Chambers, and Rulon D. Pope, "Production Economics and Farm Management: A century of Contributions," *American Journal of Agricultural Economics* 92, no. 2 (2010).
[172] Ibid; Bechdol, Gray, and Gloy, "Choices."
[173] Chavas, Chambers, and Pope, "Production Economics and Farm Management: A century of Contributions."
[174] Daniel A. Sumner, "American Farms Keep Growing: Size, Productivity, and Policy," *Journal of Economic Perspectives* 28, no. 1 (2014); "Quick Stats National Agricultural Statistics Service,"

but that is only equal to the profits from 2 acres of corn or half a dairy cow.[175] In reality, only 30% of the 2 million farms contribute significantly and less than 6% produce 3/4 of all the food consumed in the US. This is due to the agricultural transition in productivity increases, consolidation, and government subsidies.[176] The internal and external market pressures are driving smaller businesses to consolidate in order to escape inefficiency.[177] Essentially, larger farms are more efficient in capital, labor, and land use in terms of productivity. At the opposite end, the organic farm movement maintains only a minimal 2-3% of the market.[178]

Not only area beef pricing and profits influenced by regular market demands, but the current grain-fed cattle system is deeply embedded in the corn and future markets. Since most cattle end up in feedlots consuming grain, the corn market can shift the price in the beef industry. This is important because corn has what is called the futures market. This is a system developed in Chicago which allowed individuals to sell grain they did not own at a current price for some time in the future.[179] The idea is that when the sale comes due, the individual would then purchase the amount owed for a lower price and turn a profit.[180] This leads to markets shifts and cornering that can drastically change the prices of corn for purely speculative reasons without any tangible differs in the commodity.[181] This market directly ties into cattle, adding another element of risk which can lead to more conventional economical practices.

In summary, the economics behind cattle are tied to markets, the commodity of cattle, the current movement of the industry, new technology and practices, and other interconnected markets like

[175]Sumner, "American Farms Keep Growing: Size, Productivity, and Policy."
[176] Ibid; Chavas, Chambers, and Pope, "Production Economics and Farm Management: A century of Contributions."
[177] Sumner, "American Farms Keep Growing: Size, Productivity, and Policy."
[178] Ibid.
[179] William Cronon, "Pricing the Future: Grain," in *Nature's Metropolis*(New York: W.W. Norton, 1991).
[180] Ibid.
[181] Ibid.

corn. Because of this, it can be a difficult entity to predict and weighs heavily on the decision-making process of farmers. While there have been major shifts in the recent decade, the newest projections are positive which could increase the profits shown in the cattle industry.

Economic Barriers

"Show me the numbers, because if I can't see the numbers, I can't switch. Show me the numbers and then we can talk [about bison]."[182] Rasmussen made a valid point in the beginning of his interview about the need to see profit potential in the industry before even considering bison as a possibility. While he is the one chosen to be quoted, he was certainty not alone. Costs are a big topic in the agricultural community, not because they are focused on profits, but because they need to make a living. It is a high stakes gamble every season which is plagued by a complex, hard to predict market place. While there are distinct limitations to the scope, breadth, and depth of this paper, economic barriers must be considered.

Cost Comparison Results

To attempt a fair comparison, two datasheets from 2017 outlining costs for beef and bison cow-calf operations were used. The full, unedited documents can be found in Appendix D. As described in the economic methods section, these two spreadsheets were compared to one another based on four sections: replacement heifer, feed costs, variable costs, and fixed costs. Replacement heifers were calculated based on the current sale price for a cow and the average breeding lifecycle of the animal. Feed, Variable, and Fixed Costs were taken from the UW and Penn State datasheets. Profits and Break Even Prices were taken from recent sale prices. The results of the budgets in the calf-cow industry can

[182] Rasmussen.

be seen in Table 3.[183] The cost comparison shows that, according to the sources examined, bison is cheaper and provides a higher profit margin than a similar beef calf-cow operation. Final profits per head were 12 times higher in the bison calf-cow operation than the beef, showing potential for high market profits in bison. This result is slightly unexpected because the initial cost per head for bison is almost three times that of beef (a beef heifer costs $1,100 and a bison is $3,000). However, this price is mitigated through the longer breeding lifespan of the bison cow. [184] Something not calculated but worth remembering is that this means the upfront cost of purchasing a herd would be more expensive for bison. Though the initial capital is high, the profitability and longer lifespans should repay the investment relatively quickly.

Calf-Cow Budgets Cost Comparison

Item	Beef Calf-Cow Cost (in Dollars)		Bison Calf- Cow Cost (in Dollars)	
Replacement Heifer	100.00		150.00	
Feed Costs	390.44		228.00	
Variable Costs	147.02		118.95	
Fixed Costs	168.27		273.60	
Total Cost	805.74		770.55	
Profits (in Dollars)	**600 lb. Beef Calf**		**575 lb. Bison Yearling**	
	Cwt	**Head**	**Cwt**	**Head**
Break Even Price	134.04	804.24	134.14	771.33
Current Sale Price	154.87	929.33	400.00	2,300.00
Total Profits	20.83	125.09	265.86	1,529.00

Table 3. Results from the cost comparison of the University of Wisconsin Extension's source on Bison Calf-Cow Operations and Pennsylvania State University Extension's source on Beef Calf-Cow Operations. Current sale prices came from Oct 2017 for Beef and December 2016 for bison. Table was made by the author. (See footnote 183 for full citations.)

[183] Greaser, Morrow, and Harper, "Sample Bison Cow-Calf Budget."; "Trading Board Listings," ; Saso, "September Monthly Bison Report."; Halfman, Stalsberg, and Sterry, "UW Extension Cow-Calf Operation Enterprise Budget."; National Agricultural Statistics Service, "Livestock Slaughter 2015 Summary."; "Latest Feeder Cattle Price & Chart,"

[184] "Bison by the Numbers: Data and Statistics."

For transparency, Table 4 shows the cost comparison per species broken down into the different items of replacement heifers, feed cost, variable cost, and fixed cost.[185] Notes are provided to explain when variances from the original spreadsheet were made. Appendix D expands on this table. There are three differences, beyond final profits, that make bison a more economical choice: feeding, bedding, and interest costs. The earlier part of this paper mentioned the lack of buildings and difference in diet between bison and beef, which is shown in this analysis. Feed was 58% more expensive in cattle, mostly due to the winter feed needed for calving. Health was nearly 40% more expensive as well, which could be due to the lack of growth hormones or antibiotics in bison. Even before the price premium found at auction, bison were $35 cheaper to raise per head.

Machinery was an important number as well. In the analysis shown in Table 4, bison machinery costs are twice as expensive as the beef counterpart. This may come as a surprise since it was argued earlier that bison do not need machinery. In fact, from the interviews done for culture, it was discovered that most bison farmers only had one piece of machinery compared to the four or five found in conventional agriculture farms.[186] For the beef farmers in this analysis, what shows up in the machinery section is considered the machinery depreciation. This is the cost of the machinery spread out over the lifetime of the item, but does not include repairs, oil, fuel, or transportation. It is expected that beef calf-cow farmers, especially those who practice conventional agriculture, will have more machinery than their bison counterparts. These higher machinery costs come from expenses of fencing. Because bison can jump higher, run faster, and are overall stronger, their fences must be sturdier.[187] This comes at a higher cost, which is shown in the machinery category. Like the machinery used in CA, these fencing

[185] Greaser, Morrow, and Harper, "Sample Bison Cow-Calf Budget."; "Trading Board Listings," ; Saso, "September Monthly Bison Report."; Halfman, Stalsberg, and Sterry, "UW Extension Cow-Calf Operation Enterprise Budget."; National Agricultural Statistics Service, "Livestock Slaughter 2015 Summary."; "Latest Feeder Cattle Price & Chart,"

[186] Sutera; Epsy; Hutchinson; Rasmussen; Kroos; Roe and Roe; Bodner; O'Brien.

[187] "Raising Bison: Starting Your Bison Operation,"

Items in the Calf Cow Budgets Broken Down by Category

Type	Item	Beef Cost (in Dollars)	Bison Cost (in Dollars)	Notes
	Replacement Heifer	100.00	150.00	For beef, the breeding lifespan is 11 years and an average cow costs 1,100 equaling a 100 cost per calf. In bison, the cost is 3,000 per cow but a longer 20-year breeding lifespan
	Total Feed Costs	390.44	228.00	
Variable	Bedding	51.33	0.00	Because bison are not contained inside a building during winter or for breeding, there is no bedding costs
	Health and Vet	35.56	14.00	Bison do not receive the same rotation of supplements nor do they see a vet as often as cattle
	Transportation	24.00	5.00	In the beef budget, this was the Fuel and Oil category
	Miscellaneous	5.40	15.00	Both budgets had a miscellaneous section, but the beef did not have a cost associated with it. Because of this, the utilities in beef were combined into this category
	Marketing and Inspection	20.83	75.00	For the beef budget, this was a combination of dues and insurance
	Interest on Operational Capital	9.90	9.95	Labeled Operating Loan Interest in the beef budget
	Total Variable Costs	147.02	118.95	
Fixed	Labor	8.00	96.00	The higher bison price is a combination of hired labor payment and labor costs found in the budget
	Bull Replacements	13.33	22.00	Also called Breeding in the beef budget
	Interest on Investment	101.05	75.60	Includes building/machinery depreciation and long-term debt in the beef budget
	Machinery	22.50	50.00	Neither source has this category labeled as such, but it is pulled from machinery repair in beef and fencing in bison
	Building and Handling Facilities	23.40	30.00	This was the building repair category in the beef budget
	Total Fixed Costs	168.28	273.60	
	Total Costs	**805.74**	**770.55**	

Table 4. Breakdown of the different variables used in the cost comparison by topic as well as identifying anything that was renamed or combined from the original resource so that the results may be expanded upon. (For full citations see footnote 183. Table was made by the author. Full budgets can be found in Appendix D.)

costs should also depreciate over time, though there will be upkeep and replacement costs. Overall, this section was worth mentioning because the results make it appear as if bison farmers would need more machinery than beef, which the data collected would disagree with.

Beef's most expensive sector was feed while bison's was fixed costs, specifically labor. The extra costs of labor seem to be counterintuitive to the premise that bison are easier to manage. This may be due to a difference in calculating labor costs between the two datasheets or some other anomaly. Regardless, it should be considered for future research.

Cost Comparison Discussion

The goal of this section was to discover potential barriers to the bison industry, which are few according to the cost analysis. Again, this is by no means an in-depth economic analysis of the beef or bison industry, but a compilation of other calculations to be used as a tool. One of the biggest take – aways from this is that more research needs to be done in the economic sector to evaluate these findings and discover if the profits shown are congruent with industry operational data.

