Location Optimization of Dairy Processing

by

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ABSTRACT

Location optimization of a new dairy processing plant is crucial given the significant capital investment of $350 million required to build the plant. Couple this with notable differences in milk and transportation costs due to location, an examination of historical Net Present Value (NPV) of Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) adjusted by a discount rate of 3% is warranted to help determine the most optimal location for a new dairy processing plant investment. This thesis is an examination of historical EBITDA NPV for three locations: Dumas, TX, Sioux Falls, SD, and Lansing, MI in an effort to predict the optimal location of a future dairy processing plant. These locations were chosen due to each having the necessary milk supply that would both encourage milk production and support increases in dairy processing. Prices dairy processors receive for cheese can fluctuate but are not tied to the location in which the cheese is produced. Transportation costs of the cheese are determined by the distance to the processing plant from Plymouth, WI, which is where most further cheese processing takes place. Therefore, this thesis includes a sensitivity analysis for the Lansing, MI location to determine a breakeven milk cost and cheddar cheese price.

The NPV was positive for the Dumas, TX location at $100 million as compared to (-$820) million and (-$247) million at the Sioux Falls, SD and Lansing, MI locations, respectively. The results indicate an emerging EBITDA NPV trend favoring the Lansing, MI location as indicated by this location having the best performance in the last two years (2016-2017) of $104 million compared to a negative performance at both of the other locations. The previous 8 years performance would favor the Dumas, TX location, however more weight was given to the past 2 years performance as an indicator for future

economic returns. As a result, this thesis concludes the Lansing, MI location as the most favorable location for a new dairy processing investment.

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CHAPTER I: INTRODUCTION

The U.S. dairy industry has and continues to be an integral part of U.S. agriculture. At the end of February, 2018, the U.S. dairy industry had a total of 9.4 million cows with an average annual production per cow of 19,700 pounds. (USDA 2018). The top 5 largest milk producing states, beginning with the largest, are California, Wisconsin, New York, Idaho, and Pennsylvania (USDA 2018). Milk is a perishable product and is approximately 85% water, which requires dairy processing to be in close proximity to the production to avoid spoilage and lower transportation costs. As a result, dairy production and dairy processing are linked very closely together.

The optimal location of a new dairy processing plant is a significant monetary investment decision. The importance of location optimization is largely driven by the availability of milk supply, since 85 -90% of total cost to operate a dairy processing plant is comprised of milk cost (Mischel 2018). Supply, whether high or low, of milk in a region directly impacts the price paid for milk in that region. Given that milk is a perishable product and made up of a high percentage of water, processing is optimally located within reasonable proximity of its production. As a result, development of dairy production and processing generally take place in proximity to one another. The investment required in constructing a 4 million pound per day dairy processing plant is approximately $350 million. This is a sizable investment that requires support and a well-designed strategy to allow the investment to provide the desired economic return both initially and over the useful life of the asset.

The purpose of this thesis is to conduct a net present value analysis to identify the optimal location of a dairy processing facility by utilizing information flows from three specific processing plant locations by analyzing the 10 year Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA). The formula utilized to determine EDITDA for each location was EBITDA (Product Sales – Milk Cost – Transportation Cost – Variable Cost). The three sites for analysis chosen were Dumas, TX, Sioux Falls, SD and Lansing, MI. A breakeven analysis was undertaken for both milk price and cheese price for the Lansing, MI location in an effort to demonstrate how much each would need to move to provide a breakeven ten-year NPV. The percentage change variable allows for further analysis of the likelihood of the change in the past as applied to projected future changes.

The stakeholders that would benefit from this type of analysis include dairy processors, dairy producers, economic development officials, food retailers, lenders, such as my employer (Farm Credit Services of America), shipping companies, and dairy processing equipment manufacturers. Collectively, these prospective clients may be interested in such a model in order to best determine the allocation of financial, in terms of asset development, and human capital, as well as leveraging relationships. In particular, a dairy processor would utilize the model to help narrow the potential optimal locations for dairy processing facilities, which in turn helps dairy producers determine both in what location to expand or more importantly which locations not to make further investments. The users of the model operate in an environment of scarce resources and very competitive markets; therefore, the objective of these clients is to generate a competitive advantage to enhance company performance. In comparison, lenders and dairy processing clients could utilize the model to help predict those dairy processors and producers that may be best positioned to take advantage of this information and target their marketing to those entities and relationships.

CHAPTER II: LITERATURE REVIEW

The literature review chapter provides some context of the problem explored through an examination of similar projects and analysis undertaken. This section also seeks to examine relevant processing plant problem location articles via a review of these previously completed problems and or model assessments to provide guidance for the current model and framework.

2.1 Examination of Key Determinants to Location Theory as Applied to Milk Processing Plants.

In an effort to provide some context to the key factors determining the location of milk processing plants, an examination of theoretical approaches is appropriate. The processing plant should be situated at the location providing the maximum profit for the firm, including both transportation of the raw material and finished product, as well as processing costs (Olsen 1959). In addition, milk that is produced in areas far from population centers will be manufactured into products of considerably less bulk such as cheese and milk powder to help overcome the transportation required to move the finished good to market.

Olsen (1959) undertook an analysis of determining the minimum total cost based on assembly costs and processing costs. Assembly costs are determined in part by milk production density relative to the milk processing plant location. The higher the density of production, the lower assumed distance and thus cost to assemble (transport) the milk to the processing plant. In turn, processing costs can be determined by decreasing marginal costs per unit of output (cheese or milk powder), which is based on the size of the plant due to lower fixed costs as the size of the plant increases. In short, the larger the plant the lower fixed cost per unit. The type of milk processing plant, cheese or butter and powder, will also have an impact on the fixed costs, due to the difference in plant infrastructure. Cheese processing plants have higher costs than butter and powder processing plants. Olsen (1959) focused on production costs, assuming perfect competition in the market, regardless of physical location of the processing plant.

