FEASIBILITY ASSESSMENT OF ALTERNATIVE SUPPLY CHAIN DESIGNS: THE CASE OF CARGILL ANIMAL NUTRITION

by

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ABSTRACT

Cargill Animal Nutrition is a global manufacturer and distributor of animal nutrition products. They operate in the United States through 6 separately managed regions that control a number of facilities throughout the entire United States. Cargill Animal Nutrition Southeast Region manages a network of eleven plants and two warehouses in the southeast part of the United States. The purpose of this thesis is to explain the current supply chain design including the relationships that exists between facilities, analyze the costs associated with the current design and relationships, and assess the feasibility of alternative designs of supply chain strategies available.

A brief description of each facility along with production characteristics specific to each facility is given. Due to certain production characteristics, dependent relationships exist between certain plants. These relationships create restrictions to which our supply chain is subject. Other relationships are not as rigid and thus can be manipulated in pursuit of lowering overall supply chain costs. The model resulting from this thesis will facilitate the assessment of the feasibility of these changes.

There are many costs associated with the supply chain; however, costs included in this analysis are limited to the costs that could vary when changing suppliers. The price of the product, transportation costs, and certain warehouse fees deemed relevant to this research

are applied to the expected annual sales tons to reach a total cost of supply chain considering the assumptions made.

The base scenario was defined according to known facts regarding the current design of our supply chain, which included identification of suppliers, supplier prices, transportation costs, and associated handling/warehouse fees, as well as determining the quantity of product that would need to flow throughout our supply chain. Then the total cost associated with the current supply chain design was assessed according to our analytical model.

Once the total cost of the base scenario was determined, comparison to alternative scenarios could take place. Changing the relationships between locations of the supply chain results in alternative scenarios to which the analytical model and decision rule developed can be applied to determine feasibility of the alternative supply chain designs.

Operating within the confines of the research, the total cost of the current supply chain design was determined to be $15,697,426. That total cost then serves as a base figure which can be used in comparison with the overall cost of alternative scenario #1. Scenario #1 resulted in a total cost of $15,447,597 – an annual savings of $249,828. Scenarios #2 through #4 were evaluated against the total cost of scenario #1. The total cost of scenario #2 is $15,421,364 which results in annual savings of $26,234. Scenario #3 results in a total supply chain cost of $15,347,888 which equates to annual savings of $9,710 in comparison to scenario #1. The final scenario in this study results in a total cost of $15,443,547. The annual savings generated by scenario #4 in comparison to scenario #1 are $4,050.

The results indicate that there are alternative configurations of Cargill Animal Nutrition's Southeast supply chain that can be developed to increase the competitiveness of operations and improve operational excellence through cost savings. These results are used to inform management in the implementation of the new goals that have been established for the organization. Further utilization of the tool developed will result in increased knowledge of the costs associated with supply chain design. This will allow the company to be able to understand the cost of their supply chain so they can benefit from decreased supply chain costs by reacting to changing market factors.

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ACKNOWLEDGMENTS

I’d like to thank my incredible husband Noah for his support throughout this entire experience. The last three years have been challenging and exciting, but have not allowed us to spend enough time together. Without his endless patience and encouragement, I would not have had the strength to finish.

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CHAPTER I: INTRODUCTION

1.1 Cargill Animal Nutrition History

Cargill Animal Nutrition (CAN) is a global animal nutrition company which services the animal production industry across the globe. CAN is part of Cargill, a multinational company operating in 66 countries, with 142,000 employees. CAN has 16,000 employees in 37 countries, manufacturing and processing feed and selling it through a network of retail stores, dealerships, and animal producers.

CAN entered the animal feed business in 1884 in La Crosse WI, but would not officially become the Cargill Feed Division until 1941. It was not long before CAN began its campaign of growth. In 1945, CAN doubled the size of the company by acquiring Nutrena Feed Mills of Kansas City, KS. CAN continued to expand globally over the following years through a series of acquisitions as well as opening new mills. Through advancements in technology such as CAN's Optimum Value Supplier database, AutoCalc™, and Max™, CAN stayed at the forefront of the animal feed industry. By 2004, CAN had grown to a network of 163 feed mills in 22 countries with sales of over 11 million tons annually.

Since 2004, CAN has continued on their path of growth. In November of 2011, CAN finalized its purchase of Provimi – an international animal nutrition business consisting of 7,000 employees. The acquisition complemented the existing CAN business with added nutrition expertise in the form of premixes, additives, and ingredients. Significant volume from sales of minerals, ingredients, and other nutritional supplements was gained through this acquisition.

In the United States, CAN operates through nine business entities referred to as "regions". Six main regions service separate geographic areas of the United States. The Upper Midwest Region, Southeast Region, and South Central Region are very similar. They cater to large retail customers like Tractor Supply and continue to build business with smaller local customers near production facilities. The Northeast Region serves local customers, but instead of general farm store businesses of equine, chicken, and rabbit feeds, the Northeast serves a large base of bulk dairy customers. Servicing the dairy business requires many more custom feeds than farm store business. Higher margins are attainable when dealing with these custom feeds. The Pacific Northwest and Pacific Southwest Regions' business are similar to the Southeast Region, but on a smaller scale. US Aqua and Enterprise Beef serve very specific customer segments. US Aqua produces only aqua feeds and markets their products globally. Enterprise Beef specializes in bulk beef feeds and customized diets for beef cattle feedlots. The activities of the regions presented in Table 1.1 show that although the Southeast Region (CAN SE) had the highest volume of sales, it was only second in sales revenue in the 2010/2011 fiscal year. This makes CAN SE an influential operating region with the capacity to influence CAN's overall financial results.

Table 1.1: Cargill Animal Nutrition

Region	June 2010-May 2011 Sales Tons	June 2010-May 2011 Gross Sales
Enterprise Beef	708,177	$161,684,137
US Aqua	35,660	$64,583,865
Northeast Region	2,187,821	$939,238,963
Pacific Northwest Region	1,079438	$392,147,236
Pacific Southwest Region	1,273,627	$453,093,015
South Central Region	1,335,360	$447,343,174
Southeast Region	2,222,935	$762,397,570
Upper Midwest Region	**1,358,338**	$658,719,218

As a multi-site manufacturer of animal nutrition and health products, CAN SE has made a commitment to growth solidified by aggressive goals in a very competitive market. The Cargill Animal Nutrition Southeast Region Leadership Team has set earnings goals of $12 million after tax by fiscal year 2015. This calls for new strategies to position the company to be competitive throughout the animal feed industry. This includes consideration of everything from acquisitions, divestments, and retirements. It also involves assessment of new configurations of the physical layout of the business to ensure enhanced customer experience and cost savings to improve corporate performance.

As CAN SE works toward meetings its goals, it must analyze the current physical flow of products from the manufacturer to the customer to ensure that the supply chain remains efficient. The acquisition and retirement of different assets provides opportunities to examine the effects they will have on the way CAN SE manufactures, procures and distributes their products. Gaining a deeper understanding of the effect the design the supply chain has on the company's ability to successfully and efficiently meet customer expectations will allow CAN SE to better manage their assets in order to successfully realize its earnings goals in 2015.

1.2 Research Problem

Cargill Animal Nutrition and its supply chain are confronted with significant challenges in distributing products. A complex network of relationships exists between locations driven by products and resources. Each of these relationships has a cost associated. A model is needed to assess the costs associated with each of the relationships.

While profitable growth of the business through acquisitions is certainly a significant part of the plan to meet the $12 million earnings goal of Strategic Intent 2015, CAN SE also needs to address potential cost savings. Right now, the company does not have sufficient understanding of the cost structure of the current supply chain. Without this understanding, potential opportunities may be missed due to a lack of information. Servicing a growing customer base can be very expensive if our plants and warehouse space are not strategically used regarding our suppliers and customers. The recent acquisition of a plant specialized in producing pet food along with the opportunity to utilize a nearby warehouse forces the examination of the current supply chain to look for opportunities to generate savings based on capturing production efficiencies realized from increased storage space and specialized production of certain feed types. Narrowing the production of certain products to certain locations creates challenges for the distribution of our products. This creates the need for an analysis of the costs associated with our current way of managing the supply chain as well as an assessment of the costs associated with the many alternatives facing CAN SE today.

1.3 Objectives

The overall objective of this thesis is to assess the feasibility of alternate supply chain strategies available to Cargill Animal Nutrition (CAN) in the southeast United States that allow the company to meet customer expectations while maintaining operational excellence. The specific objectives are as follows:

1. Develop a complete and coherent overview of CAN's supply chain
2. Identify the operational challenges along each of the links in the chain with the view of developing a clear understanding of the issues underlying each of these challenges
3. Develop a reconfiguration of the supply chain with the view to increasing the value that is created and assess the feasibility of the alternative supply chains that are developed.

Objective 1 will be to accurately describe the supply chain environment facing CAN SE right now. This description will involve an in depth look at the operational characteristics of each location including the specific products produced by each. The relationships between facilities will also be explained.

The second objective will be to assess the costs associated with the current supply chain strategy. Costs included in the assessment will be production costs, handling costs, and transportation costs. Along with the costs, challenges presented by the current relationships will be explored.

The final objective will be to identify and implement reorganization of the supply chain structure in order to determine the feasibility of alternative supply chain strategies. This will involve applying the appropriate costs to the alternative structures which will result in cost information which can be compared to the cost of the original structure of the supply chain.