Another important economic factor to be considered is supply and demand. As mentioned previously, beef sales are at a four-year low and bison is at a four-year high.[188] This undoubtedly affected some of the results in the cost comparison. As bison becomes more common in grocery stores and restaurants, the ability for farmers to switch increases. Even with the increase in production, it has been reported that demand still outweighs supply.[189] Many ranchers believe they double their current

[188] Charles Michael Ray, "South Dakota Buffalo Farmers Relish Bison Meat Boom," *National Public Radio* Dec 21, 2011; Hansen, "Buffalo Meat Makes a Million."; Blackwell, "Are Bison the Answer."; USDA Staff, "National Feeder and Stocker Cattle Summary,"(St. Joseph, MO: United States Department of Agriculture, November 2017); "Beef Industry Statistics," ; "2017 Cattle Price Forecast: Don't Expect Much Movement," Beef Marketing, last modified 2016-11-17, Nov 2016, accessed November 12, 2017. http://www.beefmagazine.com/marketing/2017-cattle-price-forecast-don-t-expect-much-movement.

[189] Hansen, "Buffalo Meat Makes a Million."; Blackwell, "Are Bison the Answer."

production without supply outstripping demand.[190] Worth noting, though, is that if bison ever reached an equilibrium of supply and demand, the premium price seen in current evaluations may disappear. However, this would also drop the replacement heifer upfront capital price. Even so, bison have fewer inputs and are cheaper to raise so profitability should continue, though it may be smaller than what is shown.

Profitability and supply/demand are important aspects to consider when ranchers are considering transition to bison. However also worth noting is opportunity cost. Opportunity costs are those profits an individual loses when he or she chooses a different option.[191] In other words, it is what is given up when a choice is made. When a rancher chooses to raise bison, they cannot raise goats or sheep in the same pens. They also cannot raise bison and grow large amounts of row corn or wheat. The gains they would receive from these other products would be considered a negative towards the profits of bison. Opportunity cost is a vital consideration and was calculated in the cattle datasheet. It was not, however, calculated in the bison datasheet and therefore was ignored in the cost comparison. For future research, opportunity cost should be explored and calculated into these analyses.

This cost comparison analysis provides a lot of information that can be expanded upon. It was mentioned previously that bison do not need supplemental feed or any sort of corn ration. Lack of antibiotics or growth treatments for in a bison herd were also discussed. These two factors appear in the lower feed and health costs when compared to beef. Another consideration not discussed was that bison typically calve outdoors, so they do not need the extra buildings or bedding found in a conventional agriculture structures to support beef. These three factors, which are linked to the biology and management styles of bison, made a large impact on the profits of bison.

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[190] Epsy; Hutchinson; O'Brien.
[191] Paul R. Krugman and Robin Wells, *Macroeconomics*, Fourth edition. ed.(New York, NY :: Worth Publishers, 2015).

Future Possibilities

There are a few comments outside of the direct results that need to be discussed. To begin with, many of these profit increases found in bison could be shared with cattle. With Holistic Resource Management – which is the management style that focuses on short grazing and long rest periods – , there would be a decrease in feed costs as well as machinery and health. HRM is often found in similar niche markets to bison like grass-fed beef. Organic or grass-fed beef earns a premium price which increases the profit per animal, not unlike what is shown in previous tables.

Bison, being a growing member of that niche market, can drive high profits with few numbers (Table 3). This could be a major selling point for small, family farmers who are struggling in the changing culture and do not wish to sell to corporate control. Since bison use the same amount of land as beef yet draw a profit 12x higher, this could greatly impact the ability to save family farms. However, it should be considered that currently the demand outweighs the supply for bison meat. As discussed previously, if too many bison producers rush into the niche market, it is likely these premium prices will fall. Yet it is still expected to remain profitable.

Secondly, it is important to mention the externalities involved in agriculture. While going into depth on the economic value of these externalities is beyond the scope of this paper, there are indirect costs associated with industrialized farming. The design of corporate management created conditions where soil degradation, decreased water quality, dead zones, greenhouse gas release, and negative health effects were encouraged. The practices and institutions externalized the costs from the company to the public, but that could change. There may come a day where society decides to stop paying for these environmental costs, and then they will fall back on the producers.

While transitioning to bison is a large risk, the current market is not stable either. If a carbon tax or carbon cap-and-trade were to be implemented in the United States, many of these practices that

allow for large-scale beef production to flourish would have a high price. Things such as the higher greenhouse gas emissions from manure, carbon input of fertilizer in corn, and even the higher methane produced by cattle would hurt a market that is already struggling. While bison are not perfect, the prairie grasses could offset the smaller carbon impacts from these animals. Though it is speculative, producers should be hesitant to consider the beef market inherently less risky than bison. While many of these things are beyond the scope of this paper, they should be considered as potential economic barriers in the future.

Summary of Economic Sections

Bison show potential to be profitable for current cow-calf beef farmers. With less cost in feed and veterinary bills and a biology meant for a hands-off management style, the costs are lower than conventional beef farming. On top of the lower costs, bison are sold in a niche market that delievers at a premium price allowing for an increase in profit without needing to increase farm size. As families are continuously squeezed off their land due to low markets and slim profit margins, bison could have the potential to keep them on their homesteads. However, this was a very basic analysis and it requires further inquiry before any substantial conclusions should be drawn.

Solutions

There are four premises that make bison a better choice to beef: health considerations, environmental impact, management styles, and feasibility. While these premises seem to make bison a better choice, a cultural analysis of agriculture showed high risks paired with a push towards industrial-scale farming. Because of the transition in the industry, there is little freedom to make major changes. The simplified version of economics showed a significant increase in profit from beef calf-cow operations to bison, but due to its lack of depth, there are still many economic questions. These factors make it unlikely that a farmer would change his or her operation to bison. While that is the current state

of agriculture, there is potential that implementing different programs could mitigate some of the risks and encourage bison production. The solutions offered in this paper are capitalizing on the growing niche markets, implementing a carbon cap-and-trade, and introducing bison to school lunch programs.

Before discussing these solutions, it is important to remember that many of them could be also targeted towards HRM beef. While there are differences in bison and beef, the major difference comes from management style. While bison produce less methane and winter better, there are numerous environmental, social, and health benefits that come from beef that are managed with HRM. Depending on how agriculture shifts over this next generation, these solutions could benefit both cattle and bison. Another is that most of the solutions are long term. Agriculture appears to be in a dramatic transition from family-farms to corporate control. Just as that change did not happen overnight, it is not expected that these programs would instantly relieve the risks of ranchers so they could raise bison.

Capitalize on the Growing Niche Markets

As discussed in the culture section, agriculture is going through some major transitions. As family farms are pressured into turning to the industrial market, some have instead decided to move their production over to different niche markets. These would include bison, grass fed beef, free range chickens, elk, and humanely-sourced dairy to name a few. The appeal of niche markets is that they provide a resource that is difficult or directly against corporate styles of farming.[192] While hobby farms increase as corporate level farms increase, niche markets are only just beginning to gain in popularity as consumers become more educated about the impacts of some agriculture. There is a new desire, either prompted by ethical concerns, health benefits, or other reasons, to understand where produce comes from. These new consumers are looking for transparency, accountability, and a connection with the producer. Not readily found in the agricultural culture described previously, this group of consumers has

[192] "Niche Marketing," Strategies to Revitalize Rural America, last modified 2007-03-20, 2007, accessed October 16, 2017. https://www.cfra.org/renewrural/s/niche-markets.

expanded the niche markets. There are some learning curves and initial costs, such as certifications and processing, but organizations are working together to build a cooperative of these niche producers so that they can bargain fair, just prices.[193]

There has also been a recent development in grocery stores that provide these types of products. Whole Foods, Trader Joes, Fresh Thyme, and spectrum of local Co-ops are just a few of the new developments which increase profitability and mitigate risks associated with change. These new suppliers found through local or health businesses have increased the scale in which niche markets operate. There is a risk that overflooding this market will collapse this industry; however this is also potential that increasing the number of producers would increase the availability to the product leading to more businesses selling it. The market needs to be watched closely as this continues to develop.

To effectively capitalize on the increase in these niche markets, it would be helpful for a farmer to contact a consultant and their local niche market cooperative representative. There would also need to be research conducted on an individual level to assess the level of change needed to switch to bison as a niche market. While there still would be a large risk, many bison producers and sources say there is a higher demand than supply so connecting with individuals in those markets could result in guaranteed sales.

Implement a Carbon Cap-and-Trade

While this solution may seem unrelated to bison farming, prairie grass is a major sink for carbon sequestration. With as little as 3% of the original prairie remaining, scientists are realizing the potential prairie grass has in the battle against climate change.[194] Research has found that there is more carbon in soil than in the atmosphere and biota combined.[195] It also shows that it can sequester up to 794g

[193] Ibid.
[194] Judith D Schwartz, "Soil as Carbon Storehouse: New Weapon in Climate Fight?," *Sustainable Agriculture* (March 4, 2014).
[195] Ibid.

$C/m^2/yr$.[196] Not only is this positive news for the planet, but it has potential to be extremely profitable for bison producers because their animals actually make the prairie more productive.[197]

Through these interviews, there were multiple opportunities to evaluate different land management processes, but a few stand out specifically. The butterflies blocked out the sun and the grass was so thick it was hard to walk through on Dave Hutchinson's farm.[198] Being able to see firsthand the difference in wildlife and soil health when a pasture is managed with HRM at 777 with Mortiz Epsy applied the theoretical to real, physical gain. [199] At Dan Rasmussen's, the grass spacing was less than finger-width apart, compared to hands-width on nearby, differently managed land.[200] These prairies are more productive than other, unmanaged land because of the way the prairie natural evolved. This ecosystem works with large, cloven-hooved ruminants like the bison. When a bison comes through and grazes a spot of prairie land, they turn the older litter into the ground allowing the microbes to digest it and put those nutrients in the roots of the grasses.[201] They also increase nutrient cycling through their waste products. These grasses can then grow stronger, better, faster, and fuller than unmanaged land placing more carbon from the atmosphere into the ground. [202] This is because the focus of HRM is not on the livestock, but on the grass and soil.[203]

This management style, which is incredibly conducive to bison farming, would benefit from a carbon cap-and-trade because of the amount of carbon being sequestered from the healthy grazing lands. The rancher, in this situation, would have two incomes: the bison meat and the carbon cap-and-

[196] Jason West and Danelle Haake, "Estimation of Carbon Sequestration in a Restored Tallgrass Prairie Ecosystem in Eastern Missouri," *Missouri Botanical Garden* (2014).
[197] Epsy.
[198] Hutchinson.
[199] Epsy.
[200] Rasmussen.
[201] Epsy; Rasmussen.
[202] Epsy; Rasmussen.
[203] Epsy; Rasmussen.

trade money. This extra profit could help create a sense of security for farmers who wish to switch to bison but feel held back by the risky nature of the industry.