2.2 Dairy Processing Plant location with Economies of Size and Market-Share Restrictions.

In addition to the total cost analyses, economies of size and market-share restrictions should be considered when evaluating an optimization model for milk processing plant location. Kloth and Blakley (1971) set out to develop a realistic optimization model that assesses the effects on total costs and interregional milk flows under alternative degrees of market concentration when economies of size of processing plants are permitted. Central to this approach is consideration of the supply of raw milk within a given region in conjunction with the existing milk processing capacity, as well as consideration of demand within a region. These variables help determine if and where potential milk production will flow from one region to another. The model indicated the costs of processing fluid milk in an industry with economies of plant size and excess plant capacity relative to regional milk production levels, would be expected to decrease as the number of firms declined due to consolidation and the resulting economies of scale. Fewer plant locations cause both assembly costs and finished product distribution costs to increase as firm numbers decline, only if comparative advantages among regions are unaffected by changes in firm numbers (Kloth and Blakey 1971). A conclusion of the Kloth and Blakey (1971) model was that minimizing industry costs can give results that overestimate the potential savings from reorganization of the industry. A substantial portion of the savings might be attributed to the economies associated with the establishment of a single firm in the local market (Kloth and Blakey 1971). In summary, the greater the size of the plant, with a raw milk supply to support the larger size will have cost advantages in the marketplace.

2.3 Insights from Biorefinery Location Decision Models

Objective functions in past models of facility location decision-making sought to maximize profits while accounting for product sales, feedstock, transportation cost, facility location assignment and other operating costs. In the biorefinery literature, the location decision objective functions are profit based, i.e.: Profits = Product Sales – Feedstock Cost – Transportation Cost – Facility Capital Cost – Variable Operating Costs (Ian M. Bowling 2011). Bowling (2011) focused on developing an objective function that applied to a biorefinery. A similar function could be applied to a milk processing plant location decision model. In their article, Bowling (2011) defined Feedstock Cost as the sum of feedstock purchased from suppliers. The variability of this cost is a function of supply and demand which is the primary driver of profitability. The Facility Capital Cost variable was assumed to be heavily dependent on the size of the facility. However potential locations with varying access to utilities and specific needs may also result in variability in location costs. (Ian M. Bowling 2011) The capital cost was scaled to account for economies of scale and a maximum size of facility was identified. The cost to construct the facility were lumpy for specific equipment, which meant that there were intervals of size that were more advantageous due to capacity of the biorefining equipment.

2.4 Considerations for Agricultural Location Based Problems

Simple location problems, that address a sole question of where to locate new facilities, are rare in agriculture. Most agricultural location problems are more complex and incorporate multiple facility locations and facility capacity constraints. More common in agriculture are location-allocation problems, in which the number of facilities, their locations, and these interactions all become decision variables. Often these location-allocation problems are complicated by routing decisions, which are more complex by taking account of capacity and time constraints (Chhajed 2004).

Chhajed et al. (2004) found that most location problems in agriculture are of a large scale and scope. Most production of agricultural commodities is not highly concentrated and therefore a large number of producers in the analysis is required. In addition, most location problems in agriculture are broad in scope. This aspect has led to most problems focusing on the entire industry rather than a specific company or a particular stage in the process.

Due the large size of agricultural location problems, they are challenging to solve. An approach to help with this challenge is to reduce the number of variables through data aggregation and or accepting a larger constant in the optimization formula. Meaningfully aggregating data can be a challenge due the aggregation bias introduced by the person who is developing the data set. Another potential approach is to break-down larger sized problems into independent smaller sub-problems (Chhajed 2004).

The purpose of the review undertaken by the article by Chhajed (2004) was not to derive the "best" solution, but rather to assist in the decision-making process by illustrating the varied consequences of multiple choices. The review found that variability in agricultural commodities, in terms of supply, are very common due to the influence of uncontrollable factors like weather. Most agricultural location problems make assumptions regarding supply variability or did not incorporate them at all due to the lack of predictability. Finally, the review of agricultural location problems indicated that one may want to consider a time dimension rather than a "snapshot" approach due to the implication of commodity storage to meet supply demands for a future demand time horizon.

CHAPTER III: DATA AND METHODS

The goal of this thesis is to examine the optimal location for a type of dairy processing plant. The plant type chosen for this examination for each location is a commodity full fat cheddar cheese plant, producing 640 pound blocks of cheese to be sold for further processing into cubes, blocks, shreds, etc. A commodity full fat cheddar cheese plant was chosen due to growing U.S. consumer demand for cheese. Per capita cheese consumption of the U.S. population was 33.92 pounds in 2014 and is expected to increase to 37 pounds by 2025 (Statista 2014). The size of the cheese plant is set at four million pounds of milk processed per day over 365 days each year. The cheese yield utilized in the model was set to require 9.6 pounds of milk to produce one pound of cheddar cheese. The content of the milk is also standardized to 3.5% fat and 3% protein, which is the industry milk standard utilized widely, to account for potentially variable fat and protein milk composition for each location. The amount of cheese produced at each plant is the direct result of the milk pounds procured divided by the cheese yield of the milk, 1.46 billion pounds based on the cheese yield of 9.6 lbs of milk, as referenced in Table 3.1. The percentage of whey (WPC 80), lactose, and De Lactosed Permeate (DLP) produced as a percentage of milk processed, were held constant at a level of 2.75%, 2.95%, and 2.10%, respectively. The facility capital cost was set constant at a total investment of $350 million regardless of location, recognizing there may be some specific location advantages. However, the capital costs were assumed to be fixed at the same level for all locations and thus do not impact model outputs. Tax rates were assumed to be constant across all three locations chosen, even though income tax rates by state vary. Likely tax abatements and subsidies provided for economic development projects, such as a dairy processing plant, that could level the tax difference impact on the model results, therefore different tax rates by location were not included in the model. The discount rate was set at 3% for each location and was determined by a combination of long term inflation rates and term interest rates available to the industry during the 2008-2017 period examined.

Table 3.1 Model Parameters

Parameters		
% of Milk troughput to Cheese		92%
% of Milk thoughput to Whey		2.75%
% of Milk throughput to Lactose		2.950%
% of Milk throughput to DLP		2.100%
Full Fat Cheddar Cheese Milk Requirement/lbs		9.6
Plant Size (lbs milk/year)		1,460,000,000
Lbs of Cheese Produced/year		152,083,333
Facility Capital Cost	$	350,000,000
Discount Rate		3%
Variable Cost/cwt	$	2.25
Cheese Transportation Cost/lb	$	0.0612
Miles from Plymouth, WI (cut & wrap)		1112
Cost of Transportation/mile	$	2.75

The objective of the economic model is the maximize net returns to the dairy processing plant. The economic model utilized was the historical Net Present Value (NPV) as estimated by annual Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) for each location based on milk cost and cheese prices provided by USDA-ERS. The model assumed the initial investment in the cheese processing plant was made at the beginning of 2008. NPV provides an income normalization to the initial investment time period by discounting the earnings back to 2008 dollars. Each year's EBITDA present value (PV) was determined and the sum of each year's PV is the NPV. NPV was then separated into both the first five years and most recent five years to get an indication of emerging changes in each location. These calculations estimate the financial profitability of each investment over a period of years. Given the volatility of milk and cheese prices, a NPV analysis is critical to help predict future profitability and to spot emerging trends for each plant location.