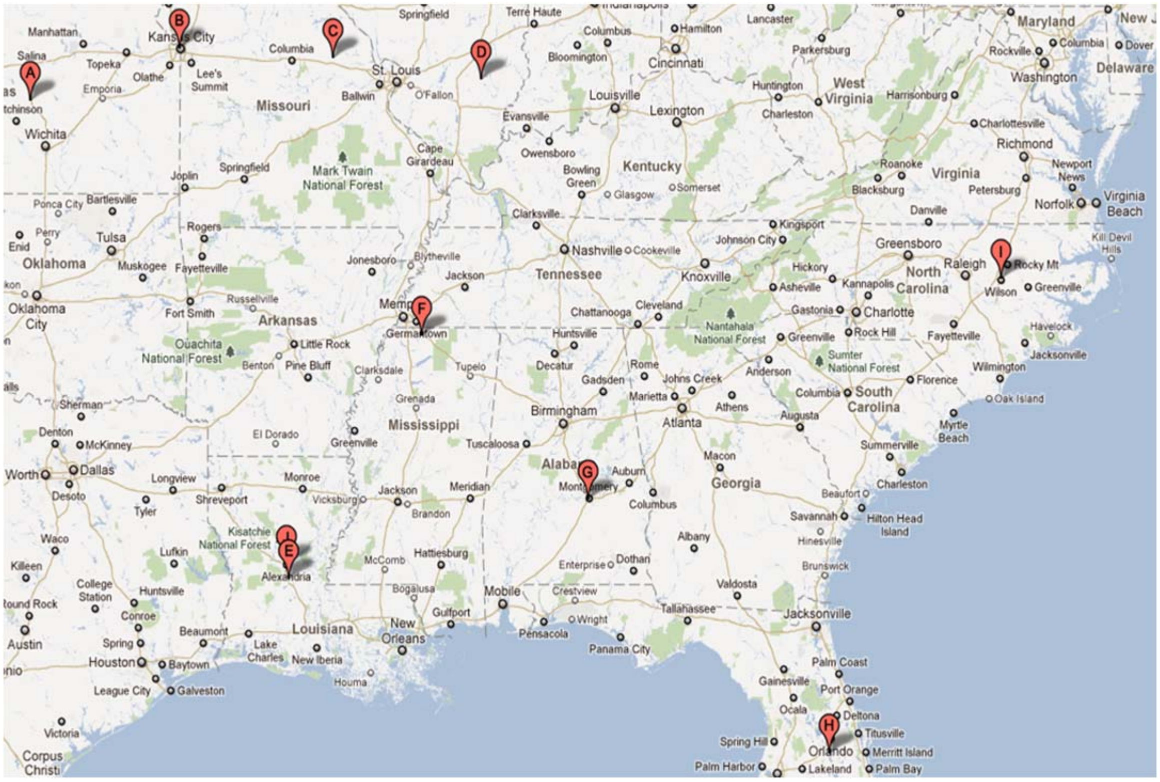
1.4 Thesis Outline

The next chapter presents an overview of the supply chain of CAN SE. This includes a description of each of the facilities that constitute the Southeast Region of Cargill Animal Nutrition as well as assets under the management of the Southeast Supply Chain that are not considered a part of the Southeast Region. In addition to sales and manufacturing statistics, the relationships in existence between the facilities will also be described. Outside suppliers of finished feeds and the products they provide for CAN SE will be defined in this chapter as well. The third chapter will consist of a review of relevant literature. Chapter 4 covers a discussion of the methods used for this analysis. This analysis includes a detailed explanation of the costs associated with the supply chain that fall within the scope of this study. Results are analyzed in Chapter 5 followed by a summary, conclusion and recommendations in Chapter 6.

CHAPTER II: CARGILL ANIMAL NUTRITION, SOUTHEAST REGION SUPPLY CHAIN STRATEGY

Cargill Animal Nutrition's Southeast Region consists of eight plants and one warehouse. The territory of CAN SE ranges from the state of Kansas to North Carolina; and from Louisiana to Florida. Figure 2.1 displays the geographic location of each of the facilities in CAN SE. Point A is the McPherson, KS plant; B is Kansas City, MO; C is Montgomery City, MO; D is Flora, IL; E is LeCompte, LA; F is Byhalia, MS; G is Montgomery, AL; H is Poinciana, FL; I is Wilson, NC; and J is the Central Warehouse located in Alexandria, LA. Along with the ability to produce basic animal feeds, a number of plants have further capabilities which allow them to produce specialty feeds. Each facility has a certain set of operational characteristics which allow it to serve its customers while also presenting challenges. To overcome specific limitations at each facility, a series of relationships exits to allow the plants and warehouse to work together to meet customer expectations in all areas of the southeast region of the United States.

Figure 2.1: Map of Southeast Region Facilities



(Google Maps 2012) Source: Google Maps (www.maps.googlecom).

The supply chain team of Cargill Animal Nutrition’s Southeast Region also manages the supply chains of two other regions: United States Aqua Region and the United States Pet Food Region. These two regions are, therefore, considered part of the same supply chain. Each of these regions has one manufacturing facility and the US Pet Food region has one warehouse in addition to its manufacturing facility. The production and warehouse locations in the identified locations presented in Figure 2.1 are described in the following subsections.

2.1 Facilities

2.1.1 McPherson, Kansas

The most western location of CAN SE is the manufacturing location in McPherson, Kansas. McPherson is one of only two plants in the current supply chain capable of producing mineral. Bulk beef feeds are also produced in McPherson. Due to the presence of certain drugs common in bulk beef feeds, no equine feeds are produced in McPherson. McPherson sold 46,879 tons of feed to external customers (customers other than other Cargill Animal Nutrition plants) from the fourth quarter of 2011 through the first three quarters of 2012. McPherson's primary customers are beef cattle feedlots in Kansas and Oklahoma along with other Cargill locations outside of the Southeast Region. Approximately 90% of the sales in McPherson are bulk beef feed sales.

2.1.2 Kansas City, Kansas

The plant located in Kansas City, Missouri sold 92,479 tons of in fiscal year 2012. Kansas City is not a specialized plant, meaning they do not produce minerals or extruded feed, but instead only produce typical animal feeds including meals, pellets, and textured feeds. Kansas City's largest customer is the retailer Orscheln Farm and Home, which accounted for nearly 40% of all bagged tonnage sold out of the Kansas City facility this year. Servicing a large retail customer like Orscheln places a different set of demands on a plant than servicing smaller local customers. Larger retail customers demand a greater degree of product variety as well as availability which places emphasis on an efficient supply chain in order to bring in a significant amount of feeds to be sold that are not manufactured at the distributing location. Private Label feeds, feeds manufactured by Cargill but sold under Orscheln's brands, are also manufactured for Orscheln out of the Kansas City mill. Historically, 35% of Kansas City's sales are in bulk form. As the bulk beef business increase, this percentage has increased slightly.

2.1.3 Montgomery City, Missouri

Montgomery City is the other plant in the southeast region capable of producing mineral. With external sales of over 78,442 tons since March of 2011, Montgomery City is the fourth largest plant in the south east region based on sales volume. Montgomery City makes a limited amount of bagged feed. A large portion of pelleted and textured feed sold out of the Montgomery City plant is provided by either Kansas City or Flora. Montgomery City serves a network of other Cargill facilities throughout the Southeast Region as well as the South Central Region and the Upper Mid-West Region. Almost all of Montgomery City's 8,548 tons of internal sales (sales to other Cargill Animal Nutrition locations) are bagged mineral. Montgomery City produces 90% of their external sales in bulk form. This includes a significant amount of bulk pork feeds sold to Cargill Pork locations throughout the Mid-West as well as bulk beef feeds sold directly to customers.

2.1.4 Flora, Illinois

The plant in Flora, IL is very similar to the plant in Kansas City, MO. Flora does not produce any specialty feeds. Instead, Flora focuses on servicing two large retailers; Orscheln Farm and Home and Rural King Supply. Flora produces a variety of pelleted and textured feeds in order to produce the assortment of feeds demanded by these large retail customers. This includes production of private label feeds for both Orscheln's and Rural King. Flora brings in a number of specialty products from various suppliers in order to meet the demand of the large retail customers. While these retail customers make up a large portion of Flora's production, Flora also services Cargill Pork. Thirty eight percent of Flora's sales are bulk sales due to this high demand for bulk pork feeds sold to Cargill Pork.

2.1.5 Wilson, North Carolina

Wilson is another plant that does not produce any specialty feeds. Wilson's main customer base currently consists of Cargill Pork and a small network of animal feed dealers. Located in rural North Carolina, there is a growing demand in this market for a variety of bagged animal feeds. Despite the opportunities in the farm store business, Wilson continues to be a large player in the bulk pork feed business. About 74% of the feed produced in Wilson is bulk, with the vast majority of that being pork feed.

2.1.6 Poinciana, Florida

Arguably the most isolated location of the CAN SE facilities, Poinciana, Florida is located south of Orlando, Florida. Poinciana does not produce any specialty feeds. With only 58,005 tons of sales to external customers, Poinciana is the second smallest plant in terms of sales volume in the southeast region. Due to the demographic of the customer base served by Poinciana, 92% of their sales are bagged. While servicing a small network of feed dealers throughout the extreme southeast, Poinciana also serves as a base for a small amount of export business, primarily to the Caribbean.