Incorporate Bison in School Lunch Programs

While there have been individuals raising bison for many years, the industry itself has only been recognized for 20-30.[204] For this and other reason, many consumers consider bison meat to be exotic, rare, or wild. This stigma has been passed into the agricultural community as well which decreases its acceptability as a feasible option. To encourage more individuals to consider bison a standard meat choice, it is necessary for the average American to encounter this type of protein. This could be addressed by having the government look at adding bison to school lunches and government assistance programs across the country. The goal would be to educate the next generation so that they consider bison a "normal" product, rather than a rarity. This mindset would lesson some of the cultural risks involved in tradition and historical farming that is prevalent in today's society as well as familiarize the next generation of food producers with bison. It could also remove some financial risks for those looking to join the market today since there would be a guaranteed buyer and income through school purchases. This concept should be considered in it's infancy and research is needed on how to raise effectively large herds, process, and cook bison inside a school setting. Part of the problem with today's beef industry is because it was trying to meet a larger, cheaper market demand, and if all aspects are not carefully considered, bison could easily end up in the same place.

Recommendations

As mentioned in the beginning, this paper is only meant to encourage more research in this topic. While the cultural analysis was as detailed as feasibly possible given the circumstances, the depth and breadth could be improved. A different study tackling a larger number of interviews or perhaps a

[204] Matheson; "Bison by the Numbers: Data and Statistics."

different section of the country is recommended. There is potential, as well, for a historical perspective on both bison farming and the cultural history of farming. A study that attempted to track the cultural history of agriculture starting around the homestead act and moving towards today could provide a deeper understanding of the current changes seen in this paper. This would produce a more accurate trajectory for the state of this industry as well as produce new solutions based around cultural risk mitigation. A thorough economic analysis could be completed to give further insight into the profitability of bison as well as a paper could be done addressing market trends. Calculating opportunity cost is also encouraged. Finally, new areas could be added including a focus on how education at both secondary and undergraduate levels effect the mindset of young farmers and an investigation into how subsidies could help or hinder the bison industry.

Conclusion

While bison have certain benefits over the beef that make them seem like easy substitutes, the current transition in agriculture from small family farms to industrialized corporations paired with the high levels of risk and strong tradition make it unlikely that many farmers would switch to bison on their own. There are certain solutions that would help increase the likelihood of that transition, like a carbon cap-and-trade, but overall it seems the market is at a standstill. The goal of this paper was to attempt to explain why more farmers are not considering bison as a livestock option. While complicated and variable, the answer put forward is that the culture and market are currently not in a position to encourage large-scale changes. As time moves forward and the community adapts to new niche markets and localized food, there may be a day where bison find their home on the market range.

Acknowledgements

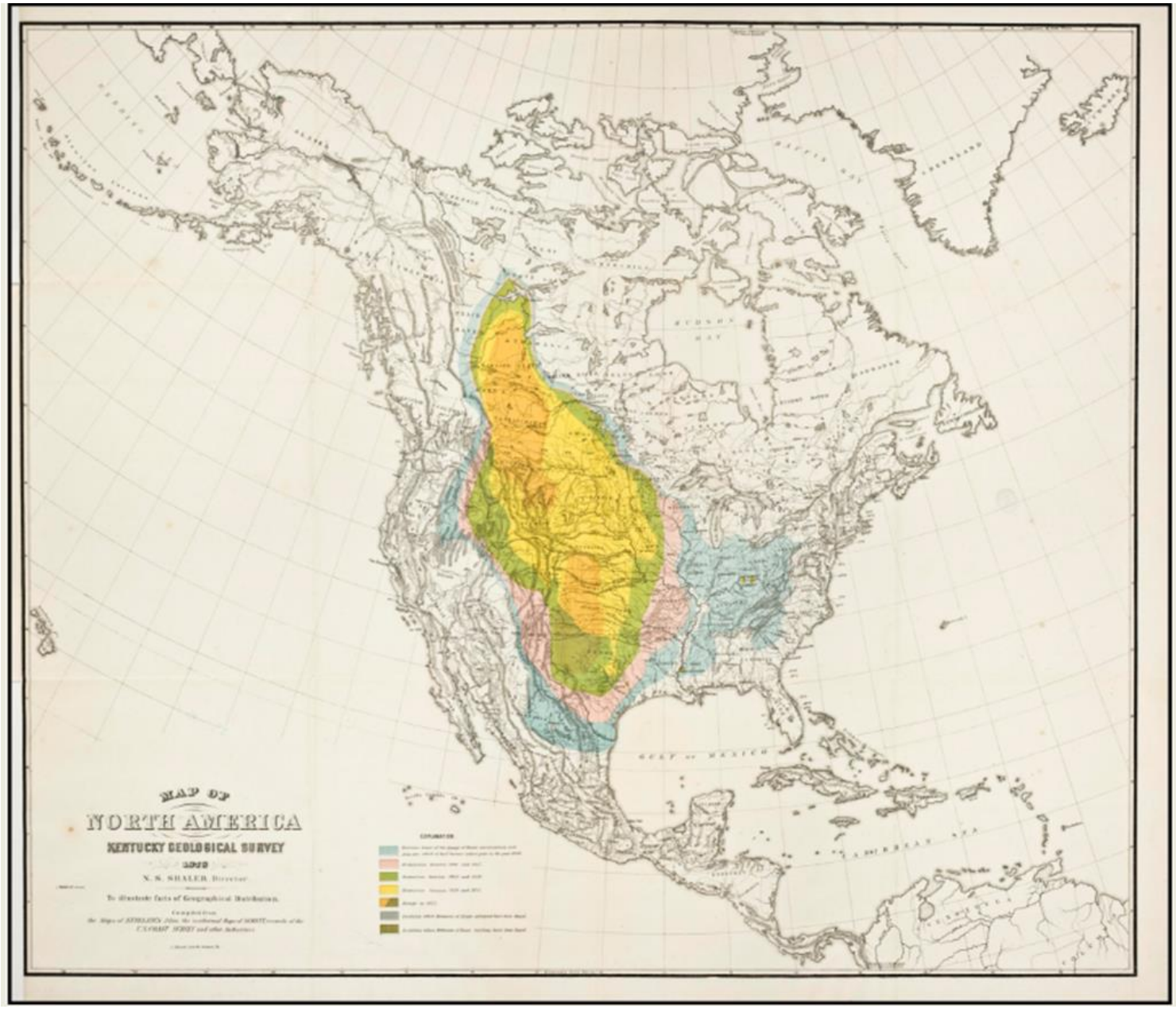
There are many people who contributed to the creation of this thesis project. Thank you to the professors in the Environmental Studies department who acted as my guides and readers. Thank you to the Department of Experience and Professional Development for providing the research grant so that I could do on site interviews. Thank you to the multiple farmers and ranchers across the Midwest who picked up the phone and talked to a stranger. A special thank you to Dan Rasmussen, Dave Hutchinson, Moritz Epsy, and Steve Sutera who opened their doors and prairies so that a better understanding of the agricultural community could be realized. Thank you to the Local Blend for never kicking me out as I wrote for hours and hours in the corner booth. Finally, thank you to my family who read, reread, and edited this work.

Appendix A

Full Map by W. T. Hornaday, 1889[205]

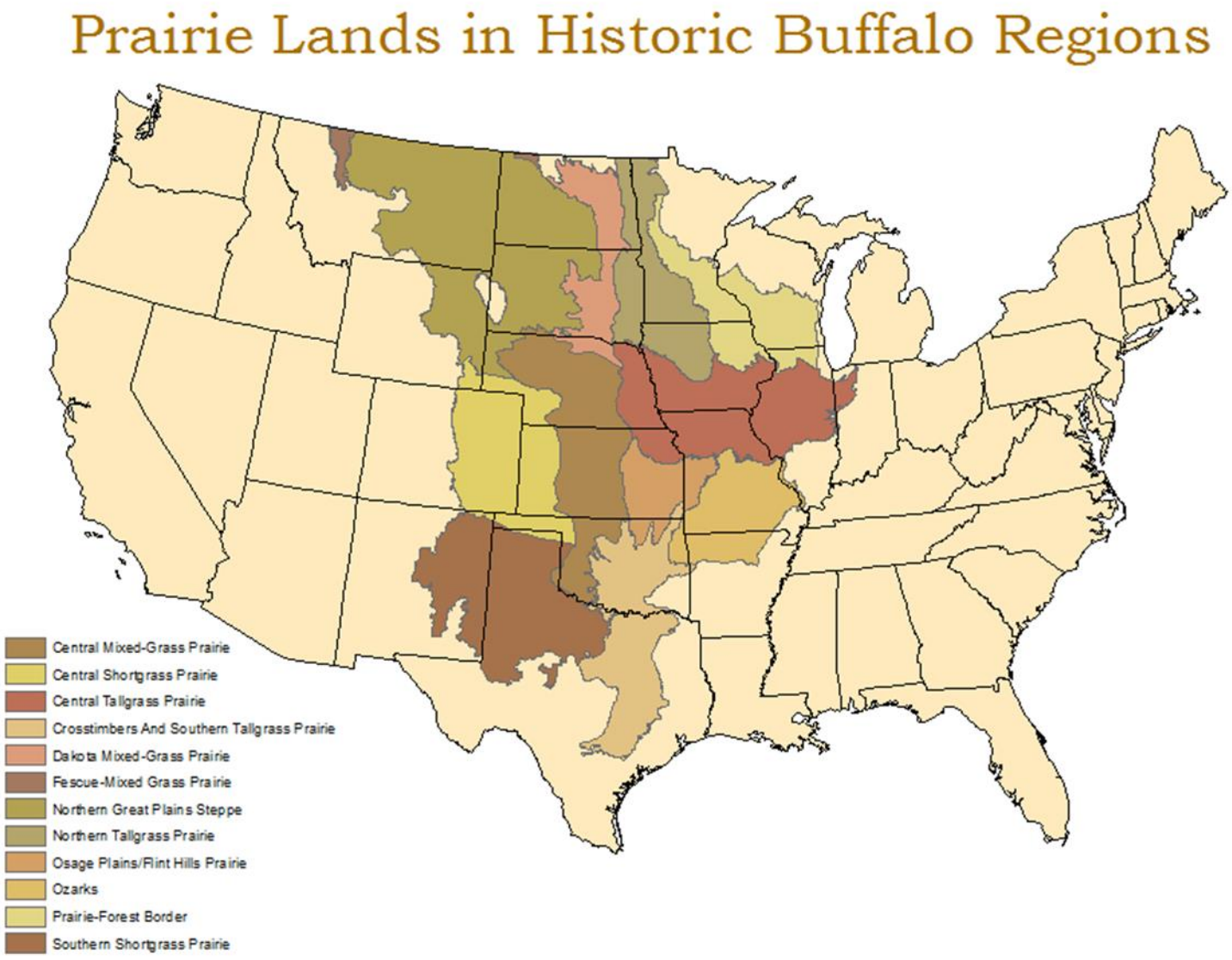
[205] Hornaday, WT. "Map Illustrating the Extermination of the American Bison." 1889.

Full map by N.S. Shaler, 1876[206]



[206] Shaler, N.S. "Map of North America." Kentucky Geological Survey, 1876.

Full Map of the Prairie Lands found in the United States Geological Survey's Eco-Region Database[207]



[207] National Gap Analysis Program. "Ecological Data GIS." United States Geological Survey. 2017.