Further, a breakeven analysis was undertaken on the Lansing, MI location to determine both the cheese price and milk price required to obtain a NPV of $0. The percentage change in these respective prices from the actual were represented to provide some perspective on the price change, either milk or cheese price, required to achieve a breakeven EBITDA NPV.

3.1 Economic Model

The economic model developed is a net present value model of milk processing plant returns utilizing the present value of Earnings Before Interest Taxes Depreciation and Amortization (EBITDA) over a ten-year time horizon across three potential plant locations. EBITDA is calculated using the formula: EBITDA = Product Sales – Milk Cost – Transportation Cost – Variable Cost. EBITDA is the value used to determine profitability, or present value, for each year by location and the subsequent Net Present Value (NPV). The EBITDA NPV approach was used because it represented historical profitability of the various plant locations which is the main driver and influencer for the user of the model. The three potential plant locations selected, Lansing, MI, Dumas, TX and Sioux Falls, SD were chosen because there has been milk supply expansion in these areas in recent years and there has been interest from milk processors in expanding processing in these areas. The EBITDA NPV is the sum of the yearly present values by location and represents the cumulative earnings outcome adjusted assuming an annual discount rate of 3%. The 2008-2017 average 10-year US Treasury Bill rate was 2.23%, which is why a discount rate of 3% was chosen (YCharts 2018). The timeframes used to examine NPV at each location include the full time period (2008-2017), the first 5 years (2008-2012) and the last 5 years (2013-2017) in an effort to determine past profitability and its application to future profitability. The 2008-2017 time period was chosen because it was the most recent and relevant period and a 10 year time period was chosen to be able to see trends and previous outcomes via a data set that is large enough to analyze. The model is intended to demonstrate the variability of the outcomes for each location to identify historical advantages and disadvantages of each location and potential emerging trends.

Table 3.1 provides an overview of the designed spreadsheet formulation of the economic model developed to examine the historical EBITDA year present value and the total net present value. EBITDA differences are tied primarily to fluctuations in milk cost by location and secondarily to transportation cost of the finished product (cheddar cheese). Product sales are a function of the cheese, dry whey, lactose, and delactosed permeate resulting from the output of the processing plant. Each of the components of the economic (and spreadsheet model) are described in more detail below.

Table 3.1 Net Present Value Milk Processing Plant Location Spreadsheet Model Example

	NPV	Location Lansing, MI Year	EBITDA (=)	(+) Product Sales	(-) Milk Cost	(-) Transportation Cost	(-) Variable Operating Cost	Cheese Price/lb	WPC 80 Price/lb	Lactose Price/lb	DPL Price/lb	Milk Price/cwt	CPI
1	($7,311,305.01)	2008	$ (7,530,644)	$ 304,657,253	$ 280,076,667	$ 3,421,514	$ 28,689,716	**1.8558**	**0.2504**	**0.2686**	**0.0262**	**19.1833**	**215.303**
2	($18,131,344.55)	2009	$ (9,475,637)	$ 217,796,349	$ 195,275,000	$ 3,409,341	$ 28,587,644	**1.2961**	**0.2585**	**0.2206**	**0.0261**	**13.3750**	**214.537**
3	($66,451,762.09)	2010	$ (23,492,716)	$ 257,594,109	$ 248,565,000	$ 3,465,264	$ 29,056,561	**1.4964**	**0.3716**	**0.3318**	**0.0265**	**17.0250**	**218.056**
4	($72,092,300.13)	2011	$ (19,394,778)	$ 320,388,607	$ 306,235,000	$ 3,574,646	$ 29,973,739	**1.8064**	**0.5325**	**0.5443**	**0.0274**	**20.9750**	**224.939**
5	$40,451,815.85	2012	$ 8,832,839	$ 319,502,158	$ 276,426,667	$ 3,648,621	$ 30,594,031	**1.6979**	**0.5935**	**0.8496**	**0.0279**	**18.9333**	**229.594**
6	($74,826,720.67)	2013	$ (13,812,826)	$ 319,988,066	$ 299,056,667	$ 3,702,065	$ 31,042,160	**1.7630**	**0.5902**	**0.6338**	**0.0283**	**20.4833**	**232.957**
7	($108,259,136.39)	2014	$ (17,376,279)	$ 369,669,896	$ 351,738,333	$ 3,762,119	$ 31,545,722	**2.1098**	**0.6538**	**0.5033**	**0.0288**	**24.0917**	**236.736**
8	($44,916,070.55)	2015	$ (6,398,581)	$ 271,432,837	$ 242,481,667	$ 3,766,585	$ 31,583,166	**1.6103**	**0.3804**	**0.2408**	**0.0288**	**16.6083**	**237.017**
9	$73,056,867.66	2016	$ 9,382,975	$ 265,517,151	$ 220,338,333	$ 3,814,117	$ 31,981,725	**1.5797**	**0.2875**	**0.2981**	**0.0292**	**15.0917**	**240.008**
10	$30,922,563.08	2017	$ 3,625,068	$ 279,346,068	$ 238,953,333	$ 3,917,667	$ 32,850,000	**1.6106**	**0.4437**	**0.3638**	**0.0300**	**16.3667**	**246.524**
10 yr NPV	**($247,557,392.80)**												
Min	**($108,259,136)**		**($23,492,716)**	**$217,796,349**	**$195,275,000**	**$3,409,341**	**$28,587,644**	**$1.2961**	**$0.2504**	**$0.2206**	**$0.0261**	**$13.3750**	**214.537**
Max	**$73,056,868**		**$9,382,975**	**$369,669,896**	**$351,738,333**	**$3,917,667**	**$32,850,000**	**$2.1098**	**$0.6538**	**$0.8496**	**$0.0300**	**$24.0917**	**246.524**
Mean	**($24,755,739)**		**($7,564,058)**	**$292,589,249**	**$265,914,667**	**$3,648,194**	**$30,590,447**	**$1.6826**	**$0.4362**	**$0.4255**	**$0.0279**	**$18.2133**	**229.567**
St. Dev.	**$55,797,189**		**$11,023,997**	**$40,631,735**	**$43,640,672**	**$166,538**	**$1,396,441**	**$0.2097**	**$0.1417**	**$0.1931**	**$0.0013**	**$2.9891**	**10.480**
NPV First 5 yrs	**($123,534,895.93)**												
NPV Last 5 yrs	**($124,022,496.88)**												