2.1.7 Montgomery, Alabama

The facility in Montgomery, Alabama is one of the plants in the southeast region capable of producing extruded feeds. Montgomery recently began producing the majority of the pet food sold in the Southeast region after assuming additional production from the plant in LeCompte, Louisiana. As the primary supplier of pet food in the south east region, the Montgomery facility bags a large amount of pet food. One of Tractor Supply's distribution centers is stocked by the Montgomery facility. This generates demand for a large variety of different feeds both produced in Montgomery and shipped in from outside suppliers. Montgomery also provides Wilson and Poinciana with many of the feeds that are not produced in those locations. Montgomery sold over 85,000 tons of feed from March of 2011 through February of 2012, with 89% being bagged sales.

2.1.8 Byhalia, Mississippi

Cargill purchased the land the Byhalia plant is built on in January of 2007 from Mountaire Feeds, Inc. The purchase included the Prime Quality feed brand. Byhalia is the only manufacturer and distributor of the Prime Quality brand while also manufacturing and distributing the Nutrena feed line. The Byhalia plant was built in 2008 making it the newest plant in the southeast region. The Byhalia facility does not produce any specialty feeds. Byhalia's main customers are Prime Quality and Nutrena dealers around the Memphis area, but Byhalia also produces a few feeds for the Central Warehouse and produces feed for a Tractor Supply distribution center. Byhalia sells the second highest amount of feed in the south east region. External sales in the final quarter of 2011 and first three quarters of 2012 were 90,870 tons. This high demand is partly due to servicing two separate feed lines, and consequently 77% of Byhalia's sales are bagged.

2.1.9 LeCompte, Louisiana

The facility in LeCompte, Louisiana has the capability to produce extruded feeds. Due to a recent withdrawal this plant will no longer produce extruded pet food, but will instead focus their extrusion capacity on all other non-pet extruded feeds produced in CAN SE. This includes a variety of deer and aqua feeds. LeCompte serves a network of small dealers, but their main customer is Tractor Supply followed by other Cargill locations. Although there is little to no storage capacity at the mill, LeCompte works very closely with the nearby Central Warehouse to service external and internal customers. Nearly 80% of the product sold out of LeCompte is in bags.

2.1.10 Central Warehouse: Alexandria, Louisiana

Central Warehouse is the primary distribution point for Cargill's service provided to Tractor Supply. 26,440 tons of feeds were shipped to external customers, primarily Tractor Supply, out of Central Warehouse between March 2011 and March 2012. Central Warehouse receives the majority of its products from the plant in LeCompte, Louisiana, but also receives a significant amount of product from Byhalia and an assortment of plants in the South Central Region located in Texas and Oklahoma. Along with shipping to Tractor Supply, Central Warehouse distributes extruded feed to other Cargill locations throughout the United States. Central Warehouse ships approximately 15,000 tons of feed to internal Cargill locations in the course of a year.

2.1.11 US Aqua Region: Franklinton, Louisiana

The plant in Franklinton, Louisiana is not part of CAN SE. However, some administrative functions, including supply chain management, are handled for Franklinton by the Southeast Region team and therefore will be included in this thesis. Franklinton produces only aquaculture feeds. While most of the feeds produced in Franklinton are for Bass, Tilapia, and Catfish, nearly 30% of their sales are for Gator feed. Fifty percent of their sales are bulk. Fiscal year 2012 sales amount to 18,461 tons through March 1st, 2012. Franklinton exports to customers such as Cargill Ghana and Ailmentos Concentrados Nacionales.

2.1.12 US Pet Food: Emporia, Kansas

The United States Pet Food Region was recently formed through the asset acquisition of a plant in Emporia, Kansas from American Nutrition, Inc. Now under management of Cargill, Emporia produces only extruded pet feeds. Initially, Emporia will primarily service other internal Cargill locations and ship direct to Cargill customers. Overtime the facility will be used to gain new customers.

Table 2.1: Plant Information and Characteristics

				Product Distribution	
Plant Location	**State**	**Specialty**	**June 2010- May 2011 Sales Tons**	**% Bag**	**% Bulk**
Kansas City	KS	None	105,398	65%	35%
Montgomery City	MO	Mineral	77,757	10%	90%
McPherson	KS	Mineral	41,284	18%	82%
Emporia	KS	Pet Food	-	100%	-
Emporia Warehouse	KS	Distribution	-	-	100%
Flora	IL	None	74,026	62%	38%
Byhalia	MS	None	93,213	77%	23%
Montgomery	AL	Pet Food	81,535	89%	11%
LeCompte	LA	Extrusion	49,369	79%	21%
Alexandria	LA	Distribution	24,119	-	100%
Wilson	NC	None	95,971	26%	74%
Poinciana	FL	None	62,582	92%	8%
Franklinton	**LA**	**Aqua**	**68,890**	**50%**	50%

2.2 Outside Suppliers

CAN SE utilizes a number of outside suppliers to fulfill customer demand. Products that fall under this category include mineral blocks, mineral tubs, and milk replacers. CAN SE is not competitive in the production of mineral blocks, mineral tubs and milk replacers. Therefore, CAN SE uses other suppliers to meet its customers' demand for these products, increasing its efficiency and operational excellence by managing the supply chain instead of attempting to compete with superior suppliers of these specialized products.

Mineral blocks are produced by a number of other Cargill locations outside of the Southeast Region. Cargill facilities in Texas and Oklahoma produce a variety of blocks for the plants in the Southeast region. Ridley Block Operations is a subsidiary of Ridley, Inc. They provide Cargill with a number of different mineral tubs. They service facilities in the Southeast region out of locations in Buffalo, Texas; Worthington, Minnesota and Flemingsburg, Kentucky. Each plant in the Southeast region stocks tubs specific to the requirements of their customer base. Milk Products, Inc. provides Cargill with a line of milk replacers known as Dairy Way™ Milk Replacers. These product lines are stocked to varying degrees in the plants in the northern part of our region. Milk Products is located in Chilton, Wisconsin.

There are six principal feed types that are commonly sourced from outside facilities either owned or not owned by Cargill. For each location, the supplier of each of the most common types of outside manufactured feed (Mineral, Pet Food, Extruded Feed, Milk Replacer, Tubs, and Blocks) is given in Table 2.2. The table shows, for example, that Montgomery City produces its own minerals but procures pet food from American Nutrition and tubs from Ridley. If the facility supplies its own product, it is designated as the manufacturer. Some types of feed are not sold at each location.

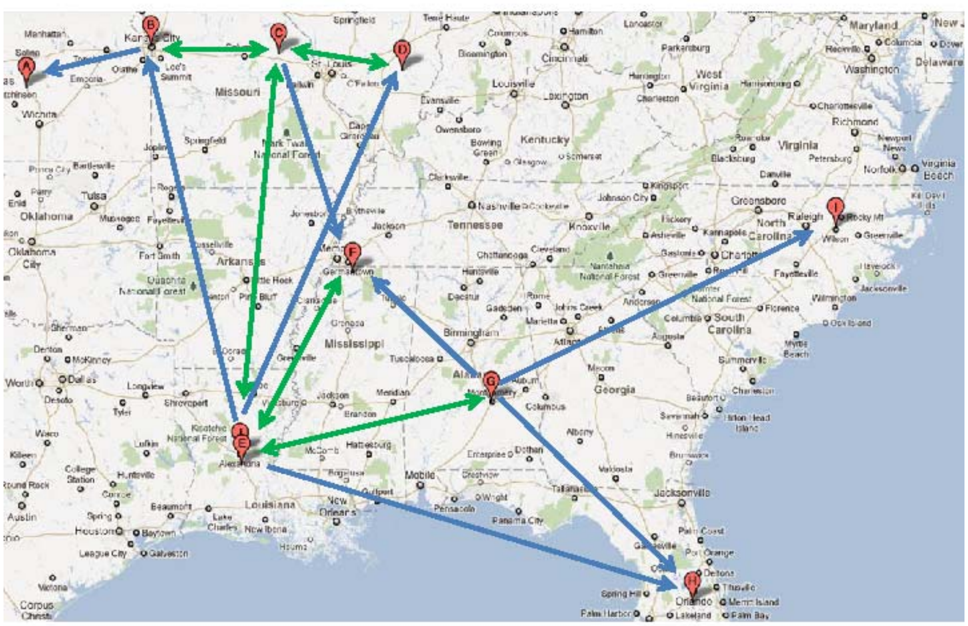
Table 2.2: Current Sources of Feed for CAN SE Locations

	Feed Supply Source					
Location	**Mineral**	**Pet Food**	**Extruded Feed**	**Milk Replacer**	**Tubs**	**Blocks**
Montgomery City	Self	American Nutrition	LeCompte	Milk Products	Ridley	-
McPherson	Self	American Nutrition	Kansas City	Kansas City	Ridley	-
Emporia	-	Self	-	-	-	-
Flora	Montgomery City	American Nutrition	LeCompte	Montgomery City	Montgomery City	-
Byhalia	Montgomery City	Texas Farm Products	LeCompte	Montgomery City	Ridley	South Central Region
Montgomery	Montgomery City	Self	LeCompte	-	Ridley	South Central Region
LeCompte	Montgomery City	Central Warehouse	Self	Montgomery City	Central Warehouse	Central Warehouse
Alexandria	Montgomery City	Texas Farm Products	LeCompte	-	Ridley	South Central Region
Wilson	Montgomery City	Montgomery	Montgomery	-	Montgomery	Montgomery
Poinciana	Montgomery City	Montgomery	LeCompte	-	Montgomery	-
Franklinton	-	-	-	-	-	-

2.3 Relationships

The described characteristics of the facilities above create the need for efficiency-driven relationships to exist between locations. Physical flow of products between suppliers and facilities allow for customer demands to be met regardless of the operational characteristics of the closest plant geographically. These links in the supply chain in the Southeast region exist primarily for the distribution of minerals, pet food and other extruded feeds. The relationships are described in more detail, as well as illustrated, below in Figure 2.2. The green lines represent a freight lane in which freight is moved both ways between the facilities. These freight lanes can be set up as round trips on the same carrier which can result in lower freight rates. The blue lines represent a freight lane in which products are only moved one way.