Appendix B

I) Constant in the 3 beef production stages

A) Calf-cow operations calculated the time a baby calf stayed with his mom, typically on open rangeland grazing.

1) This was the most variable section of calculations and depended greatly on rainfall, elevation, and management.

B) The Weaning stage was the acreage calculated in feed and land used for the time when the baby calf was removed from his or her mother and began eating solid, trough food.

1) The type of feed varied slightly between states between hay, roughage, or creep diets.
2) Hay was calculated at 6,000 lbs per acre[208] .
3) Corn was calculated at 8,4000 lbs (150 bushels) per acre which may be a conservative estimation [209] [210].
4) In the calculation, each calf was given half an acre of space for standing in attempt to average out the two main types of weaning (confined and pastured).

II) State Calculations

A) Montana

1) Calf-cow operations in Montana typically use 2.5 acres per month for around 6 months and then the calf is weaned [211].
   (i) 2.5 acres/ month x 6 months = 15 cow/calf acres
2) Weaning takes place over a 2 month period in which the calf is fed a roughage diet of around 41 lbs, 15 lbs corn and 26 lbs hay, per day [212].
   (i) 15 lbs corn x 60 days = 900 lbs corn
   (ii) 900lbs corn/ 8,400 lbs/ acre= .107 acres
   (iii) 26 lbs hay x 60 days = 1,560 lbs hay
   (iv) 1,560 lbs hay / 6,000 lbs/ acre = .260 acres
   (v) .107 corn acres + .260 hay acres = .367 feed acres
   (vi) .367 feed acres + .5 standing acres = .867 weaning acres
3) In order to relate back to the two averages calculated earlier, it is assumed that the Beef Cow number includes calf-cow operations and weaning so these two sections need to be added together.
   (i) 15 calf-cow acres + .867 weaning acres = 15.867 Beef Cow acres
4) Feedlot operations need four months of 25 lbs/ day [213].
   (i) 25 lbs of corn x 120 days = 3,000 lbs of corn
   (ii) 3,000 lbs of corn/ 8,400 lbs/ acre = .357 acres
   (iii) .357 feed acres + .007 standing acres = .364 Cattle Excluding Cow Acres

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[208]Danny Greene et al., "Calculating Hay Yields," *Purdue Hay Day* (June, 1993).
[209] Roe and Roe.
[210] Doe.
[211] Bodner.
[212] Ibid.
[213] Ibid.

B) Nebraska
   1) Calf-cow operations in Nebraska typically use 1.333 acres per month for around 4 months and then the calf is weaned. [214]
      (i) 1.333 acres/ month x 4 months = 5.333 cow/calf acres
   2) Weaning takes place over a 3 month period in which the calf is fed a creep diet of around 41 lbs, 21 lbs corn and 20 lbs hay, per day [215].
      (i) 21 lbs corn x 90 days = 1890 lbs corn
      (ii) 1890 lbs corn/ 8,400 lbs/ acre= .225 acres
      (iii) 20 lbs hay x 90 days = 1800 lbs hay
      (iv) 1,800 lbs hay / 6,000 lbs/ acre = .300 acres
      (v) .225 corn acres + .300 hay acres = .525 feed acres
      (vi) .525 feed acres + .5 standing acres = 1.025 weaning acres
   3) In order to relate back to the two averages calculated earlier, it is assumed that the Beef Cow number includes calf-cow operations and weaning so these two sections need to be added together.
      (i) 5.333 calf-cow acres + 1.025 weaning acres = 6.358 Beef Cow acres
   4) Feedlot operations need 5 months of 25 lbs/ day [216].
      (i) 25 lbs of corn x 150 days = 3,750 lbs of corn
      (ii) 3,750 lbs of corn/ 8,400 lbs/ acre = .446 acres
      (iii) .446 feed acres + .007 standing acres = .453 Cattle Excluding Cow Acres

C) North Dakota
   1) Calf-cow operations in North Dakota typically use 3.333 acres per month for around 6 months and then the calf is weaned [217].
      (i) 3.333 acres/ month x 6 months = 20 cow/calf acres
   2) Weaning takes place over a 2 month period in which the calf is fed a roughage diet of around 41 lbs, 15 lbs corn and 26 lbs hay, per day [218].
      (i) 15 lbs corn x 60 days = 900 lbs corn
      (ii) 900lbs corn/ 8,400 lbs/ acre= .107 acres
      (iii) 26 lbs hay x 60 days = 1,560 lbs hay
      (iv) 1,560 lbs hay / 6,000 lbs/ acre = .260 acres
      (v) .107 corn acres + .260 hay acres = .367 feed acres
      (vi) .367 feed acres + .5 standing acres = .867 weaning acres
   3) In order to relate back to the two averages calculated earlier, it is assumed that the Beef Cow number includes calf-cow operations and weaning so these two sections need to be added together.

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[214] Melody Benjamin, interview by Skylar PeytonMar 20, 2017, Vice President of Member Services, Nebraska Cattlemen's Association.
[215] Ibid.
[216] Roe and Roe.
[217] Scott Wrestler, interview by Skylar PeytonMar 20, 2017, Environmental Services Director, North Dakota Stockmen's Association.
[218] Ibid.

(i) 20 calf-cow acres + .867 weaning acres = 20.867 Beef Cow acres

4) Feedlot operations need four months of 25 lbs/ day [219].
   (i) 25 lbs of corn x 120 days = 3,000 lbs of corn
   (ii) 3,000 lbs of corn/ 8,400 lbs/ acre = .357 acres
   (iii) .357 feed acres + .007 standing acres = .364 Cattle Excluding Cow Acres

D) South Dakota
1) Calf-cow operations in South Dakota typically use 2.396 acres per month for around 6 months and then the calf is weaned [220].
   (i) 2.396 acres/ month x 6 months = 14.375 cow/calf acres
2) Weaning takes place over a 2 month period in which the calf is fed a predominately hay diet of 38 lbs, 4 lbs corn and 34 lbs hay, per day [221].
   (i) 4 lbs corn x 60 days = 240 lbs corn
   (ii) 240lbs corn/ 8,400 lbs/ acre= .027 acres
   (iii) 34 lbs hay x 60 days = 2040 lbs hay
   (iv) 2040 lbs hay / 6,000 lbs/ acre = .340 acres
   (v) .027 corn acres + .340 hay acres = .367 feed acres
   (vi) .367 feed acres + .5 standing acres = .867 weaning acres
3) In order to relate back to the two averages calculated earlier, it is assumed that the Beef Cow number includes calf-cow operations and weaning so these two sections need to be added together.
   (i) 14.375 calf-cow acres + .867 weaning acres = 15.242 Beef Cow acres
4) Feedlot operations need four months of 25 lbs/ day[222].
   (i) 25 lbs of corn x 120 days = 3,000 lbs of corn
   (ii) 3,000 lbs of corn/ 8,400 lbs/ acre = .357 acres
   (iii) .357 feed acres + .007 standing acres = .364 Cattle Excluding Cow Acres

E) Wyoming
1) Calf-cow operations in Wyoming typically use 2.750 acres per month for around 6 months and then the calf is weaned [223].
   (i) 2.750 acres/ month x 6 months = 16.5 cow/calf acres
2) Weaning takes place over a 2 month period in which the calf is fed a hay diet of 17lbs of hay per day [224].
   (i) 17 lbs hay x 60 days = 1,020 lbs hay
   (ii) 1,020 lbs hay / 6,000 lbs/ acre = .170 acres
   (iii) .170 feed acres + .5 standing acres = .670 weaning acres

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[219] Ibid.
[220] Boltz.
[221] Ibid.
[222] Ibid.
[223] Amy Nagler et al., "Wyoming Cattle Final Report,"(University of Wyoming Department of Agricultural and Applied Economics, 2006).
[224] Niels Hansen, interview by Skylar PeytonMar 25, 2017, Farmer in South Central Wyoming.

3) In order to relate back to the two averages calculated earlier, it is assumed that the Beef Cow number includes calf-cow operations and weaning so these two sections need to be added together.
   (i) 16.5 calf-cow acres + .670 weaning acres = 17.17 Beef Cow acres
4) Feedlot operations need four months of 25 lbs/ day [225].
   (i) 25 lbs of corn x 120 days = 3,000 lbs of corn
   (ii) 3,000 lbs of corn/ 8,400 lbs/ acre = .357 acres
   (iii) .357 feed acres + .007 standing acres = .364 Cattle Excluding Cow Acres

III) Bison Sources

A) Because the environmental improvements come from the lack of outside grain and grazing styles of the bison, the calculations were based off of a 100% grass fed diet for the full 12 months.
   1) Montana – 15 acres [226].
   2) Nebraska – 17 acres [227].
   3) North Dakota- 18 acres .
   4) South Dakota- 12 Acres [228] [229].
   5) Wyoming – 18 acres [230] .

[225] Ibid.
[226] Kroos.
[227] "Blue Creek Ranch," Turner Ranches, 2017, accessed April 2, 2017. http://www.tedturner.com/turner-ranches/turner-ranch-map/blue-creek-ranch-nebraska/.
[228] O'Brien.
[229] Espy.
[230] "Durham Bison Range," 2017, accessed April 2, 2017. http://durhambisonranch.com/.

Appendix C

Site- Interview Questions

Incompatible Farming Style

- Would you walk me through your average day on the farm?
- What does a yearlong cycle look like with your livestock?

Risk Management and Adaptation

- What role does machinery play in your faming style? Are there other major factors to what you do?
- Have you made any major changes to your practices since you/ your family began farming this land?
- What are some of the key risks you face in the industry and how do you manage them?
- What role does the market play in your practice?

Family and Traditional Values

- What makes you want to farm?
- Why do you continue farming?
- Why bison (if applicable)

Future Trajectory

- If you could hope something for the next generation or your land, what would it be?
- What are your biggest concerns or fears for the future of either your land or agriculture as a whole?

General Questions about Bison and the Industry

- What do you wish people knew?
- What is the first word that comes to your head when I say “bison”?
- Have you ever thought of switching to bison? Would you be willing to? (If applicable)
- Is there anything else you want me to know or wish I would have asked?

Appendix D

In this appendix is the unaltered versions of the two datasheets for beef and bison calf-cow operations. They will be left completely intact, as can be found in their original placements. Before each spreadsheet, there will be a note with the changes that were made to make them equal to one another.

BEEF CALF-COW

Most numbers come from a datasheet created by the Extension Office of the University of Wisconsin.[231] Any other data will be cited. Costs were considered per head (pink column).