3.1.1 Milk Processing Plant Locations

The three sites chosen for analysis were Lansing, MI, Dumas, TX and Sioux Falls, SD. Each of these three sites was chosen due to its stability and expansion of milk supply representing the dairy producer's willingness to invest. Both the stability and expansion of milk supply are critical to new dairy processing and was the main driver of why these three locations were chosen.

3.1.2 Product Sales

Product sales data are historical price fluctuations of product sales (Cheddar Cheese 40# Blocks, Dry Whey, and Lactose) obtained from the Chicago Mercantile Exchange (CME) and USDA as compiled by the University of Wisconsin Madison (Gould 2017). The most recent price was the only published price for Delactosed Permeate (DLP) and as a result historical prices levels were adjusted according to changes in the Consumer Price Index (CPI) over the 10-year time horizon. Consumer Price Index is a measure of the average change over time in the prices paid by urban customers for a market basket of consumer goods and services (Labor 2018). CPI is a commonly used index to demonstrate price inflation or deflation for goods and services.

The tables below represent the historical finished product prices for CME cheddar cheese (Table 3.2), USDA dry whey (Table 3.3), and USDA lactose (Table 3.4) prices. Based on the historical prices for each product gathered for the 2008 – 2017 period, the finished product prices are correlated with the price of milk. For example, in 2014 the average all milk price at the Lansing, MI location was $24.09/cwt, which was the highest price for the 10 years examined. Conversely, 2014 was also the highest average yearly price for cheddar cheese at $2.1098/pound and dry whey at $0.6538. The 2014 average price level for lactose did not follow suit as the highest level, however it was the fourth highest price over the 10-year period.

Table 3.2 CME Cheddar Cheese 40# Block Price (2008-2017)

CME Cheese 40# Blocks USDA Dairy Market News - US (2008 - 2017) Quoted in $/lb

"Year"	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2008	1.8257	2.0023	1.8234	1.8826	2.0976	2.035	1.9673	1.7398	1.8762	1.7963	1.7099	1.5132	**1.8558**
2009	1.0833	1.2171	1.2455	1.2045	1.1394	1.1353	1.1516	1.3471	1.3294	1.4709	1.5788	1.6503	**1.2961**
2010	1.4536	1.4526	1.2976	1.4182	1.442	1.3961	1.5549	1.6367	1.7374	1.7246	1.4619	1.3807	**1.4964**
2011	1.514	1.9064	1.8125	1.6036	1.6858	2.0995	2.115	1.9725	1.7561	1.7231	1.8716	1.617	**1.8064**
2012	1.5546	1.4793	1.5193	1.5039	1.5234	1.6313	1.6855	1.8262	1.9245	2.0757	1.9073	1.7439	**1.6979**
2013	1.6965	1.642	1.624	1.8225	1.8052	1.714	1.7072	1.7493	1.7956	1.8236	1.8478	1.9283	**1.7630**
2014	2.1931	2.1945	2.3554	2.2439	2.0155	2.0237	1.987	2.182	2.3499	2.1932	1.9513	1.6276	**2.1098**
2015	1.5218	1.5382	1.5549	1.589	1.6308	1.7052	1.6659	1.7111	1.6605	1.6674	1.6176	1.4616	**1.6103**
2016	1.4757	1.4744	1.4877	1.4194	1.3174	1.5005	1.6613	1.7826	1.6224	1.6035	1.8775	1.7335	**1.5797**
2017	1.6866	1.6199	1.4342	1.4976	1.6264	1.6022	1.6586	1.6852	1.637	1.7305	1.659	1.49	**1.6106**

Table 3.3 Dry Whey Price (2008-2017)

Dry Whey Average Price (Announced) - US (2008 - 2017) Quoted in $/lb

"Year"	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2008	0.3992	0.2736	0.2435	0.256	0.27	0.2758	0.2642	0.247	0.2183	0.1945	0.1895	0.173	**0.2504**
2009	0.1696	0.1567	0.1662	0.1949	0.2317	0.2693	0.2912	0.2925	0.2979	0.3183	0.3471	0.3668	**0.2585**
2010	0.388	0.3925	0.3761	0.3643	0.3645	0.3688	0.3641	0.359	0.3615	0.3676	0.3736	0.3789	**0.3716**
2011	0.3935	0.4234	0.4578	0.4808	0.4929	0.5233	0.5494	0.5691	0.5926	0.6152	0.638	0.6538	**0.5325**
2012	0.6876	0.64	0.6107	0.5921	0.5389	0.5013	0.5023	0.5352	0.5846	0.6205	0.648	0.661	**0.5935**
2013	0.6503	0.6393	0.6048	0.5741	0.5765	0.5738	0.5804	0.5778	0.5791	0.5731	0.5831	0.5706	**0.5902**
2014	0.6025	0.6314	0.6554	0.6774	0.6745	0.6789	0.689	0.688	0.6725	0.6525	0.6365	0.5871	**0.6538**
2015	0.5875	0.5169	0.4824	0.461	0.445	0.4245	0.3937	0.3108	0.2442	0.2309	0.2341	0.2336	**0.3804**
2016	0.2351	0.2469	0.2477	0.2466	0.2505	0.2601	0.2742	0.2846	0.3055	0.3303	0.369	0.3994	**0.2875**
2017	0.4421	0.4894	0.5239	0.5243	0.5094	0.4917	0.4514	0.4345	0.4167	0.379	0.3587	0.303	**0.4437**

Table 3.4 Lactose Price

Lactose USDA Dairy Market News CENTRAL AND WEST Quoted in $/lb	
Year	Value
2008	0.2686
2009	0.2206
2010	0.3318
2011	0.5443
2012	0.8496
2013	0.6338
2014	0.5033
2015	0.2408
2016	0.2981
2017	0.3638

3.1.3 Milk Cost

The milk cost utilized for the model was the All Milk price as quoted by USDA rather than the Class III milk price, which is the class of milk used to make cheese. The reason the All Milk price was used is because it reflects regional differences in milk cost due to supply and demand dynamics present in each area as compared to a Class III milk price that would be the same for each region.