Figure 2.2 Map of Existing Relationships Between Cargill Facilities



(Google Maps 2012) Source: Google Maps (www.maps.googlecom).

2.3.1 Mineral

Currently, the McPherson plant services their own customer base as well as providing mineral for the Upper Mid-West and Pacific North West regions. The Montgomery City plant services the entire Southeast region, excluding McPherson, along with providing for the Upper Mid-West region as well. They service their own customer base, and reach the rest of our customers using the other facilities as a network of distribution points. Montgomery City currently ships direct to all of our plants except for Poinciana.

2.3.2 Pet Food

Montgomery currently services the majority of our customers in the Southeast region for the River Run®, Pro Premium, and Marksman lines of pet food. Montgomery ships directly to customers as well as to our plants in Byhalia, LeCompte, Poinciana, and Wilson. Kansas City, Montgomery City, McPherson and Flora source the River Run® line from the recently purchased Emporia plant. Loyall® is currently produced only by the Emporia plant. Each plant in the Southeast region stocks Loyall®. To reduce demands on the production team and equipment in Montgomery, the decision has been made to bring in certain types of feeds from other locations to meet Montgomery's customers' demands. Products that will now be manufactured elsewhere include any non-pet food extruded product from LeCompte and cubes from Byhalia. While this relieves pressure on the plant from a production standpoint it creates other issues with receiving and shipping finished feeds and ingredients. With only six truck docks and two employees capable of loading and unloading trucks from 7:00 a.m. to 1:00 p.m., Montgomery is limited to loading and unloading only a few trucks each day. When the demand for this space exceeds capabilities, lead times surpass the 48 hour window expected.

2.3.3 Miscellaneous Extruded Feeds

Any extruded feed other than pet food is produced by LeCompte. This includes a number of deer feeds, aqua feeds, and select specialty cattle feeds. All of these feeds are shipped from the LeCompte plant to Central Warehouse located 16 miles away. They are picked up from Central Warehouse by the other Cargill locations in any combination of quantity.

2.3.4 Other Relationships

While the relationships mentioned above are the most significant, other relationships do exist for a variety of reasons. McPherson focuses production capabilities on bulk feed and mineral and therefore receives a number of textured and pelleted products from Kansas City. Demand for these feeds in McPherson is negligible in comparison to the demand for mineral and bulk feeds. The same situation exists between Montgomery City and Kansas City. As Montgomery City focuses on supplying mineral to the rest of the region, Kansas City supplies the minimal amount of textured and pelleted products demanded by Montgomery City's customer base. Flora also provides textured and pelleted feeds from Montgomery City in return for mineral and cubes.

Byhalia receives extruded feeds from Central Warehouse, and in return produces a limited number of textured feeds for Central Warehouse to distribute to Tractor Supply. A similar exchange takes place between Byhalia and Montgomery. Montgomery produces a large amount of dog food for Byhalia and in return Byhalia produces cubes and other textured and pelleted poultry feeds for Montgomery.

The most dependent relationships exist between Montgomery and Wilson and Montgomery and Poinciana. Centrally located Montgomery serves as a distribution point for more remote Wilson and Poinciana. These are each one way relationships with neither Poinciana nor Wilson produce any feeds for Montgomery.

CHAPTER III: LITERATURE REVIEW

Korpela et al. (2002) uses an analytical approach to determine the effect of different customer expectations on supply chain design as well as production capability allocation. The supply chain had been traditionally managed in three parts: procurement, production, and distribution. Over time these three separate areas have merged into total supply chain management. One key factor left out of most analytical models is the difference in levels of customer importance. Korpela et .al define a framework for systematically assigning greater value to those customers who score higher on a scale based on profitability, strength of relationship, and volume. When determining how to allocate the typical constraints of production capacities, transportation capacities, and warehouse space, customer importance should be considered. Meeting the demands of certain customers leads to a higher return than meeting the demands of less important customers. Just as customer importance can be systematically evaluated, so can the alternative supply chain structures. Different alternative supply chain designs will result in varying levels of lead times, reliability, and cost. If the customer in question places most importance on lead time, then they will sacrifice cost. Being aware of the level of customer importance and the customer expectations will lead to a more accurate assessment of a supply chain strategy.

Allocating plant production capabilities is an important part of determining supply chain strategy. An important question to ask when designing a supply chain strategy is which products should be made at each plant and in what quantities? The variable that becomes very important in this decision is change over, or set up, times and costs. When it takes significant time to change from one product to the next, or if significant costs are involved with this change over, plants focused on the production of one type of good are justifiable (Benjaafar 1998). While highly flexible facilities with high capacities and low change over or set up times and costs are ideal, the reality is that not all supply chains have such assets at their disposal. Specialization of production is necessary and is preferred when the costs associated with attempts at flexibility are higher than the costs of distributing the products throughout the supply chain.

According to some estimates, transportation costs can contribute up to 50% of the total logistic costs of a product (Swenseth 2002). Swenseth and Godfrey (2002) discussed the importance of adding the cost of transportation into any decision regarding inventory replenishment. In their article, they expanded the original economic order quantity model to include functions designed to incorporate the freight rates associated with shipping different weights of goods. According to research performed by Swenseth and Godfrey, freight rates decrease at a decreasing rate as the weight of the shipment increases. The magnitude of the decrease would depend on the freight rates negotiated by the company requiring shipment and the freight company. Efficiencies gained when shipping larger shipments are evident by this. A point does exist where the weight of a shipment would result in an LTL rate higher than the rate that could be achieved by using a full truck carrier. By taking the total weight of the shipment times the per unit of weight freight rate, the cost of an LTL could exceed the cost of contracting with a full truck load carrier. At this point, and up to the full truck capacity, utilizing a full truck load carrier will result in the most cost efficient way to transport the goods even though the truck may not be filled to capacity. While examining the design of our supply, the freight rates associated with specific shipment weights will need to be included in order to capture and optimize the entire logistics cost of our supply chain design and alternatives accurately.

Determining the location of a warehouse of an agricultural company must take into consideration certain characteristics in order to be successful in the agriculture industry. Lucas and Chajed (2004) discussed the different issues that arise when a company in the agriculture industry faces a location analysis problem. While location problems consist of maximizing profits or minimizing costs, agriculture location analysis must include other factors such as supply variability and time. Variations in raw material supply can be evident in different regions and in different time frames. Weather, or more specifically droughts, floods, untimely freezing temperatures, or damaging storms, plays a very large role in agriculture and can potentially wreak havoc on otherwise dependable sources of supply. Any of the weather related catastrophe's mentioned above could decrease the supply of commodities to a varying extent. While extreme weather events may have a devastating impact on supply, less extreme changes in weather patterns can alter the timing of growing seasons enough that supply is not available when needed. The ability to store large quantities of commodities over time also creates issues for standard location analysis. Lucas and Chajed identified that models have been built to accommodate some of these issues. Network algorithms and heuristics are just some of the tools mentioned to help confront characteristics unique to agricultural location analysis.

Ballou (1968) stressed the importance of analyzing the potential location of a warehouse based on factors that are relevant currently, as well as throughout the life of the warehouse.

The author argues that the best location for a warehouse would be the location where the cumulative total profit from each of the years less any relocation costs is the true optimal location for the warehouse. Although this model is limited due to our inability to predict the future with any level of certainty, it does bring to light the important fact that the optimal location of a warehouse must be considered over the entire life of the warehouse and not just at one point in time.

Walters (2011) distinguished the difference between supply chain management and demand chain management. Understanding customer demand, as well as supply chain constraints, allows the company to manage customer expectations. Marketing strategy can be used emphasize goods or services that allow the company to succeed. Cost savings for the company, and the end consumer, can be realized from removing identified excess or unnecessary inventories. Increased customer satisfaction results from the company having a greater understanding of what the customer really wants and the company's realistic ability to fulfill that need. Being able to easily identify which products add the most cost to the supply chain would provide a good starting point for this kind of analysis.

Designing flexible supply chains is one way to handle the uncertainty that develops over time. The ability to adjust a supply chain to react to changes in customer demand is referred to as reconfigurability (Costantino, et al. 2009). As conditions change, supply chain design needs to be continually assessed to make sure that costs of the supply chain are always known. Costantino et al. propose a model that can be used to determine optimal configurations of a supply chain based on certain criteria. The resulting optimized models are optimal only in respect to the criteria used and cannot be considered optimal overall. Each optimized model would provide a supply chain design, or scenario, that could then be assessed further to determine feasibility.