- The first section of this product was ignored. Instead of working off a previously active farm that is buying and selling cull, replacement, and calves, the process was simplified to one heifer.
    - The heifer price was taken from the November 2017 Livestock and Stocker Summary Report for an average of $1,100.[232]
    - The average breeding cycle of a heifer is 11 years, as summarized in The Cattle Site based of the 1984 research which was the largest data collection of its kind.[233]
    - This produces a 100-dollar cost per calf.
- For feed costs, the purchased and grown costs were combined for a total of 390.44 and labeled Feed Costs.
- Bedding was shown as is under variable costs.
- Veterinary expenses were labeled Health Costs under variable costs.
- Pasture expenses were not a part of the calculation because beef and bison use similar land which would produce similar costs.[234]
- Breeding purchases were labeled as Bull Replacements under fixed costs.
- Machinery and Equipment Depreciation was labeled Interest on Investment in fixed costs.
- Buildings and Facility Depreciation was labeled Interest on Investment in fixed costs.
- Related Expenses were broken down by item, and some were left out of the equations because they were not calculated for bison.
    - Custom Hire was 0 so it was ignored.
    - Hired Labor was labeled Labor under fixed costs.
    - Fuel and Oil was labeled Transportation under variable costs.
    - Utilities were labeled Miscellaneous under variable costs.
    - Machinery Repair was labeled Machinery in fixed costs.
    - Facility and Building Repair was labeled Building and Handling Facilities under fixed costs.
    - Operating Loan Interest was labeled Interest on Operating Capital under variable costs.

[231] Halfman, Stalsberg, and Sterry, "UW Extension Cow-Calf Operation Enterprise Budget."
[232] Staff, "National Feeder and Stocker Cattle Summary."; National Agricultural Statistics Service, "Livestock Slaughter 2015 Summary."
[233] "Cow Age: When Is She Too Old?," November 2014, http://www.thecattlesite.com/articles/4092/cow-age-when-is-she-too-old/.
[234] Ogle and Brazee, "Estimating Initial Stocking Rates."

    - Intermediate and Long-Term Debt Interest was labeled Interest on Investment under fixed costs.
    - Real Estate and Personal Property Taxes were omitted from calculations due to variability by size and state.
    - Farm Insurance was labeled Marketing and Inspection under variable costs.
    - Dues and Professional Fees was labeled Marketing and Inspection under variable costs.
    - Permits and Certifications were 0 so it was omitted.
    - Advertising was 0 so it was omitted.
    - Machinery leases were 0 so it was omitted.
    - Building Leases were 0 so it was omitted.
- Opportunity Cost could not be calculated nor found in Bison so it was omitted
- The next portion of the datasheet is a summary. Due to the movement, combination, and omittance of different subject, this section was ignored. This followed all the way until the end of the document.
- Because the numbers were adjusted, a new calculation was needed to create breakeven and current market prices.
    - This was done by taking the average weights of calves sold at slaughter and the closing market price from October 25th, 2017 when the analysis was completed.[235]
    - This created the total profits mentioned in the table on page 36.

[235] "Latest Feeder Cattle Price & Chart,"

Unaltered document from the University of Wisconsin[236]:

UW Extension
University of Wisconsin-Extension

Double click on this link for directions: Adobe Acrobat Document The directions provide helpful hints for each section.

UW Extension Cow-Calf Operation Enterprise Budget

Enter values in blue boxes, yellow, pink and tan boxes are calculated numbers.

Number of Cows & Springing Heifers in the herd	90
Average Market Value per head of Cows & Heifers if sold as Replacements	$1,100.00
Total Value of Cow Herd	**$99,000.00**

Revenue

Item	Head	Weight in cwts	Unit	Price/ cwt	Total cwt sold	Total $ income	Per Cow	cwts of calf sold: 435 Per cwt of calf sold
Feeder steers	45	6	cwt	$122.00	270	$32,940.00	$366.00	$75.72
Feeder heifers	30	5.5	cwt	$116.00	165	$19,140.00	$212.67	$44.00
Cull cows & heifers	14					$12,000.00	$133.33	$27.59
Cull bulls	1					$1,700.00	$18.89	$3.91
Other Livestock Sales	0					$0.00	$0.00	$0.00
Total Gross Revenue						**$65,780.00**	**$730.89**	**$151.22**

Expenses

Home Grown Feed

Feed stuff		Quantity used	Unit	Market value per unit		Total Cost	Per Cow	Per cwt of calf sold
Good hay		70	tons	$110.00		$7,700.00	$85.56	$17.70
Medium hay		30	tons	$85.00		$2,550.00	$28.33	$5.86
Cow hay		240	tons	$65.00		$15,600.00	$173.33	$35.86
Shell corn		1100	bu.	$2.75		$3,025.00	$33.61	$6.95
Oats		350	bu.	$1.30		$455.00	$5.06	$1.05
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
Total Home Grown Feed						**$29,330.00**	**$325.89**	**$67.43**

[236] Halfman, Bill, Kory Stalsberg, and Ryan Sterry. "UW Extension Cow-Calf Operation Enterprise Budget." edited by University of Wisconsin- Extension, Jan 2017.

Purchased Feed

Feed stuff		Quantity used	Unit	Cost per unit		Total Cost	Per Cow	Per cwt of calf sold
Mineral		5.5	tons	$800.00		$4,400.00	$48.89	$10.11
Weaning pellets		2	tons	$485.00		$970.00	$10.78	$2.23
Trace mineral salt blocks		55	blocks	$8.00		$440.00	$4.89	$1.01
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
						$0.00	$0.00	$0.00
Total Purchased Feed						**$5,810.00**	**$64.56**	**$13.36**

Total Feed Costs	**$35,140.00**	**$390.44**	**$80.78**
Revenue over Feed Costs	**$30,640.00**	**$340.44**	**$70.44**

Bedding

Material		Quantity used	Unit	Market Value per unit		Total Cost	Per Cow	Per cwt of calf sold
Corn stalks		66	tons	$60.00		$3,960.00	$44.00	$9.10
Wood shavings		12	tons	$55.00		$660.00	$7.33	$1.52
							$0.00	$0.00
							$0.00	$0.00
							$0.00	$0.00
Total Bedding						**$4,620.00**	**$51.33**	**$10.62**

Vet, Med & Breeding

Item		Total Annual Cost	Per Cow	Per cwt of calf sold
Vaccines- calves		$720.00	$8.00	$1.66
Vaccines- cows		$570.00	$6.33	$1.31
Dewormer		$600.00	$6.67	$1.38
Semen & AI Fees		$300.00	$3.33	$0.69
Vet bill		$900.00	$10.00	$2.07
Ear tags		$110.00	$1.22	$0.25
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
Total		**$3,200.00**	**$35.56**	**$7.36**

Pasture Expenses

Item		Total Annual Cost	Per Cow	Per cwt of calf sold
Seed		$1,000.00	$11.11	$2.30
Fertilizer		$750.00	$8.33	$1.72
Limestone		$800.00	$8.89	$1.84
Herbicide		$300.00	$3.33	$0.69
			$0.00	$0.00
Pasture rent		$900.00	$10.00	$2.07
			$0.00	$0.00
			$0.00	$0.00
			$0.00	$0.00
Total Pasture Expenses		**$3,750.00**	**$41.67**	**$8.62**

Breeding Livestock Purchases

Keep a number in the "years intend to keep" column even if row is blank to avoid divide by zero problems

Description	sex	Year bought	Purchase Price	Years intend to keep		Annual Pro-rated Cost	Per Cow	Per cwt of calf sold
Tank	bull	2014	$3,600.00	3		$1,200.00	$13.33	$2.76
				1		$0.00	$0.00	$0.00
Rufus	bull	2015	$3,300.00	3		$1,100.00	$12.22	$2.53
Heat seeker	bull	2016	$2,700.00	3		$900.00	$10.00	$2.07
			$0.00	1		$0.00	$0.00	$0.00
6 bred heifers	female	2016	$8,400.00	7		$1,200.00	$13.33	$2.76
				1		$0.00	$0.00	$0.00
				1		$0.00	$0.00	$0.00
				1		$0.00	$0.00	$0.00
				1		$0.00	$0.00	$0.00
				1		$0.00	$0.00	$0.00
			$0.00	1		$0.00	$0.00	$0.00
			$0.00	1		$0.00	$0.00	$0.00
Total			**$18,000.00**			**$4,400.00**	**$48.89**	**$10.11**

Machinery & Equipment Depreciation

Item	Current Market Value	Years of useful life left before replacement	Estimated Salvage/ Trade in Value	Annual Depreciation Expense	Estimated % allocated to cow calf enterprise	Annual cost to cow- calf enterprise	Per Cow	Per cwt of calf sold
Manure spreader	$9,000.00	9	$1,200.00	$866.67	75	$650.00	$7.22	$1.49
Loader tractor	$22,500.00	15	$7,000.00	$1,033.33	85	$878.33	$9.76	$2.02
Skid steer	$10,000.00	12	$1,800.00	$683.33	75	$512.50	$5.69	$1.18
1 ton dually	$24,000.00	8	$5,000.00	$2,375.00	60	$1,425.00	$15.83	$3.28
Cattle trailer	$9,500.00	12	$1,500.00	$666.67	100	$666.67	$7.41	$1.53
Squeeze chute	$2,500.00	10	$500.00	$200.00	100	$200.00	$2.22	$0.46
Bale feeders (12)	$3,000.00	6	$120.00	$480.00	100	$480.00	$5.33	$1.10
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
Total	**$80,500.00**					**$4,812.50**	**$53.47**	**$11.06**

Buildings and Facility Depreciation

Item	Current Market Value	Years of useful life		Annual depreciation expense	Estimated % allocated to cow-calf enterprise	Annual expense to cow-calf operation	Per Cow	Per cwt of calf sold
Hay shed	$25,000.00	15		$1,666.67	100	$1,666.67	$18.52	$3.83
Winter shed	$29,000.00	25		$1,160.00	100	$1,160.00	$12.89	$2.67
Machine shed	$40,000.00	25		$1,600.00	25	$400.00	$4.44	$0.92
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
		1		$0.00		$0.00	$0.00	$0.00
Subtotal	**$94,000.00**					**$3,226.67**	**$35.85**	**$7.42**

Related Expenses

Item	Annual Amount for Farm	% Allocated to cow- calf	Annual expense to cow-calf	Per Cow	Per cwt of calf sold
Custom Hire	$2,100.00	0	$0.00	$0.00	$0.00
Paid / Hired Labor	$720.00	100	$720.00	$8.00	$1.66
Fuel & Oil	$5,400.00	40	$2,160.00	$24.00	$4.97
Utilities	$1,620.00	30	$486.00	$5.40	$1.12
Machinery Repair	$4,050.00	50	$2,025.00	$22.50	$4.66
Facility & Building Repair	$3,240.00	65	$2,106.00	$23.40	$4.84
Operating Loan Interest	$2,700.00	33	$891.00	$9.90	$2.05
Intermediate and Long Term Debt Interest	$3,200.00	33	$1,056.00	$11.73	$2.43
Real Estate and Personal Property Taxes	$1,328.00	50	$664.00	$7.38	$1.53
Farm Insurance	$2,500.00	50	$1,250.00	$13.89	$2.87
Dues and Professional Fees	$630.00	100	$630.00	$7.00	$1.45
Permits and Certification			$0.00	$0.00	$0.00
Advertising			$0.00	$0.00	$0.00
Machinery Leases			$0.00	$0.00	$0.00
Building Leases			$0.00	$0.00	$0.00
Miscellaneous					
			$0.00	$0.00	$0.00
Total Annual Related Expenses for Cow-Calf Enterprise			**$11,988.00**	**$133.20**	**$27.56**