Milk cost for the Sioux Falls, SD location was derived from the Minnesota All Milk price rather than the South Dakota All Milk price, since the South Dakota price was not available from 2008-2012. The milk cost for the Dumas, TX location was derived from the New Mexico All Milk price due to the location of Dumas relative to New Mexico and that the Texas panhandle milk price is more similar to New Mexico prices. The state of Texas is large and there is significant price differences for milk produced in East Texas (higher). Milk cost was obtained from USDA All Milk prices as compiled by the University of Wisconsin Madison for each location (Gould 2017). Table 3.5 depicts the variability of the yearly average milk price for each location. The highest maximum value was $24.83/cwt in Sioux Falls, SD and the lowest maximum value was $22.28/cwt at the Dumas, TX location for a gap of $2.55/cwt. This significant gap also holds true for the mean between the Dumas and Sioux Falls locations with a difference of $1.48/cwt. The Lansing, MI location had the largest standard deviation of $2.989/cwt, which represents the location with the highest price variability.

Table 3.5 Average Yearly Milk Cost Statistics by Location from 2008-2017

All Milk Prices - USDA Quoted in $/cwt			
	Dumas, TX	**Sioux Falls, SD**	**Lansing, MI**
Min	$12.13	$13.39	$13.38
Max	$22.28	$24.83	$24.09
Mean	$17.14	$18.62	$18.21
St. Dev.	$2.55	$2.91	$2.99

Table 3.6 Dumas, TX (New Mexico All Milk Price)

Milk All - Price - NEW MEXICO (2008 - 2017) Quoted in $/cwt

"Year"	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2008	20	18.5	17.1	17.5	17.2	18.2	19	17.7	17.1	17.1	16.4	14.9	**17.56**
2009	13.2	11	10.9	11.2	10.7	10.3	10.5	11.4	12.4	13.5	14.9	15.6	**12.13**
2010	15.7	15.5	14.5	14.1	14.5	14.9	15.4	16.1	17	18.2	17.9	16.6	**15.87**
2011	16.2	18.6	20.2	19.2	19.2	20.2	21	21.3	20.3	18.3	18.9	18.8	**19.35**
2012	17.9	16.5	15.9	15.4	15.1	15.4	16.1	17.3	18.7	20.2	21.2	19.7	**17.45**
2013	19	18.4	17.8	18.1	18.2	18	17.8	18.1	18.9	19.8	20.5	20.9	**18.79**
2014	22.5	23.8	23.5	23.4	22.4	20.9	21.1	21.9	23.8	23.5	21.1	19.4	**22.28**
2015	16.4	16	15.7	15.5	16	15.6	15.9	15.4	16.6	16.6	17.5	16	**16.10**
2016	15.3	15	14.6	14.4	14	13.9	15.2	16.6	16.8	15.9	17	18.2	**15.58**
2017	17.9	17.1	15.7	14.5	15	15.7	16.2	16.8	16.6	16.7	17	16.2	**16.28**

Table 3.7 Sioux Falls, SD (Minnesota All Milk Price)

Milk All - Price - MINNESOTA (2008 - 2017) Quoted in $/cwt

"Year"	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
2008	21.2	19.5	19	18.7	19.7	20.6	19.6	18.5	18.8	18.8	17.7	16.6	19.06
2009	13.1	12.3	12.6	12.5	11.9	11.5	11.6	13	13.8	15.3	16.2	16.9	13.39
2010	16.1	15.9	14.6	14.6	14.9	14.9	15.3	16.5	18.2	18.9	17.7	16.3	16.16
2011	16.2	19.5	20.9	19.1	19.4	21.2	22.5	22.7	21.1	20.6	21.7	21	20.49
2012	19.7	18.6	18	17.7	17.3	17.4	18	19.5	21.3	23.5	23.3	21.4	19.64
2013	20.6	19.9	19.5	20	20.5	19.9	19	19.8	20.2	21.1	21.9	22	20.37
2014	24	26	26.1	26.6	25	23.4	23.7	24.6	27.1	26.5	24.4	20.5	24.83
2015	18.3	17.7	17.4	17.6	17.8	17.9	17.4	17.5	17.8	17.7	17.7	17	17.65
2016	16.4	16.1	15.8	15.6	14.8	15	16.8	18.1	17.9	17.2	18.8	19.6	16.84
2017	19.1	18.7	17.5	16.8	17	17.5	16.8	18	17.9	18.5	18.7	17.2	17.81

Table 3.8 Lansing, MI (Michigan All Milk Price)

Milk	All - Price - MICHIGAN (1980 - 2017) USDA											
"Year"	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Average**
2008	21.8	20	18.7	18.8	18.7	19.8	20.3	19.5	19.2	18.5	18.1	16.8	**19.18**
2009	14.9	12.2	12	12.4	12.2	12	12	12.5	13.4	14.7	15.6	16.6	**13.38**
2010	16.9	16.7	15.7	15	15.6	16.3	16.7	17.5	18.1	19.3	18.9	17.6	**17.03**
2011	17.4	19.2	21.1	20.6	20.6	21.6	22.7	23.2	22.6	21.1	21	20.6	**20.98**
2012	19.8	18.5	17.9	17.3	16.8	16.4	17.1	18.2	19.7	21.6	22.4	21.5	**18.93**
2013	20.5	19.9	19.7	19.8	20	20.2	19.9	20.4	20.6	21	21.7	22.1	**20.48**
2014	23.5	24.9	25.2	25.4	24.5	23.5	23.7	24.4	26.2	24.3	23	20.5	**24.09**
2015	17.6	16.6	16.2	16.2	16	16	15.9	16	17.2	17.3	17.8	16.5	**16.61**
2016	15.3	14.8	14.1	14	13.5	13.7	14.8	15.6	16.2	15.3	16	17.8	**15.09**
2017	18.1	17.5	16.5	15.4	15.3	15.8	16	16.6	16.5	16.3	16.6	15.8	**16.37**

The milk price by location was quite variable when you compare the New Mexico All Milk Price (Dumas, TX location Table 3.6) to both the Minnesota (Table 3.7) and Michigan (Table 3.8) All Milk Price. The New Mexico price had a minimum price that was $1.25/cwt lower and a maximum price that was $1.81/cwt lower than the Michigan price indicating the Dumas, TX location had the lowest variability of the three locations. As a result, the standard deviation of the New Mexico price was the lowest at $2.55/cwt. Both of these factors would indicate the Dumas, TX location may be a desired location.