The field of mathematical programming provides many tools for determining the optimal way to utilize scarce resources. Many linear and nonlinear optimization models have been successfully applied in supply chain management to accomplish a variety of objectives, including minimizing costs. In order to be classified as an optimization problem, certain characteristics must exist. There must be decisions, constraints, and an objective function (Ragsdale 2008). The research problem may be defined to encompass these characteristics for an optimization technique to be used to find a solution. Unfortunately, for a business decision tool in an environment such as the one faced by CAN SE, the constraints and decision variables may not be complete due to the complexity of the system. Thus, an effective optimization model would require numerous decision variables and their technical coefficients, which may not be available. Therefore, using an optimization model for this study may create significant uncertainty considering the practicality of the results and maybe impractical for the purpose of the company's situation.

An alternative to the optimization modeling approach is a scenario analysis approach. A scenario analysis approach includes comparing a base scenario to alternative scenarios to assess the merit of the alternative scenarios. By using scenario analysis, the optimal design of the supply chain may not be discovered, but much more valuable knowledge about the true costs of the supply chain strategy and the financial effect of any changes may be gained. The process of discovering actual data is much more valuable to managers when facing difficult decisions than debatably optimal solutions based on uncertain terms.

CHAPTER IV: METHODS AND DATA

4.1 Methods

The scenario analysis approach was used in this study. This approach was selected because the high degree of flexibility and its relatively low demand for data with high applicability in a complex business environment. The ability to easily manipulate the alternative scenarios makes this approach more useful in the decision environment envisaged in this project.

4.2 Cost Assessment

Microsoft Excel® was the principal software utilized for the analyses. The total cost associated with each procurement decision by each CAN SE location is estimated using Equation 4.1 below:

$$TC = \sum_{k=1}^{K}\sum_{i=1}^{I}\sum_{j=1}^{J} Q_{ijk}(P_{ijk} + T_{ijk} + H_{ijk}) \quad 4.1$$

where TC is total cost across all of CAN SE locations, k, procuring quantity Q of product j at unit prices of P , unit freight costs of T from supplier i, and handling charges H. These handling charges are associated with particular Cargill locations that supply products not manufactured by Cargill. They are typically $3.50 per ton for all locations and products with the exception of Alexandria, where they are set at $18.75 per ton. The nomenclature of the different products, j, are presented in Table 4.1 while that of the different locations are presented in Table 4.2.

Table 4.1: Nomenclature of Procured Products (j)

1	2	3	4	5	6
Mineral	Pet Food	Extruded Feed	Milk Replacer	Tubs	Blocks

Table 4.2: Legend of Procurement and Supply Locations

Location	***k, i***	**Outside Suppliers**	***i***
Montgomery City	1	American Nutrition	13
McPherson	2	Milk Products	14
Emporia	3	Ridley	15
Kansas City	4	Texas Farm Products	16
Flora	5	South Central Region	17
Byhalia	6	Central Warehouse	18
Montgomery	7	No Source	0
LeCompte	8		
Alexandria	9		
Wilson	10		
Poinciana	11		
Franklinton	12		

* Location *k* can also be a supplier, *i*. However, Supplier *i* is not necessarily a location *k*. When *i* = 0, it implies that the product is not sold, used or produced at the relevant location.

In the following sub-sections, the characteristics of the foregoing variables are presented and discussed in more detail.

4.2.1 Quantities

Quantity was determined for any product currently not produced at any of the CAN SE plants. For example, any product not produced at Byhalia, Mississippi, but sold to internal or external customers out of the Byhalia plant are included in Byhalia's quantity of products. These products are considered an "Outside Manufactured" product for CAN SE regardless of whether or not the products were produced by another Cargill location or by a separate business. They incur the necessary transshipment charges described in sections below.

Most of CAN manufacturing plants are capable of producing the most common types of animal feed demanded by our customers: textured feeds, pelleted feeds, meals, grains, and cubes. However, there are a few plants that are currently sourcing these types of feeds from other Cargill locations out of CAN SE. The costs associated with this business practice were included in the assessment of the costs associated with the current design of our supply chain for those plants as they are an outside manufactured feed even though they would not have to be.

The quantity of feed for which costs were assessed was based on past sales of each product to external customers. Historical sales data were gathered utilizing Cargill software applications. Sales data includes sales of bagged feed to external customers only. This excludes any shipments to other Cargill Animal Nutrition plants. These sales were left out in order to capture only the demand each plant can expect from its own customer base without the addition of demand for products being sold to another plant. Bagged sales were used to determine the demand for products to ship between plants as bulk shipments will not be transported between plants.

Quarterly sales data beginning with first quarter 2009 through third quarter 2012 served as the basis for determining the average quarterly quantity demanded. By using the average quarterly sales for each product as the average expected demand, capturing the exact cost of the supply chain design is impossible. However, seasonal trends in the animal feed industry are quarterly in nature. Meaning sales are similar in each month of the corresponding quarter. This characteristic of sales trends makes quarterly data an acceptable measure of demand.

4.2.2 Product Costs

From outside suppliers, the purchase price of each product will reflect both variable and fixed costs associated with its production. This will include the cost of the raw materials, labor, packaging, overhead expenses such as sales and marketing expenses, allocated depreciation and interest. This price will also include any margin the supplier desires to earn on the product. Prices supplied by the manufacturer in the form of published price lists of each product supplied by an outside supplier are considered the product cost. These prices are subject to change at any time per the supplier's discretion. The product prices used in this thesis are typically changed on a monthly basis although some do change on a quarterly basis.

Prices for products sourced from other Cargill plants within the supply chain were taken directly from Cargill's internal price tracking system. These prices also include production costs such as labor and overhead as well as ingredient and packaging costs. Specified margins for products sold to other Cargill locations are added to each product based on the form of the product. For example, mineral is one form of product and is sold with a different internal margin than extruded pet food which is another form of animal feed.

4.2.3 Freight Costs

Freight is one of the most important costs in this analysis. For some products, freight costs can contribute a significantly high percentage of the total costs. Each lane is assessed by supply chain specialists on at least a quarterly basis to determine the lowest per ton freight rate to utilize to move products between point A and point B. Freight rates used in each of the following scenarios are based on real market data. Less than Truck Load (LTL) rates were determined using Cargill's rate look up tool during the month of February, 2012. This website leverages Cargill's economies of scale to provide decreased LTL rates to each of its separate operating units. Truck Load rates were determined through research based on actual freight rates for lanes currently used, and through discussions with practicing freight brokers for the lanes which we previously had no freight rate information. Truck load rates are set at the amount which we can expect to legally move a full truck, 22 tons, over a specific lane under normal business conditions. Certain time frames where these freight rates would become inaccurate would include national holidays and times of significant weather events. While the differences in rates paid during these times can be significant, these added costs are only realized in specific isolated time periods and not on a regular basis. Therefore the same freight costs are applicable throughout an entire year.

4.2.4 Handling and Storage Costs

In some cases, products are sourced from Cargill locations that did not manufacture the product. Byhalia purchases milk replacer from Montgomery City that is manufactured by Milk Products Inc. is Chilton, WI. These products will include a $3.50 per ton handling charge in built into the product price charged by a Cargill location to other Cargill locations. This addition covers costs associated with the unloading, loading, and potential temporary storage of goods as they pass through a non-manufacturing location operating temporarily as a distribution point. However, if the said product passes through Central Warehouse in Alexandria, Louisiana the handling and storage charge is $18.75/ton. This charge covers the fees charged to Cargill by the owners of the warehouse for storage and handling. This charge is added to every product manufactured by LeCompte but sold out of Central Warehouse to other Cargill locations. This cost is included in the product price sourced from CAN SE's price tracking system used to establish the product prices for this research.

4.3 Cost Assumptions

In order to restrict the model to allow variability of only the pertinent variables, assumptions must be made. Demand used in the model is based on historical sales data and therefore may not be indicative of future sales. The assumption is made that past sales are indicative of future sales. If any changes to future sales were known, like the discontinuation of a certain product, the model could be adjusted to accommodate these changes.

Although each of the outside suppliers included in the model has a different set of order requirements and payment terms, the exclusion of these factors is not critical to the success of the model as sixteen of the twenty four suppliers are other Cargill locations with identical payment terms and lead times. If significant differences were to arise, the model is capable of dealing with separate differences at an individual supplier level. If either the lead time or payment terms of a potential supplier were to be considered using this model, it could be built in at a later date.

Purchasing costs are the costs incurred in the procurement process. They include the time to place orders and enter purchase orders in the system, track the purchases and record their delivery times and conditions. It is assumed that these costs are similar across products and locations and are, therefore, not included in the estimation of costs.

The last assumption is the mix of facilities and suppliers is static. While the model is capable of assessing the costs associated with a change in the facility mix, under the analysis performed for this study, no new facilities will be added, nor will any be closed.

4.3 Scenario Development

In order to assess the total cost associated with the design of the current supply chain, each of the individual costs mentioned above must be applied to the products to which they pertain. To do this, the costs mentioned above were applied to five different designs of the supply chain, which will be explained further below, according to the total cost equation (4.1) and quantity equation (4.2) explained above. The sum of each product at each location results in an overall cost for the entire supply chain for one year. It is this total annual cost that will be used as a base to compare the total annual costs of the alternative scenarios as shown in equation 4.3.

$$TC_s = (\sum_{k=1}^{13}\sum_{i=1}^{5}\sum_{j=1}^{6} Q_{ijk}(P_{ijk} + T_{ijk} + H_{ijk}))_s \qquad (4.2)$$

$$s = 0,1,\ldots,4$$

4.3.1 Base Scenario

The base scenario was built based on the current design of CAN SE's supply chain given in Table 2.2. Using pricing received from all suppliers in February of 2012, average per ton freight rates for each transportation lane, and average quarterly demand for each product at each plant, the total cost of the current supply chain design was determined using the total cost equation. For each outside manufactured product at each plant, the annual demand for each product was multiplied by the delivered price plus any applicable handling charge for that product. The sum of the cost of each product at each plant leads us to the total cost of the supply chain for the base scenario. Where total cost is the total cost of the prevailing supply chain as defined from Equation 4.3. Application of the total cost equation in the base scenario is shown below in table 4.3 for the five highest selling outside manufactured products in Montgomery City.