Opportunity Cost on Overhead Investment

Opportunity Cost Interest Rate Percent on Cattle			1.00%	$1,170.00	$13.00	$2.69
Opportunity Cost Interest Rate Percent on Machinery & Equipment			1.00%	$805.00	$8.94	$1.85
Opportunity Cost Interest Rate Percent on Buildings and Facilities			1.00%	$940.00	$10.44	$2.16
	acres	$ value/acre	% int. Rate			
Opportunity Cost for owned Pasture	160	$2,700.00	1.00%	$4,320.00	$48.00	$9.93
Total Opportunity Cost				**$7,235.00**	**$80.39**	**$16.63**

Summary

Income			
Feeder Sales	$52,080.00	$578.67	$119.72
Cull Sales	$13,700.00	$152.22	$31.49
Other Livestock Sales	$0.00	$0.00	$0.00
Total Gross Revenue	**$65,780.00**	**$730.89**	**$151.22**
Expenses			
Home Grown Feed	$29,330.00	$325.89	$67.43
Purchased Feed	$5,810.00	$64.56	$13.36
Bedding	$4,620.00	$51.33	$10.62
Vet, Med & Breeding	$3,200.00	$35.56	$7.36
Pasture Expenses	$3,750.00	$41.67	$8.62
Bull Purchase Expenses	$4,400.00	$48.89	$10.11
Related Expenses	$11,988.00	$133.20	$27.56
Total Variable Expenses	**$63,098.00**	**$701.09**	**$145.05**
Return to Labor, Management, and Capital	**$2,682.00**	**$29.80**	**$6.17**
Fixed Expenses			
Machinery	$4,812.50	$53.47	$11.06
Buildings	$3,226.67	$35.85	$7.42
Total	**$8,039.17**	**$89.32**	**$18.48**
Opportunity Cost on Investment	**$7,235.00**	**$80.39**	**$16.63**
Return to Unpaid Labor and Management Prior to Servicing Debt	**($12,592.17)**	**($139.91)**	**($28.95)**
Breakeven		**$870.80**	**$180.17**
Breakeven feeder sale price less cull and other sales with zero return to unpaid labor and management			**$148.67**

	Total	% Allocated to Cow Calf			
Principal Payments on Intermediate Term Loans			$0.00	$0.00	$0.00
Principal Payments on Long Term Loans			$0.00	$0.00	$0.00
Return to Unpaid Labor and Management after Debt Serviced			($12,592.17)	($139.91)	($28.95)
Breakeven after Debt Serviced				$870.80	$180.17
Breakeven feeder sale price less cull and other sales after debt service with zero return to unpaid labor and management					$148.67

Sensitivity Analysis of Feed Cost and Feeder Calf Prices, results shown on a per cwt of feeder calf price difference in profit or loss

		-15.00%	-10.00%	-5.00%		5.00%	10.00%	15.00%
		$126.37	$133.80	$141.24	$148.67	$156.11	$163.54	$170.97
-15.00%	$68.66	($10.18)	($2.75)	$4.68	$12.12	$19.55	$26.98	$34.42
-10.00%	$72.70	($14.22)	($6.79)	$0.64	$8.08	$15.51	$22.95	$30.38
-5.00%	$76.74	($18.26)	($10.83)	($3.39)	$4.04	$11.47	$18.91	$26.34
	$80.78	($22.30)	($14.87)	($7.43)	$0.00	$7.43	$14.87	$22.30
5.00%	$84.82	($26.34)	($18.91)	($11.47)	($4.04)	$3.39	$10.83	$18.26
10.00%	$88.86	($30.38)	($22.95)	($15.51)	($8.08)	($0.64)	$6.79	$14.22
15.00%	$92.90	($34.42)	($26.98)	($19.55)	($12.12)	($4.68)	$2.75	$10.18

Spreadsheet developed by Bill Halfman, Kory Stalsberg and Ryan Sterry, UW Extension Agriculture Agents in Monroe, Grant/ Lafayette, and St. Croix Counites

BISON CALF-COW

Most numbers were taken from a datasheet released by the Extension Office of Pennsylvania State University.[237] All other data will be cited. Costs were calculated per head (amount column).

- Like the beef section, the first part of this datasheet (Receipts) was ignored. Instead of working off an active farm, the comparison was done in terms of one cow.
    - This means for the replacement heifer, the price of 3,000 was taken from the USDA's Monthly Bison Report for the month of September.[238]
    - The average breeding year is 20 years, as noted by the National Bison Association.[239]
    - This means cost per calf was 150 dollars.
- Feed Requirements for Cow and Calf (which is Pasture, Hay, Soybean Meal, Salt and Minerals) were considered the Feed Costs.
- Feed Costs for finishing bull and replacements were ignored because this study was focused on only the calf-cow operation
- Total Feed Costs was ignored because it combined Finishing Bull and Replacements with Feed Requirements for Cow and Calf.
- Health Program was labeled Health Costs under variable costs.
- Hired Labor was labeled Labor under fixed costs.
- Transportation was labeled Transportation under variable costs.
- Marketing and Inspection was labeled Marketing and Inspection under variable costs.
- Supplies and Miscellaneous was labeled Miscellaneous under variable costs.
- Interest on Operating Capital was labeled Interest on Operating Capital under variable costs.
- Total Variable Costs was ignored and calculated independently.

[237] Greaser, Morrow, and Harper, "Sample Bison Cow-Calf Budget."
[238] Saso, "September Monthly Bison Report."
[239] "Bison by the Numbers: Data and Statistics."

- Labor Charges were labeled Labor under fixed costs.
- Bull Replacement Costs were labeled Bull Replacements under fixed costs.
- Interest on Investment was labeled Interest on Investment under fixed costs.
- Fencing was labeled Machinery under fixed costs.
- Buildings and Handling Facilities were labeled Building and Handling Facilities.
- Total Fixed Costs were ignored and calculated independently
- Total Costs and Returns were omitted and calculated using current market prices.
    - The current sale price for yearling bison was pulled from the National Bison Association's auction site.[240] Specifically, from a sale in December of 2016.
    - The weight was pulled from the same source.[241]
    - This creates the total market profits mentioned on pg 36.

Unaltered document from Pennsylvania State University[242]:

Sample Bison Cow-Calf Breeder Budget (One Cow)

Bulls and heifers sold as breeding stock; hay-pasture program.

Item	Quantity	Your Quantity	Unit	Price/unit	Your Price	Amount	Calculated Estimate
Reciepts (per cow)							
Bull calf	0.45	_____	head	$ 2,000.00	_____	$ 900.00	_____
Heifer calf	0.11	_____	head	$ 2,000.00	_____	$ 220.00	_____
Heifers (cull replacements)	75	_____	lb	$ 2.50	_____	$ 187.50	_____
Price for uncleaned skull (slaughtered bull)					_____	$ 29.00	_____
Price untanned hide (culls/slaugher animals)					_____	$ 39.00	_____
Cull cows	120	_____	lb	$ 1.25	_____	$ 150.00	_____
Cull bulls	32	_____	lb	$ 1.50	_____	$ 48.00	_____
Total receipts						**$ 1,573.50**	_____

[240] "Trading Board Listings,"

[241] Ibid.

[242] Greaser, George L, Melissa Morrow, and Jayson K Harper. "Sample Bison Cow-Calf Budget." edited by Pennsylvania State University Extension, August 2017.

Variable Costs

Feed requirements for cow and calf									
Pasture (hay equivalent)	3.5		ton	$	40.00		$	140.00	
Hay (mixed grass and legumes)	0.9		ton	$	80.00		$	72.00	
Soybean meal	0.5		cwt	$	12.00		$	6.00	
Salt and minerals	90		lb	$	0.12		$	10.80	
Feed costs cow and calf							$	228.80	
Feed for finishing bull and replacements									
Pasture (hay equivalent)	2.8		ton	$	40.00		$	112.00	
Hay (mixed grass and legumes)	0.9		ton	$	80.00		$	72.00	
Corn	11		bu	$	3.20		$	35.20	
Soybean meal	2		cwt	$	14.00		$	28.00	
Salt and minerals	90		lb	$	0.12		$	10.80	
Feed costs, bull and replacements							$	258.00	
Total feed costs							$	486.80	
Health program	1		cow	$	14.00		$	14.00	
Hired labor	6		hour	$	6.00		$	36.00	
Transprotation	1		cow	$	5.00		$	5.00	
Marketing and inspection	1		cow	$	75.00		$	75.00	
Supplies and miscellaneous	1		cow	$	15.00		$	15.00	
Interest on operating capital							$	9.93	
Total variable costs							**$**	**617.73**	

Fixed Costs									
Labor charges	10		hour	$	6.00		$	60.00	
Bull replacement costs							$	22.00	
Interest on investment	1		cow	$	75.60		$	75.60	
Fencing	1		cow	$	50.00		$	50.00	
Buildings and handling facilities	1		cow	$	30.00		$	30.00	
Total fixed costs							**$**	**237.60**	