Table 3.9 USDA All Milk Price Variability by Location in $/cwt

Year	Dumas, TX	Sioux Falls, SD	Lansing, MI
2008	17.56	19.0583	19.1833
2009	12.13	13.3917	13.3750
2010	15.87	16.1583	17.0250
2011	19.35	20.4917	20.9750
2012	17.45	19.6417	18.9333
2013	18.79	20.3667	20.4833
2014	22.28	24.8250	24.0917
2015	16.10	17.6500	16.6083
2016	15.58	16.8417	15.0917
2017	16.28	17.8083	16.3667
Min	$12.13	$13.39	$13.38
Max	$22.28	$24.83	$24.09
Mean	$17.14	$18.62	$18.21
St. Dev.	$2.55	$2.91	$2.99

3.1.4 Transportation Cost

The transportation cost represented is for the finished product (Cheddar Cheese 640# Blocks) only. Milk transportation cost was assumed to be paid by the milk producer and thus does not impact the EBITDA NPV results. The freight rates are different for each location due to the number of miles from Plymouth, WI and were obtained from an existing cheese company (Mischel 2018). This is the assumed ending location of the cheese produced because Plymouth, WI is a hub for cheese buyers, as well as cheese processing cut and wrap operations. The farther the location from Plymouth, WI, the lower the rate per mile. This is due to efficiencies gained from spreading the fixed cost of transportation per load (pickup and drop off fixed charges) over more miles. As a comparison, the Dumas, TX location freight rate was $2.75/mile and Lansing, MI is at $3.50/mile, which is the closest location. Load size is assumed to be 50,000 pounds/load. Table 3.10 demonstrates the total transportation cost by location.

Table 3.10 Total Transportation Cost by Location

Dumas, TX	Sioux Falls, SD	Lansing, MI
$86,616,283	$45,707,225	$36,481,940

Other finished products Dry Whey, Lactose, and Delactosed Permeate have no transportation cost with the price represented for these products being FOB (picked up) from the plant location. Access to rail transportation may reduce the transportation cost, regardless this cost advantage can be utilized in the model if the cost is known for future applications.

3.1.5 Variable Cost

Total variable cost is calculated to be $2.60/cwt of milk procured, based on an interview with an existing processor (Mischel 2018). Variable costs include labor, utilities, supplies, and repairs. The transportation cost to move the raw milk from the producer to the processing plant is part of the variable cost of each plant and is calculated at a stable rate of $0.35/cwt of milk procured by the plant.

3.2 Sensitivity Analysis

The Lansing, MI location was chosen to perform a sensitivity analysis to determine the breakeven present value by adjusting either the cheddar cheese price or the milk price. The Lansing, MI location had an emerging trend of better profitability in 2016-2017, which is primarily why this site was chosen to perform a sensitivity analysis. The significant impact of cheddar cheese prices on product sales and milk price on milk cost within the formula is why these prices were selected as adjustable parameters for the sensitivity analysis. The sensitivity analysis determined the amount of change required to determine how viable such a change is based on actual price levels and to identify if minor value changes in the market would lead to significant impacts on present value calculations and optimal location decisions. The breakeven milk or cheese price is useful because it demonstrated the amount of change required for each value to create a breakeven EBITDA from which this change was evaluated to determine the likelihood such a change was reasonable.

CHAPTER IV: MODEL RESULTS

Chapter IV provides the results of the EBITDA net present value economic model of 10 year historical EBITDA performance for the three locations selected – Dumas, TX, Sioux Falls, SD and Lansing, MI.

4.1 NPV Results

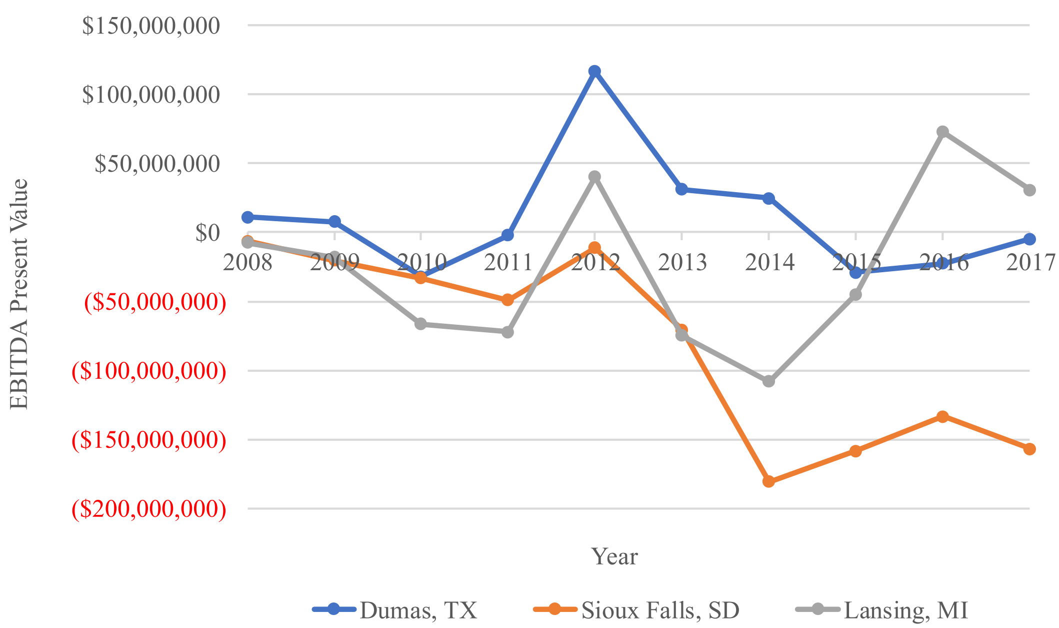
The NPV results revealed some interesting differences in the three locations that were examined both as a full 10-year time period and in two five-year increments of 2008-2012 and 2013-2017. The minimum, maximum, mean and standard deviation are provided to provide some additional context to the results.