Table 4.3: Application of Total Cost Equation

Product	Supplier	Annual Quantity	Product Price	Transportation Rate	Handling Fee	Total Cost
SafeChoice®	Flora	247	$348	$25	$0	$92,131
Life Design ® Senior	Flora	204	$424	$25	$0	$91,596
Stock and Stable 10% Multi Species	Kansas City	151	$257	$25	$0	$42,582
River Run ® 21% Dog Food	American Nutrition	145	$596	$28	$0	$90,480
Stock and Stable 12% Multi Species	Kansas City	92	$254	$25	$0	$25,668

4.3.2 Scenario #1

The first scenario assesses the change in total cost associated with purchasing pet food for resale in Central Warehouse and Byhalia from Montgomery, AL instead of purchasing it from outside supplier, Texas Farm Products. Pet food is not sold to external customers out of Central Warehouse, but rather is shipped into Central Warehouse from an outside supplier and then shipped to LeCompte as demand and space in LeCompte allows. The differences in supplier are displayed in figure 4.1 and summarized in table 4.4. Blue lines indicate product flows under the prevailing scenario and orange lines represent product flows under the alternative scenario.

Figure 4.1: Scenario #1

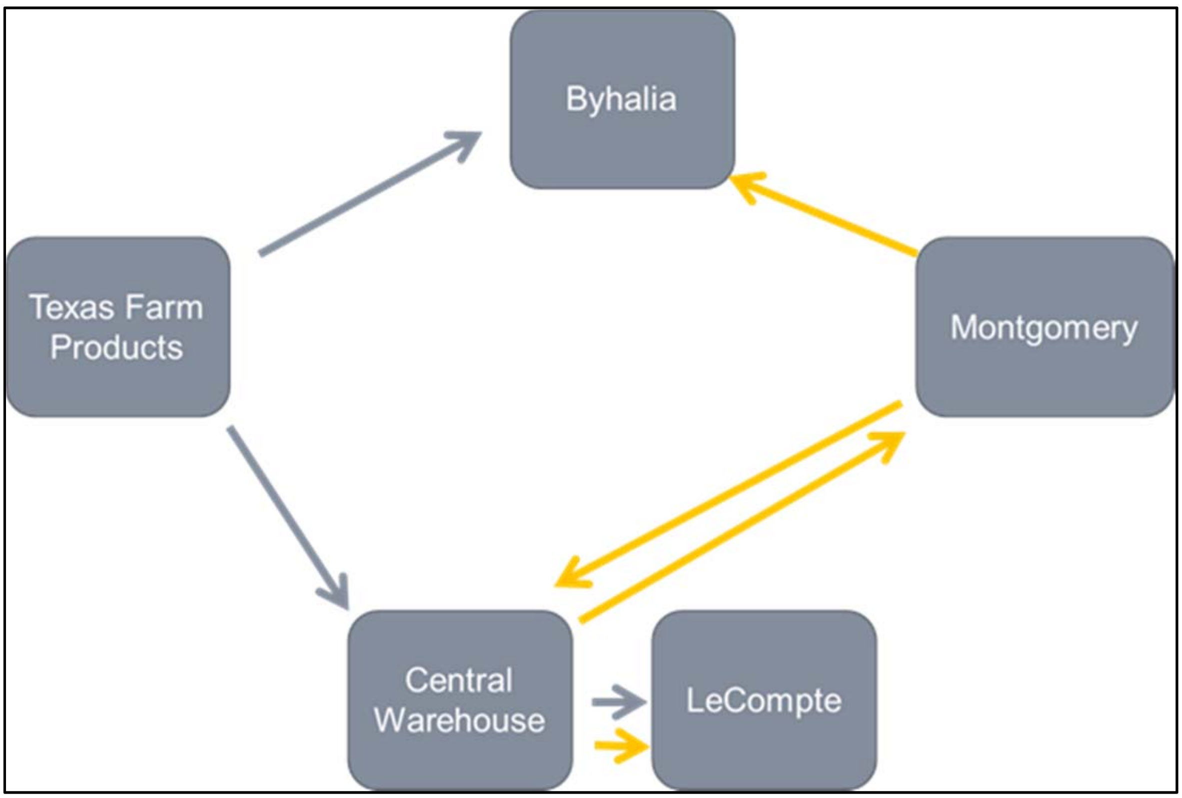


Table 4.4: Sources of Pet Feed for CAN SE Locations – Scenario #1

	Pet Food Supplier	
Location	Base Scenario	Scenario #1
Montgomery City	American Nutrition	American Nutrition
McPherson	American Nutrition	American Nutrition
Emporia	Self	Self
Flora	American Nutrition	American Nutrition
Byhalia	Texas Farm Products	Montgomery
Montgomery	Self	Self
LeCompte	Central Warehouse	Central Warehouse
Alexandria	Texas Farm Products	Montgomery
Wilson	Montgomery	Montgomery
Poinciana	Montgomery	Montgomery
Franklinton	-	-

Changing supplier from Texas Farm Products to Montgomery also results in changes in product price and freight rate. The economic effects of which will be analyzed in the results section of this study.

4.3.3 Scenario #2

Scenario #2 involves purchasing mineral for resale for LeCompte from McPherson, KS instead of Montgomery City, MO. This change enables LeCompte to purchase half loads of mineral out of McPherson in combination with half loads of Loyall pet food from Emporia. The changes in supplier are displayed in figure 4.2 and summarized in table 4.5.

Figure 4.2: Scenario #2

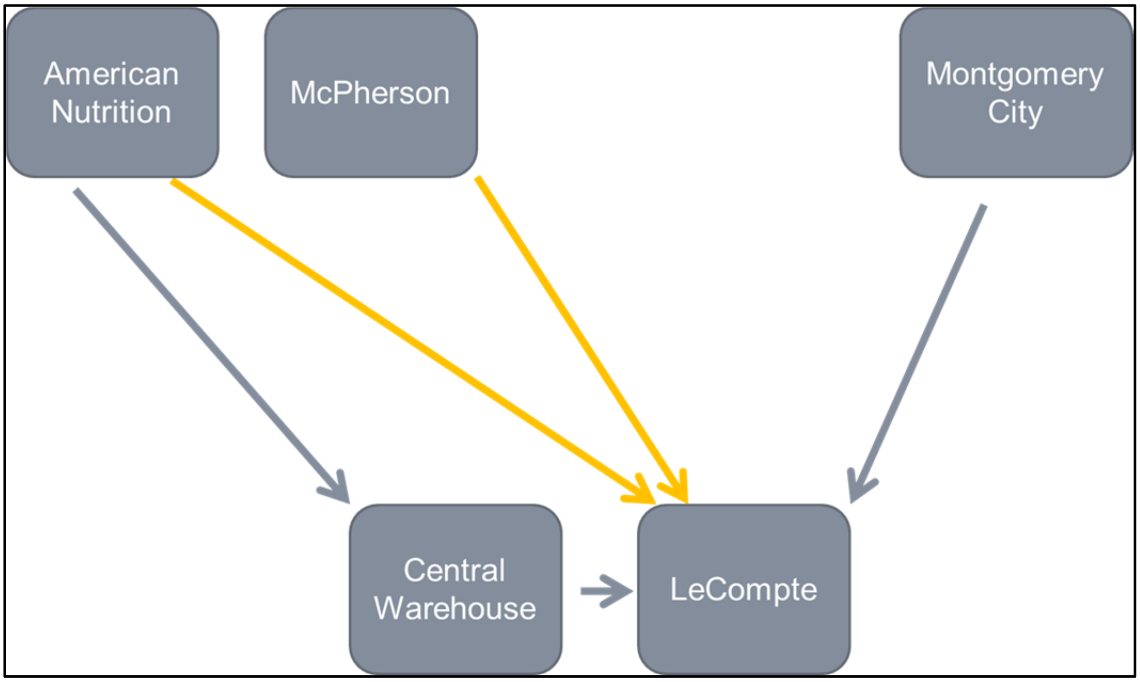


Table 4.5: Sources of Mineral for CAN SE Locations – Scenario #2

Location	Mineral Supplier	
	Base Scenario	Scenario #2
Montgomery City	Self	Self
McPherson	Self	Self
Emporia	-	-
Flora	Montgomery City	Montgomery City
Byhalia	Montgomery City	Montgomery City
Montgomery	Montgomery City	Montgomery City
LeCompte	Montgomery City	McPherson
Alexandria	Montgomery City	Montgomery City
Wilson	Montgomery	Montgomery
Poinciana	Montgomery	Montgomery
Franklinton	-	-

This scenario will result in a change in supplier of mineral for LeCompte, change in price of mineral for LeCompte, and change in freight rate per ton based on changing the origin of the mineral. Also, there are additional cost savings to be had through this supply chain design as the handling fee incurred when storing pet food in Central Warehouse would be avoided by shipping Loyall directly to LeCompte instead of Central Warehouse. The economic effect of each change will be analyzed in the results section.