Total costs							$	855.33	

Returns									
							$	955.77	
Net returns							$	718.17	

Returns over variable costs

Bibliography

"Adult Obesity Facts." edited by Center for Disease Control and Prevention, 2017.
Agricultural Research Services. "USDA Food Composition Databases." edited by United States Department of Agriculture, 2017.
"American Buffalo (Bison)." Wildlife Species Information. 1998. Accessed March 19, 2017. https://www.fws.gov/species/species_accounts/bio_buff.html.
Arthun, Dave, and John L. Holechek. "The North American Bison." *Rangelands* 4, no. 3 (1982): 1-4.
Association, American Sociological. "What Is Culture." 2018. Accessed March 31, 2018. http://www.asanet.org/topics/culture.
Barkley, Melanie. "Basic Beef Production Guidelines (Beef Cattle)." 2017. Accessed March 26, 2017. http://extension.psu.edu/animals/beef/production/articles/basic-beef-production-guidelines.
"Basic Facts About Bison." Last modified Feb 15, 2012, 2012. Accessed March 19, 2017. http://www.defenders.org/bison/basic-facts.
Bechdol, Elizabeth, Allan Gray, and Brent Gloy. "Choices." *Agricultural & Applied Economics Association* (2010).
"Beef Industry Statistics." Beef USA. 2017. Accessed September 10, 2017. http://www.beefusa.org/beefindustrystatistics.aspx.
Benjamin, Melody. "Phone Interview with Melody Benjamin." By Skylar Peyton (Mar 20, 2017).
"Bison by the Numbers: Data and Statistics." edited by National Bison Association, 2017.
Blackwell, Kelsey. "Are Bison the Answer to Sustainable Meat?". *Health and Nutrition Research* (2011-07-19 Jul 19, 2011).
"Blue Creek Ranch." Turner Ranches. 2017. Accessed April 2, 2017. http://www.tedturner.com/turner-ranches/turner-ranch-map/blue-creek-ranch-nebraska/.
Bodner, Jay. "Phone Interview with Jay Bodner." By Skylar Peyton (Mar 20, 2017).
Boltz, Stan. "Phone Interview with Stan Boltz." By Skylar Peyton (March 28, 2017).
Broucek, Jan. "Production of Methane Emissions from Ruminant Husbandry: A Review." *Journal of Environmental Protection* 05, no. 15 (2014-11-25 2014): 1482.
"Cattle Ranching Industry Overview." 2018.
Chavas, Jean-Paul, Robert G. Chambers, and Rulon D. Pope. "Production Economics and Farm Management: A century of Contributions." *American Journal of Agricultural Economics* 92, no. 2 (2010): 356-75.
Chiba, Lee I. "Beef Cattle Nutrition and Feeding." *Animal Nutrition Handbook* (2014): 454-85.
Chicago Board of Trade. "Latest Feeder Cattle Price & Chart." Oct 25 2017. http://www.nasdaq.com/markets/feeder-cattle.aspx.
———. "Live Cattle Prices." *Market Insider*, November 23 2017.
Christopherson, R.J., R.J. Hudson, and R.J. Richmond. "Comparative Winter Bioenergetics of American Bison, Yak, Scottish Highland and Hereford Calves." *ACTA Theriologica* 23, no. 2 (1978): 49-54.
"Commodities: Latest Corn Price." Nasdaq, 2017.
Conroy, E., J. N. Turner, A. Rymszewicz, J. J. O'Sullivan, M. Bruen, D. Lawler, H. Lally, and M. Kelly-Quinn. "The Impact of Cattle Access on Ecological Water Quality in Streams: Examples from Agricultural Catchments within Ireland." *Science of The Total Environment* 547, no. Supplement C (2016/03/15/ 2016): 17-29.
Cook, Rob. "Cattle Inventory Vs Human Population by State." September 24, 2017. Accessed September 25, 2017. http://beef2live.com/story-cattle-inventory-vs-human-population-state-0-114255.
Corah, L.R. "Development of a Corn-Based Beef Industry." *American Society of Animal Science* (2008).

Correspondents. "If Nc Wants to Feed Itself – and the World – It Needs to Save Its Farms." *The News and Observer*, March 24, 2017,.

Craine, Joe. *Climate Change* (blog). https://blog.nature.org/science/2013/06/24/climate-change-bison-cattle-grassland/.

Craine, Joseph M. "Long-Term Climate Sensitivity of Grazer Performance: A Cross-Site Study." *PLOS ONE* 8, no. 6 (2013): e67065.

Cronon, William. *Changes in the Land : Indians, Colonists, and the Ecology of New England*. First edition. New York : Hill and Wang, 1983., 1983.

———. "Pricing the Future: Grain." In *Nature's Metropolis*. New York: W.W. Norton, 1991.

Damhoureyeh, S, and D Hartnett. "Effects of Bison and Cattle on Growth, Reproduction, and Abundances of Five Tallgrass Prairie Forbs." *American Journal of Botany* 84, no. 12 (December 1, 1997 1997): 1719.

Deas, Gerald W. "To Beef or Not to Beef…Health Is the Question." *New York Amsterdam News* 102, no. 17 (2011): 30-30.

Dimitri, Carolyn, Anne Effland, and Neilson Conklin. "The 20th Century Transformation of U.S. Agriculture and Farm Policy." In *Economic Information*: United States Department of Agriculture, June 2005.

Doe, Jane. "Phone Interview with Jane Doe." By Skylar Peyton (October 15, 2017).

Doe, John. "Phone Interview with John Doe." By Skylar Peyton (Mar 21, 2017).

"Durham Bison Range." 2017. Accessed April 2, 2017. http://durhambisonranch.com/.

Epsy, Moritz. "Site Interview with Moritz Epsy." By Skylar Peyton (September 29, 2017).

Espy, Moritz. "Phone Interview with Moritz Espy." (March 29, 2017).

"Farm and Ranch Irrigation Survey." edited by USDA Census of Agriculture Historical Archive, 1910-2002.

Food and Drug Administration. "Farm Animal Welfare: An Assessment of Product Labeling Claims, Industry Quality Assurance Guidelines, and Third Party Certification Standards." In *A Farm Sanctuary Report*: Department of Health and Human Services, 2005.

Foulke, Thomas, Steven J Torok, Tex Taylor, and Edward Bradley. "Enterprise Budget: Bison Cow-Calf." University of Wyoming College of Agriculture, January 2001.

Fraas, Wyatt. "Niche Marketing." Strategies to Revitalize Rural America. Last modified 2007-03-20, 2007. Accessed October 16, 2017. https://www.cfra.org/renewrural/s/niche-markets.

Gilbertson, C. B., T. M. McCalla, J. R. Ellis, O. E. Cross, and W. R. Woods. "Runoff, Solid Wastes, and Nitrate Movement on Beef Feedlots." *Journal (Water Pollution Control Federation)* 43, no. 3 (1971): 483-93.

Goldschmidt, Walter. "Large-Scale Farming and the Rural Social Structure." *Rural Sociology* 43, no. 3 (1978): 362.

Greaser, George L, Melissa Morrow, and Jayson K Harper. "Sample Bison Cow-Calf Budget." edited by Pennsylvania State University Extension, August 2017.

Greene, Danny, Stephen Hawkins, Keith Johnson, David Petritz, and David Trotter. "Calculating Hay Yields." *Purdue Hay Day* (June, 1993): 1-4.

"Greenhouse Gas Equivalencies Calculator." edited by Environmental Protection Agency, 2018.

Hahn, William. "Beef and Pork Values and Price Spreads Explained." In *Electronic Outlook Report from the Economic Research Service*: United States Department of Agriculture- Economic Research Service, May 2004.

Halfman, Bill, Kory Stalsberg, and Ryan Sterry. "UW Extension Cow-Calf Operation Enterprise Budget." edited by University of Wisconsin- Extension, Jan 2017.

Hansen, Kristine. "Buffalo Meat Makes a Million." *CNN Money*, Mar 13, 2012.

Hansen, Niels. "Email Correspondence with Niels Hansen." By Skylar Peyton (Mar 25, 2017).

Harrington, Lisa MB, and Max Lu. "Beef Feedlots in Southwestern Kansas: Local Change, Perceptions, and the Global Change Context." *Global Environmental Change* 12, no. 4 (2002): 273-82.

Hayes, Denis, and Gail Boyer Hayes. *Cowed: The Hidden Impact of 93 Million Cows on America's Health, Economy, Politics, Culture, and Environment*. First Edition ed. New York: W.W. Norton & Company, 2015.

Henry, Alison. "How Bison Survive Winter in the Northern Great Plains." 2017. Accessed September 18, 2017. https://www.worldwildlife.org/stories/how-bison-survive-winter-in-the-northern-great-plains.

Hornaday, W. T. *Map Illustrating the Extermination of the American Bison*. Julius Bien & Co. Lith., 1889.

Hutchinson, Dave. "Site Interview with Dave Hutchinson." By Skylar Peyton (September 15, 2017).

Hyner, Christopher. "A Leading Cause of Everything: One Industry That Is Destroying Our Planet and Our Ability to Thrive on It." *Stanford Environmental Law Journal* (2017).

"Industrial Agriculture: The Outdated, Unsustainable System That Dominates U.S. Food Production." Food and Agriculture. 2017. Accessed November 12, 2017. http://www.ucsusa.org/our-work/food-agriculture/our-failing-food-system/industrial-agriculture.

Institute of Agriculture and Natural Resources. "Beef Production Calendar." 2017. http://beef.unl.edu/beefprodcal.shtml.

Jaeger, JR, GJ Pirelli, and DW Weber. "Beef Cow-Calf Management Guide." Oregon State University, 2003.

Kassel, Kathleen. "U.S. Net Farm Income Is Forecast to Rise in 2017 after Declining in the Prior 3 Years." August 2017. Accessed November 23, 2017. https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=76952.

Klamm, Michael. "Phone Interview with Michael Klamm." By Skylar Peyton (March 23, 2017).

Klinkenborg, Verlyn. "Death of a Farm." *The New York Times*, 20100731 2010.

Kroos, Roland. "Phone Interview with Roland Kroos." By Skylar Peyton (March 29, 2017).

Krugman, Paul R., and Robin Wells. *Macroeconomics* [in English]. Fourth edition. ed. New York, NY :: Worth Publishers, 2015.

Ling Wang, Sun, Richard Nehring, and Roberto Mosheim. "Indices of Farm Output, Input, and Total Factor Productivity for the United States, 1948-2015." In *Agricultural Productivity in the U.S.*, edited by USDA ERS, Oct 2017.

Link, Alexandra, and Christ Ling. "Farmers' Markets and Local Food Systems." June 2007. Accessed February 9, 2018. https://crcresearch.org/case-studies/crc-case-studies/farmers-markets-and-local-food-systems.

Lobao, Linda, and Katherine Meyer. "The Great Agricultural Transition: Crisis, Change, and Social Consequences of Twentieth Century Us Farming." *Annual Review of Sociology* 27, no. 1 (2001/08/01 2001): 103-24.

Lyons, Erin Patrick. "Give Me a Home Where the Buffalo Roam: The Case in Favor of the Management-Function Transfer of the National Bison Range to the Confederated Salish and Kootenai Tribes of the Flathead Nation Student Note." *Journal of Gender, Race & Justice* 8 (2004-2005 2004): 711-34.

Lyson, Thomas A., and Amy Guptill. "Commodity Agriculture, Civic Agriculture and the Future of U.S. Farming." *Rural Sociology* 69, no. 3 (2004): 370-85.

MacDonals, James M., and Robert Hoppe. "U.S. Cropland Is Consolidating into Larger Farms." Farm Size and Organization of U.S. Crop Farming. December 2017. Accessed Dec 20, 2017. https://www.ers.usda.gov/amber-waves/2017/december/us-cropland-is-consolidating-into-larger-farms/.

Marcotty, Josephine, and Dave Hage. "Can We Save Bison by Eating Them?" *Star Tribune*, Feb 28, 2015.

Matheson, Jim. "Phone Interview with Jim Matheson." By Skylar Peyton (March 28, 2017).

"Meat Price Spreads." 2017. Accessed Dec 20, 2017. https://www.ers.usda.gov/data-products/meat-price-spreads/.

Metzger, Steve, and Vern Anderson. "Commercial Bison Production: Economic Analysis and Budget Projections." *Carrington Area Farm Business Management Program (1993-1996)* (1998).

Mitchell, Tesla. "Aging Farmers, Fewer Farmers: Trends in Agriculture Bring Sweeping Changes in Winona County, Countrywide." *Winona Daily Mail*, Feburary 8, 2015.

"Modern Beef Production: Fact Sheet." edited by Cattlemen's Beef Board and National Cattlemen's Beef Association, 1-2: Explore Beef, 2009.

"Monthly Bison Report Summary January 2017 Vs December 2016 and Vs Previous Five Years." edited by United States Department of Agriculture, 2017.