Table 4.1 EBITDA NPV Results by Location

Year	Dumas, TX	Sioux Falls, SD	Lansing, MI
2008	$11,157,699	($6,379,468)	($7,311,305)
2009	$7,591,689	($20,246,614)	($18,131,345)
2010	($32,085,211)	($33,139,029)	($66,451,762)
2011	($2,163,877)	($49,221,974)	($72,092,300)
2012	$116,670,256	($11,135,395)	$40,451,816
2013	$31,409,107	($70,670,747)	($74,826,721)
2014	$24,778,214	($180,891,799)	($108,259,136)
2015	($29,153,094)	($158,359,910)	($44,916,071)
2016	($22,697,604)	($133,387,808)	$73,056,868
2017	($4,623,503)	($157,074,613)	$30,922,563
10 yr NPV	$100,883,676	($820,507,356)	($247,557,393)
Min	**($32,085,211)**	**($180,891,799)**	**($108,259,136)**
Max	**$116,670,256**	**($6,379,468)**	**$73,056,868**
Mean	**$10,088,368**	**($82,050,736)**	**($24,755,739)**
St. Dev.	**$40,984,657**	**$64,831,463**	**$55,797,189**
NPV First 5 yrs	**$101,170,557**	**($120,122,478)**	**($123,534,896)**
NPV Last 5 yrs	**($286,880)**	**($700,384,877)**	**($124,022,497)**

The model results, as indicated by Table 4.1, indicate that only the Dumas, TX location achieved a positive EBITDA NPV over the 10-year time horizon, with a NPV value of $100,883,676. Dumas, TX had a yearly positive EBITDA present value in 5 of the 10 years examined. The Dumas, TX results are supported by it having the lowest minimum at -$32,085,211 and highest maximum yearly EBITDA present value at $116,670,256. Conversely, the Sioux Falls, SD location had the lowest, or most negative 10-year EBITDA NPV at -$820,507,356 and was not able to generate a positive yearly EBITDA present value from 2008 to 2017. The Lansing, MI location generated a 10-year EBITDA NPV of -$247,577,393 as demonstrated in Table 4.1. The Landing, MI site however did return the best performance of the over the final two years (2016-2017) at $103,979,431. During 2016-2017 both the Dumas, TX and Sioux Falls, SD produced a negative EBITDA of -$27 million and -$290 million respectively. Figure 4.1 below demonstrates graphically how each location performed by year. Interestingly, the performance of each location appeared to diverge from one another as time increased which is a function of discounting the EBITDA results over the 10 year time period.

Figure 4.1 EBITDA Yearly Present Value Results by Location

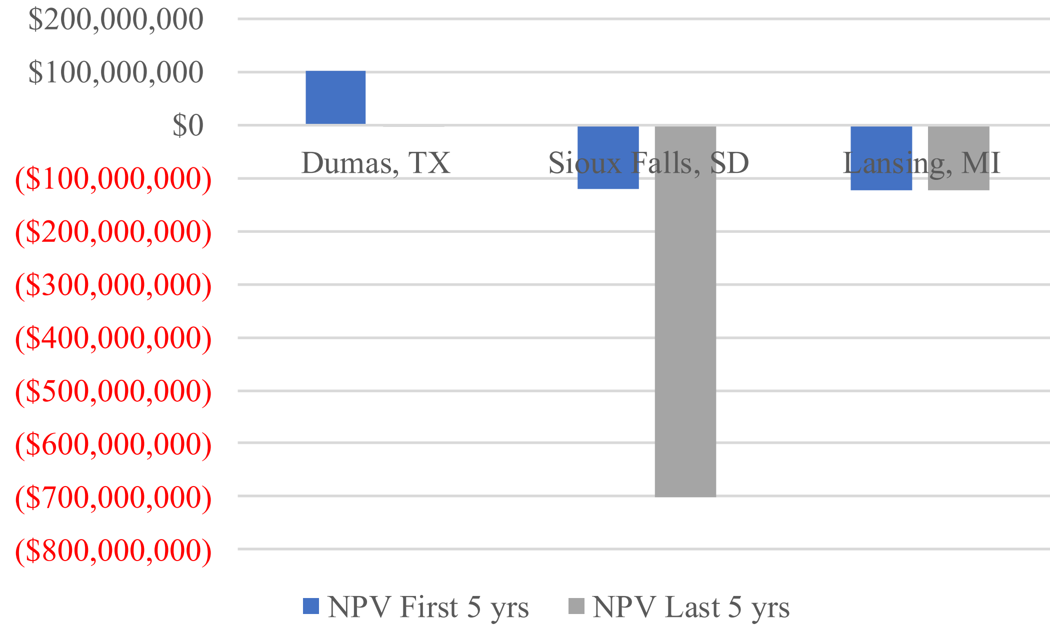


4.1.1 Time Segment EBITDA NPV Analysis

The EBITDA NPV was divided into two segments, 2008-2012 (First 5 years) and 2013-2017 (Last 5 years) to demonstrate changes in profitability during these segments as represented in Figure 4.2. An examination of these time segments was useful due the convergence of milk price for the three locations, which resulted in shifting outcomes during the full time period of 10 years. The model indicated the Dumas, TX location had the best 2008-2012 performance at an EBITDA NPV of $101,170,557 compared to the Lansing, MI location, which achieved a the lowest NPV of -$123,534,896, a difference of $224 million over the same time period. Over the last five years, 2008-2017, the Dumas, TX location also had the best performance at -$286,880 with all locations demonstrating a negative EBITDA NPV performance during this time period with Sioux Falls, SD at a considerable loss of -$700,384,877.

The emerging trend that presented itself, was the emergence of the Lansing, MI location over the final 2 years (2016-2017), as demonstrated in Table 4.1. Based on the oversupply of milk in Michigan, the trend of better performance at the Lansing, MI site is expected to continue. During that period, the Lansing, MI site achieved a EBITDA NPV of $104 million as compared to the other locations which both had a negative NPV over this period. This outcome is the direct result of milk price diminishing at an increasing rate when compared to the other locations, which can be explained by an oversupply of milk relative to the currently available dairy processing capacity.