4.3.4 Scenario #3

The third scenario results from sourcing textured feeds for Montgomery City solely from Kansas City instead of where they are currently produced, in both Flora and Kansas City. Kansas City already produces each of the feeds purchased by Montgomery City from Flora. This change would result in a change in supplier for twelve textured products sold from Montgomery City. The change in supplier for each product is shown below in figure 4.3 and summarized in table 4.6.

Figure 4.3: Scenario #3

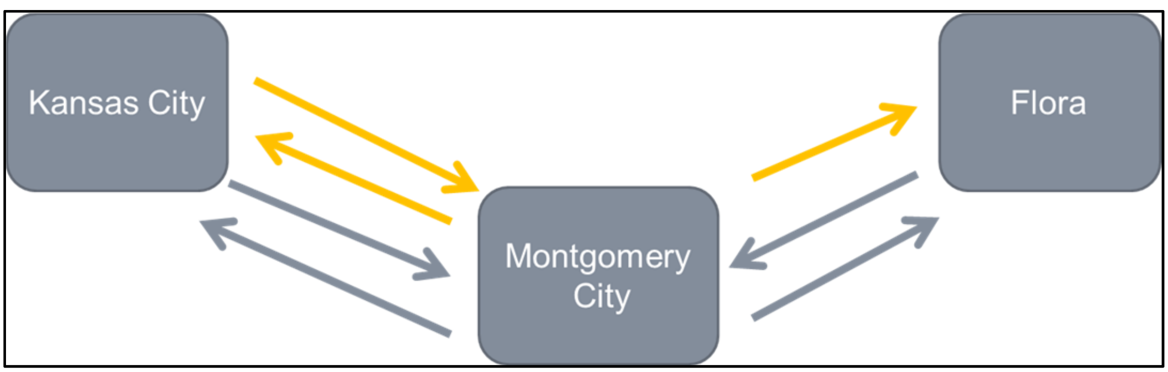


Table 4.6: Sources of Textured Feeds for Montgomery City – Scenario #3

	Supplier	
Product	Base Scenario	Scenario #3
Life Design ® Senior	Flora	Kansas City
SafeChoice ®	Flora	Kansas City
NatureWise ® Rabbit Pellets	Flora	Kansas City
Country Feeds ® Layer Crumble	Flora	Kansas City
Country Feeds ® Layer Pellet	Flora	Kansas City
Country Feeds ® Scratch Grains	Flora	Kansas City
NatureWise ® Meat Bird	Flora	Kansas City
Triumph ® Senior	Flora	Kansas City
NatureWise ® Layer Pellet	Flora	Kansas City
Country Feeds ® Chick Starter	Flora	Kansas City
NatureWise ® Chick Starter	Flora	Kansas City
NatureWise ® All Flock	Flora	Kansas City

This change in supplier results in a change of product price for each product. The changes will be discussed in the result section.

4.3.5 Scenario #4

The final scenario in our study results from moving production of one product from the U.S. Aqua region to LeCompte. Sportsman's Choice® TrophyFish™ is high performance extruded fish feed that is purchased from the U.S. Aqua Region in Franklinton, LA in the base scenario. The change in supplier is displayed in figure 4.4 and summarized in table 4.7.

Figure 4.4: Scenario #4

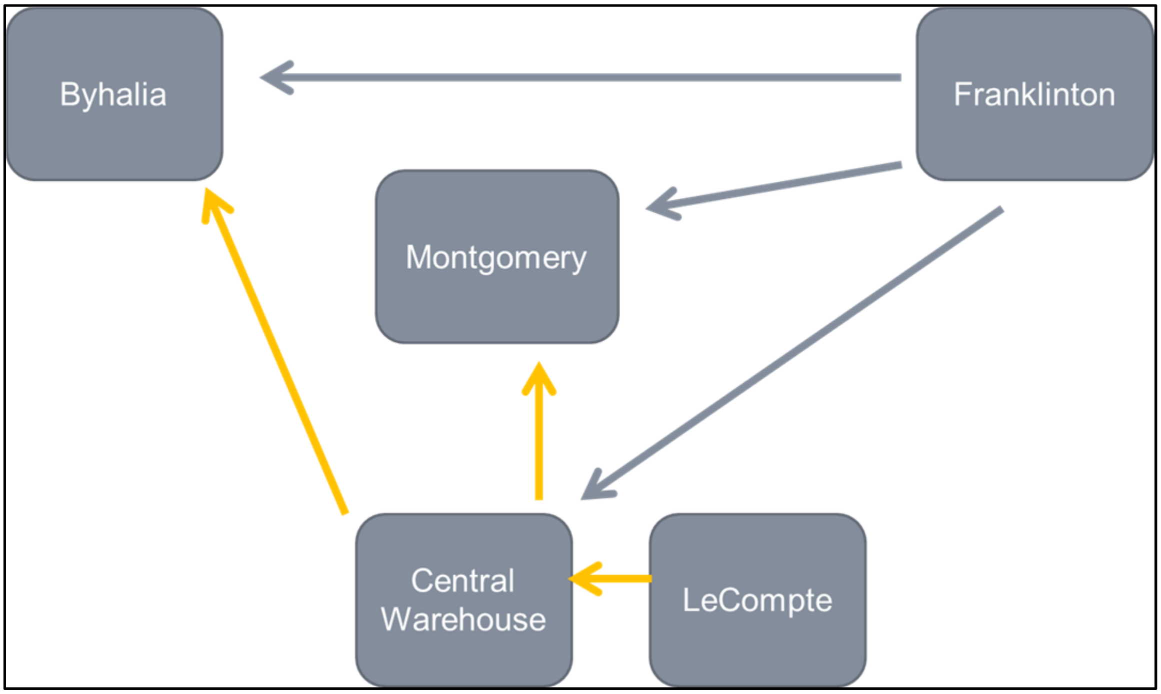


Table 4.7: Source of Extruded Fish Feeds for CAN SE – Scenario #4

	Sportsman's Choice® TrophyFish™ Supplier	
Location	Base Scenario	Scenario #4
Montgomery	Franklinton	Central Warehouse
Central Warehouse	Franklinton	Central Warehouse
Byhalia	Franklinton	Central Warehouse

In Scenario #4, this product is produced at LeCompte, shipped to Central Warehouse, and then sold to external customers as well as other Cargill locations out of Central Warehouse. This scenario includes a change in supplier, product price, and freight rate. There is also an opportunity for additional changes to the overall cost of the supply chain if the product is able to be pulled straight out of the LeCompte plant for the other CAN SE locations due to the avoidance of the $18.75 per ton handling charge incurred by products moving through

Central Warehouse. The economic effects and production challenges presented by this scenario are discussed in further detail in the results section.

CHAPTER V: RESULTS

Analysis of each separate supply chain strategy was performed using scenario analysis. The prevailing conditions were defined as the base scenario in the scenario analysis and formed the reference point for assessing the alternative scenarios. Analysis of the first scenario consisted of a thorough check of reasonability in order to verify the validity of the tool built to help perform the analysis. The first alternative scenario measures the cost savings associated with bringing production of a major feed line in house instead of sourcing from an outside supplier. Scenario two was built according to moving the production of mineral for one of our plants to another plant, allowing for potential savings due to freight advantages and the avoidance of certain warehousing fees. The third alternative involves the transfer of production of textured feeds for Montgomery City from Flora to Kansas City. The final scenario presented in this study also involves bringing production of a certain type of feed into the southeast region.

5.1 Base Model

As indicated, Results for the base scenario are below in Table 5.1. This is the first time that the costs associated with CAN SE supply chain design have been measured. The result of the base scenario is $15,697,426 of supply chain costs on an annual basis. Differences in the costs in each quarter exemplify the seasonal differences in the animal feed industry. The cost during the first quarter (June 1 – August 31st) was the lowest at $3,474,337. The driver for this decrease in cost is significantly less demand for feed. First quarter cost account for only 22% of the total annual cost. The lowest amount of sales in tons is also in the first quarter with only 22% of total annual sales taking place in the first quarter. The second and third quarters realize higher total costs, but also see a similar increase in the amount of tons sold.

The lowest cost per ton of feed is during the second quarter. The highest percentage of non-extruded feeds occurs during the second quarter. The cost for extruded feeds is higher than the cost of general textured or pelleted feeds due to the increased energy used during the production process. This drives the product price for extruded feeds higher than that of other feed types. Only 55% of the feeds moved through the Southeast supply chain in the second quarter are extruded. This is in comparison to the fourth quarter, when 64% of the feeds in the supply chain are extruded and CAN experiences its highest overall cost per ton.

Table 5.1: Base Results

Period	Total Cost	Total Tons	Cost/Ton	Percent of Sales Tons of Extruded Products
First Quarter	$3,474,337	5,751	$604	60%
Second Quarter	$4,053,816	6,947	$584	55%
Third Quarter	$4,149,613	6,944	$598	57%
Fourth Quarter	$4,019,660	6,417	$626	64%
Annual	**$15,697,426**	**26,059**	**$602**	**59%**

5.2 Scenario #1

Once the cost of the original supply chain design was established, a baseline which can be used to assess the feasibility of alternative scenarios was available. The second scenario analyzed in this study involved changing the supplier of extruded pet food. In the base model, River Run pet food for the LeCompte and Byhalia plant were being purchased from an outside supplier, Texas Farm Products (TFP). Historically this product was made in the LeCompte mill for both LeCompte and Byhalia; however an issue regarding product quality in early December of 2011 forced production from LeCompte to the supplier who could provide us the product in the timeliest fashion. At the time, TFP was that supplier. While TFP was supplying the needs of Byhalia and LeCompte for River Run, it was determined that our plant in Montgomery, Alabama would have the capacity to begin producing River Run for Byhalia and LeCompte if a few changes to the design of the supply chain were made.