Nagler, Amy, Sian Mooney, Chris Bastian, John P. Hewlett, Ben Aldrige, Brent Allen Sarchet, Wendy Umberger*, et al.* "Wyoming Cattle Final Report." 1-135: University of Wyoming Department of Agricultural and Applied Economics, 2006.

National Agricultural Statistics Service. "Cattle on Feed February Report." 1-19: U.S. Department of Agriculture, Feb 24, 2017.

———. "Farms and Land in Farms 2016 Summary." 1-20: United States Department of Agriculture, February 2017.

———. "Land Values 2017 Summary." August 2017.

———. "Livestock Slaughter 2015 Summary." 1-68: U.S. Department of Agriculture, April, 2016.

National Gap Analysis Program. "Ecological Data GIS." *United States Geological* Survey 2017.

Neilson, Laura. "Grass-Fed Bison Meat for Conscious Carnivores." *Cool Hunting*, 2012-06-21 June 21, 2012.

O'Brien, Dan. "Phone Interview with Dan O'brien." By Skylar Peyton (Mar 17, 2017).

Ogle, Dan, and Brendan Brazee. "Estimating Initial Stocking Rates." In *Technical Note*: USDA- National Resources Conservation Services, June 2009.

Oklahoma Cooperative Extension Service. "Cow Age: When Is She Too Old?" November 2014. http://www.thecattlesite.com/articles/4092/cow-age-when-is-she-too-old/.

Pan, A., Q. Sun, A. M. Bernstein, M. B. Schulze, J. E. Manson, M. J. Stampfer, W. C. Willett, and F. B. Hu. "Red Meat Consumption and Mortality: Results from 2 Prospective Cohort Studies." *Arch Intern Med* 172, no. 7 (Apr 09 2012): 555-63.

Pelletier, Nathan, Rich Pirog, and Rebecca Rasmussen. "Comparative Life Cycle Environmental Impacts of Three Beef Production Strategies in the Upper Midwestern United States." *Agricultural Systems* 103, no. 6 (2010/07/01/ 2010): 380-89.

"Per Capita Consumption of Poultry and Livestock, 1965 to Estimated 2018, in Pounds - the National Chicken Council." edited by United States Department of Agriculture, 2017.

Plumb, Glenn E., and Jerrold L. Dodd. "Foraging Ecology of Bison and Cattle on a Mixed Prairie: Implications for Natural Area Management." *Ecological Applications* 3, no. 4 (1993): 631-43.

"Raising Bison: Starting Your Bison Operation." 2017. 2017. https://bisoncentral.com/raising-bison/.

"Raising Cattle for Beef Production & Beef Safety." Explore Beef. 2017. Accessed March 26, 2017. http://www.explorebeef.org/raisingbeef.aspx.

Rasmussen, Dan. "Site Interview with Dan Rasmussen." By Skylar Peyton (September 30, 2017).

Ray, Charles Michael. "South Dakota Buffalo Farmers Relish Bison Meat Boom." *National Public Radio*, Dec 21, 2011.

Ro, Sam. "Here's a Price List for a Whole Bunch of Cool, Brand New Farm Equipment." *Business Insider*, 2014-05-08 May 8 2014.

Roe, Johnny, and John Roe. "Phone Interview with John and Johnny Roe." By Skylar Peyton (Mar 22, 2017).

Royne, Marla B., Marian Levy, and Jennifer Martinez. "The Public Health Implications of Consumers' Environmental Concern and Their Willingness to Pay for an Eco-Friendly Product." *The Journal of Consumer Affairs* 45, no. 2 (2011): 329-43.

Sananes, Rebecca. "As Big Milk Moves in, Family-Owned U.S. Dairy Farms Rapidly Fold." *National Public Radio*, January 11, 2017.

Saso, Breanna. "September Monthly Bison Report." United States Department of Agriculture, Oct 11 2017.

Schwartz, Judith D. "Soil as Carbon Storehouse: New Weapon in Climate Fight?". *Sustainable Agriculture* (March 4, 2014).

"Scientific Consensus: Earth's Climate Is Warming." *NASA Global Climate Change* (2017).

Sejian, Veerasamy, Rattan Lal, Jeffrey Lakritz, and Thaddeus Ezeji. "Measurement and Prediction of Enteric Methane Emission." *International Journal of Biometeorology* 55, no. 1 (Jan 2011): 1-16.

Severson, Kim. "As Bison Becomes More Popular, Two Views Emerge on How to Treat Them." *The New York Times*, 20160209 Feb 9 2016.

Shaler, N.S. "Map of North America." Kentucky Geological Survey, 1876.

Sinha, Rashmi, Amanda J. Cross, Barry I. Graubard, Michael F. Leitzmann, and Arthur Schatzkin. "Meat Intake and Mortality: A Prospective Study of over Half a Million People." *Archives of internal medicine* 169, no. 6 (2009): 562-71.

Soeters, Karen, and Gertjan Zwanikken. "Meat the Truth." 72 min. Amsterdam: Alalena Production, 2008.

"Sources of Greenhouse Gas Emissions." Last modified 2018-04-14, 2017. Accessed November 22, 2017. https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions.

Staff, USDA. "National Feeder and Stocker Cattle Summary." St. Joseph, MO: United States Department of Agriculture, November 2017.

Stalcup, Larry. "2017 Cattle Price Forecast: Don't Expect Much Movement." Beef Marketing. Last modified 2016-11-17, Nov 2016. Accessed November 12, 2017. http://www.beefmagazine.com/marketing/2017-cattle-price-forecast-don-t-expect-much-movement.

Sumner, Daniel A. "American Farms Keep Growing: Size, Productivity, and Policy." *Journal of Economic Perspectives* 28, no. 1 (2014): 147-66.

Sutera, Steve. "Site Interview with Steve Sutera." By Skylar Peyton (September 16, 2017).

"The Beef Lifecycle: From Farm to Fork." Last modified 2014-08-27, August 27, 2014. Accessed March 26, 2017. https://factsaboutbeef.com/2014/08/27/the-beef-lifecycle-from-farm-to-fork/.

"The Ecology of Big Beef: The Shadows of Consumption." edited by Peter Dauvergne. Consequences for the Global Environment, 147-54: MIT Press, 2008.

"The Efficient Steer: Fast, Fat, and Cheap." In *The Shadows of Consumption*, edited by Peter Dauvergne. Consequences for the Global Environment, 135-46: MIT Press, 2008.

The Wall Street Journal. "Shifting Appetites: Change in the U.S. Consumption of Beef, Chicken, Pork & Seafood | Scatter Chart Made by Dreamshot | Plotly." In *plot.ly*: Dreamshot, 2017.

Towne, E. Gene, David C. Hartnett, and Robert C. Cochran. "Vegetation Trends in Tallgrass Prairie from Bison and Cattle Grazing." *Ecological Applications* 15, no. 5 (2005): 1550-59.

"Trading Board Listings." October 2017. Accessed October 25, 2017. https://bisoncentral.com/trading-board-listings/.

Troxel, Tom R, and Kenny Simon. "Best Management Practices for Small Beef Cow-Calf Herds." Division of Agriculture- University of Arkansas.

"Turner Ranches." 2017. Accessed September 9, 2017. http://www.tedturner.com/turner-ranches/.

United States Department of Agriculture. "Bison 2014: Health and Management Practices on U.S. Ranched-Bison Operations." edited by USDA–APHIS–VS–CEAH–NAHMS., 1-200. Fort Collins, CO, Dec 2016.

———. "Quick Stats National Agricultural Statistics Service." 2017. 2017. https://quickstats.nass.usda.gov/#F5F5719A-D65A-307E-8A11-22013E5AE7EF.

US Census Bureau. "Population by State." edited by United States Department of Commerce and Labor, 2010.

"USDA Census of Agriculture Historical Archive." edited by Albert R. Mann Library - Information Technology Services, 2017.

Vasconcelos, J. T., L. O. Tedeschi, D. G. Fox, M. L. Galyean, and L. W. Greene. "Review: Feeding Nitrogen and Phosphorus in Beef Cattle Feedlot Production to Mitigate Environmental Impacts." *The Professional Animal Scientist* 23, no. 1: 8-17.

Veterinary Services. "Mortality of Calves and Cattle on U.S. Beef Cow-Calf Operations." edited by United States Department of Agriculture: Animal and Plant Health Inspection Service, May 2010.

Vilsack, Tom. "United States Summary and State Data." 1-694: United States Department of Agriculture, 2012.

Vilsack, Tom, and Cynthia C.F Clark. "2012 Census of Agriculture: United States Summary and State Data." In *Geographic Area Series*, May 2014.

Wechsler, Seth J. "Recent Trends in Ge Adoption." Adoption of Genetically Engineered Crops in the U.S. July 2017. Accessed Dec 20, 2017. https://www.ers.usda.gov/data-products/adoption-of-genetically-engineered-crops-in-the-us/recent-trends-in-ge-adoption.aspx.

West, Jason, and Danelle Haake. "Estimation of Carbon Sequestration in a Restored Tallgrass Prairie Ecosystem in Eastern Missouri." *Missouri Botanical Garden* (2014).

Wolk, A. "Potential Health Hazards of Eating Red Meat." *J Intern Med* 281, no. 2 (Feb 2017): 106-22.

Wrestler, Scott. "Phone Interview with Scott Wrestler." By Skylar Peyton (Mar 20, 2017).

Wuerthner, George. "The Truth About Land Use in the United States." *Watersheds Messenger* 9, no. 2 (2002).

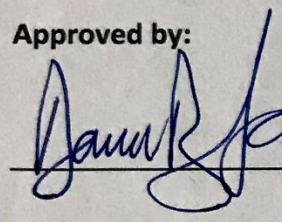
Yang, Shang-Ho, and Timothy A. Woods. "Assessing Consumer Willingness to Pay for Ground Bison Given Nutrition Information." 1-16. Southern Agricultural Economics Association Annual Meeting: AgEcon Search, February 2013.

Signature Page

Project title: Home on the Market Range: An Evaluation of Cultural and Economic Barriers to Large-Scale Bison Farming

By Skylar Peyton

Approved by:



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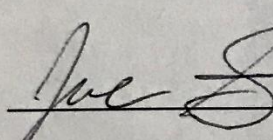

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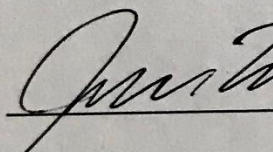

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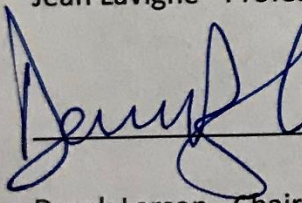
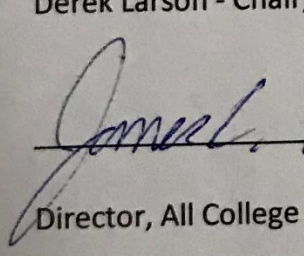


Derek Larson - Chair, Department of Environmental Studies



Director, All College Thesis Program