Figure 4.2 EBITDA Time Segment NPV



4.2 Sensitivity Analysis

Lansing, MI was chosen to perform a sensitivity analysis to determine the breakeven present value by adjusting either the cheddar cheese price or the milk price. The sensitivity analysis was to determine the amount of change required for each value to determine how viable such a change is based on actual price levels and to identify if minor value changes in the market would lead to significant impacts on present value calculations and optimal location decisions. The sensitivity analysis is in actuality a breakeven analysis for the cheese plant by adjusting milk and cheese prices.

The model demonstrates that milk price contributes the most to the total cost of the dairy processing plant. As an example, at the Lansing, MI location, milk cost contributed $2.65 billion to the total cost of $3.00 billion, which is 88.6% over the 10-year period. As a result, the breakeven analysis for the Lansing, MI site indicates that milk price would have needed to decrease by an average of 2.65% or $0.5181/cwt to achieve an NPV that was equal to zero. A reduction of $0.5181/cwt is not significant and appears to be achievable due to the standard deviation in actual milk price of $2.9891/cwt during the 10-year period examined.

Table 4.2 Breakeven Milk Price at Lansing, MI Location

Year	BE Milk Price/cwt	Actual Milk Price/cwt	Difference $/cwt	% Change
2008	**$18.6675**	**$19.1833**	**-$0.5158**	**-2.689%**
2009	**$12.7260**	**$13.3750**	**-$0.6490**	**-4.852%**
2010	**$15.4159**	**$17.0250**	**-$1.6091**	**-9.451%**
2011	**$19.6466**	**$20.9750**	**-$1.3284**	**-6.333%**
2012	**$19.5383**	**$18.9333**	**$0.6050**	**3.195%**
2013	**$19.5372**	**$20.4833**	**-$0.9461**	**-4.619%**
2014	**$22.9015**	**$24.0917**	**-$1.1902**	**-4.940%**
2015	**$16.1701**	**$16.6083**	**-$0.4383**	**-2.639%**
2016	**$15.7343**	**$15.0917**	**$0.6427**	**4.258%**
2017	**$16.6150**	**$16.3667**	**$0.2483**	**1.517%**
Min	**$12.7260**	**$13.3750**	**($1.6091)**	**-9.451%**
Max	**$22.9015**	**$24.0917**	**$0.6427**	**4.258%**
Mean	**$17.6952**	**$18.2133**	**($0.5181)**	**-2.655%**
St. Dev.	**$2.7546**	**$2.9891**	**$0.7551**	**4.160%**

The model demonstrates that cheddar cheese prices contribute the most to product sales when compared to whey, lactose, and delactosed permeate, which is similar to the milk price. Fluctuations in cheese prices have significant impacts on the overall EBITDA realized for each year. For example, at the Lansing, MI location, cheese price contributed a total of $2.55 billion to the total product sales of $2.95 billion, which is 87.5% over the 10-year period examined. The breakeven analysis indicated that cheese price would need to increase by an average of $0.0497/lb or 2.923% to provide an EBITDA of $0 for the cheese plant. This compares to the actual cheese price standard deviation of $0.2097/pound. Over the time period, the range of change in cheese price was $0.81/lb or 48.3% of the average cheese price, which demonstrates the high degree of volatility in the cheese market.

Table 4.3 Breakeven Cheese Price at Lansing, MI Location

Year	BE Cheese Price/lb	Actual Cheese Price/lb	Difference $/lb	% Change
2008	**$1.9053**	**$1.8558**	**$0.0495**	**2.668%**
2009	**$1.3584**	**$1.2961**	**$0.0623**	**4.807%**
2010	**$1.6508**	**$1.4964**	**$0.1545**	**10.323%**
2011	**$1.9340**	**$1.8064**	**$0.1275**	**7.060%**
2012	**$1.6398**	**$1.6979**	**-$0.0581**	**-3.421%**
2013	**$1.8538**	**$1.7630**	**$0.0908**	**5.152%**
2014	**$2.2240**	**$2.1098**	**$0.1143**	**5.416%**
2015	**$1.6524**	**$1.6103**	**$0.0421**	**2.613%**
2016	**$1.5180**	**$1.5797**	**-$0.0617**	**-3.906%**
2017	**$1.5868**	**$1.6106**	**-$0.0238**	**-1.480%**

Min	**$1.3584**	**$1.2961**	**($0.0617)**	**-3.906%**
Max	**$2.2240**	**$2.1098**	**$0.1545**	**10.323%**
Mean	**$1.7323**	**$1.6826**	**$0.0497**	**2.923%**
St. Dev.	**$0.2357**	**$0.2097**	**$0.0725**	**4.393%**

CHAPTER V: CONCLUSIONS

The historical EBITA NPV model results demonstrated a high level of variability in primarily at the Dumas, TX and Lansing, MI moving each from periods of profits and loss. The Dumas, TX location had the highest levels of EBITDA during the first eight years of the analysis, however over the final two years, the EBITDA advantage shifted toward the Lansing, MI location. Over this two-year time period the performance at the Lansing, MI site outpaced both other locations. The results showed the shifting milk price environments and its significant impact on profit levels. Given the emerging EBITDA advantage of Lansing, MI, the model supports potentially locating the dairy processing plant at this site if conditions remain favorable there. The results do demonstrate results at the Lansing, MI site were highly variable over the full time period and would not support this location based on using the full time period. This risk is offset by weighting the 2016-2017 results more heavily because these outcomes are from the most recent past and provide a better indication of future results. Further support is provided by the variability in all locations decreasing over the 10 years examined. Additional support for locating the new dairy processing plant at the Lansing, MI location is provided by the actual development of a large, eight million pound per day processing plant to be located near Grand Rapids, MI to be owned by Dairy Farmers of America (DFA), Select Milk Producers Cooperative and Glanbia, an Irish dairy processor. Alternatively, the less variable milk price environment and strong historical EBITDA performance at the Dumas, TX location support this location as a viable location, as well. Clearly the model does not represent the Sioux Falls, SD location as a suitable location and given its past performance, it is unlikely it will be viable in the near future.

The sensitivity analysis demonstrated the high EBITDA impact due to slight changes in the cheddar cheese and milk prices. Given both cheddar cheese prices and milk prices are highly linked to one another, the impact of these prices on the EBITDA NPV is amplified.

Further analysis could be undertaken in subsequent models to evaluate a different type of dairy processing plant, such as milk powder production to determine if similar outcomes were presented as the model utilized in this project. Also, one could choose additional locations other than the ones in the project to identify other desirable locations.

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