Table 5.2 displays the historical and projected demand for extruded feed placed on LeCompte and Montgomery if Montgomery were to focus solely on producing pet food while LeCompte produces the remaining various types of extruded feed produced in the southeast region. Trading production of all non-pet extruded feeds for Byhalia and LeCompte's pet food needs results in a slight increase in the total demand of extruded feed for Montgomery. It was determined that the projected 26,527 tons of annual demand for extruded feed would be within the capacity of the Montgomery plant. In turn, production of over 5,000 tons of aqua, deer, and equine extruded feed would be transferred to LeCompte.

Table 5.2: Extrusion Capacity Analysis

Type	LeCompte Extruded Demand 10/11	Montgomery Extruded Demand 10/11	LeCompte Projected Demand 11/12	Montgomery Projected Demand 11/12
Aqua	8,759	3,164	9,317	-
Equine	5,860	573	9,599	-
Deer	3,878	1,549	7,469	-
Pet	8,221	18,059	-	26,527
Total Projected Demand	**22,981**	**23,344**	**26,663**	**26,527**

Once it was determined that there would be enough production capacity to implement the change, the cost savings associated with the change needed to be determined. The tool developed in this thesis is capable of measuring the change in cost due to the design of the supply chain. This will not include cost savings due to longer run sizes and quicker inventory turnover. In the base model, the cost of producing non pet food extruded feeds at Montgomery was included in the cost of the supply. Including the production cost of these feeds in the base model allows for a more accurate comparison of the increase in cost for these select products once the products are sourced from a different plant. The alternative scenario will not include the margin earned by Montgomery on sales of pet food to Byhalia and LeCompte or the margin earned on non-pet food extruded feeds alternatively produced at LeCompte. By leaving out these earnings we overestimate the costs associated with our supply chain.

Savings result from change in product price and changes in freight rates as shown below for Byhalia in Table 5.3 and LeCompte in Table 5.4.

Table 5.3: Scenario #1 Per Ton Costs - Byhalia

	Base Scenario			Scenario #1			
Product	**Product Cost**	**Freight**	**Total Cost**	**Product Cost**	**Freight**	**Total Cost**	**Difference**
River Run® Professional 27-18	$781	$33	$814	$645	$30	$675	($139)
River Run® Professional 24-20	$781	$33	$814	$635	$30	$665	($149)
River Run ® 21% Dog Food 50#	$618	$33	$651	$488	$30	$518	($133)
River Run ® 21% Dog Food 40#	$628	$33	$661	$494	$30	$524	($137)
River Run ® No Soy 40#	$701	$33	$734	$545	$30	$575	($159)

- Handling Cost is $0 in each scenario.

Table 5.4: Scenario #1 Per Ton Costs - LeCompte

	Base Scenario			Scenario #1			
Product	Product Cost	Freight	Total Cost	Product Cost	Freight	Total Cost	Difference
River Run® Professional 27-18	$781	$26	$826	$639	$4	$662	($162)
River Run® Professional 24-20	$781	$26	$826	$672	$4	$695	($131)
River Run ® 21% Dog Food 50#	$618	$26	$663	$748	$4	$771	$108
River Run ® 21% Dog Food 40#	$628	$26	$673	$498	$4	$521	($152)
River Run ® No Soy 50#	$690	$26	$735	$585	$4	$608	($127)
River Run ® No Soy 40#	$701	$26	$746	$578	$4	$601	($145)

- Handling Cost is $18.75 in each scenario.

Further results from the scenario analysis are below in Table 5.5. They show that the alternative discussed above would decrease the cost of the supply chain by $249,828 on an annual basis. Savings from moving production of pet food from TFP to Montgomery is $402,393. These savings are offset by the additional cost associated with sourcing deer and aqua feeds from CW instead of producing them in Montgomery.

Table 5.5: Results of Scenario #1 ($'000)

	Base Scenario Cost				Scenario # 1 Cost				Difference			
Quarter	Total	Deer	Aqua	Pet	Total	Deer	Aqua	Pet	Total	Deer	Aqua	**Pet**
Total	**$15,697**	**$493**	**$676**	**$6,034**	**$15,447**	**$561**	**$762**	**$5,743**	**$249**	**($68)**	**($86)**	**$402**

Savings realized in the first and second quarter are significantly lower due to the increase in cost of purchasing extruded aqua and deer feeds for Montgomery. In the first two quarters, sales of aqua feeds, though declining, are still considered "in season". At the same time, deer feed sales begin to increase. During this time frame, 54% of aqua feed sales and 71% of deer feed sales take place. While Montgomery produced both of these feeds in the base scenario, they are purchasing both from LeCompte in the alternative scenario. That added cost offsets the potential savings from purchasing pet food from Montgomery instead of TFP.

Further scenarios are compared against the total cost of Scenario #1 due to the fact that Scenario #1 has been implemented.

5.3 Scenario #2

The second scenario analyzed involves sourcing mineral needs for LeCompte from McPherson, Kansas instead of Montgomery City, Missouri as is the case in the base scenario. Splitting partial loads of mineral from McPherson with partial loads of pet food from Emporia allows for savings generated by shipping more full trucks. River Run and Marksman pet foods can be sourced more efficiently in Montgomery. Loyall pet food is only produced in Emporia. Currently, Loyall is purchased in quantities ranging from sixteen to nineteen tons. Less than full truck loads are being purchased due to the lack of consistent demand for Loyall products in LeCompte. LeCompte is currently purchasing the majority of their mineral in less than truck load quantities of four to six tons, with an occasional sixteen to eighteen ton truck load. This drives the average freight rate up to $175 per ton on mineral shipping from Montgomery City to LeCompte. Mineral sales in LeCompte are also sporadic, much like Loyall sales. McPherson, Kansas is only 82 miles west of Emporia, Kansas. Originating loads in McPherson and continuing through Emporia to LeCompte would only add $50-$75 more to the current freight rate from Emporia to LeCompte. The additional cost is more than offset by the opportunity to put greater amounts of product on the truck. An argument could be made that customer service would also be increased due to increased availability of fresh product. Mineral and Loyall could be delivered twice as often in smaller quantities, which would provide higher inventory turns.

Savings on mineral make up the majority of the savings possible through this alternative. The savings consist almost completely of freight rate savings instead of product cost savings. Purchasing mineral at an average freight rate of $80, in comparison to the current average freight rate of $175 per ton, results in a $95 per ton savings. LeCompte sells approximately 250 tons of mineral each year. Total savings for only mineral is $23,849. Including Loyall, the savings associated with this alternative are $26,233 annually.

Loyall savings result from delivering these split loads of mineral and Loyall directly to LeCompte in order to avoid the $18.75 per ton fee charged by Central Warehouse and the additional $5 per ton additional freight rate paid when transferring product from Central Warehouse to LeCompte. Currently all mineral is delivered straight to LeCompte while all Loyall is delivered first to Central Warehouse. By decreasing the quantity ordered at one time and increasing the frequency of product deliveries, the space currently occupied by only mineral would be sufficient to store the resulting smaller quantities of Loyall and Mineral in LeCompte in the alternative scenario.

Table 5.4: Results of Scenario #2

Quarter	Scenario #1 Cost	Scenario #2 Cost	Difference
1st	$3,446,837	$3,440,515	($6,322)
2nd	$4,001,337	$3,994,049	($7,288)
3rd	$4,059,850	$4,053,330	($6,520)
4th	$3,939,573	$3,933,470	($6,103)
Total	**$15,447,597**	**$15,421,364**	**($26,233)**

5.5 Scenario #3

In Scenario #3, the costs associated with producing Montgomery City's textured feed needs in Kansas City instead of Flora were analyzed. This involves a change in product price for each feed. The freight rate for each feed would stay the same.

Table 5.6: Sources of Textured Feeds for Montgomery City – Scenario #3

	Supplier		**Product Price per Ton**		
Product	Scenario #1	Scenario #3	Scenario #1	Scenario #3	Difference Per Ton
Life Design ® Senior	Flora	Kansas City	$424	$405	($19)
SafeChoice ®	Flora	Kansas City	$348	$328	($20)
NatureWise ® Rabbit Pellets	Flora	Kansas City	$345	$303	($42)
Country Feeds ® Layer Crumble	Flora	Kansas City	$278	$284	$6
Country Feeds ® Layer Pellet	Flora	Kansas City	$278	$284	$6
Country Feeds ® Scratch Grains	Flora	Kansas City	$327	$326	($1)
NatureWise ® Meat Bird	Flora	Kansas City	$411	$384	($27)
Triumph ® Senior	Flora	Kansas City	$249	$261	$12
NatureWise ® Layer Pellet	Flora	Kansas City	$359	$361	$2
Country Feeds ® Chick Starter	Flora	Kansas City	$314	$314	-
NatureWise ® Chick Starter	Flora	Kansas City	$406	$373	($33)
NatureWise ® All Flock	Flora	Kansas City	$393	$393	-

Although some products are actually more expensive from Kansas City than they are from Flora, the combined savings from switching all products mentioned in the table above is $9,710. Tons associated with this change would be approximately 45 tons each month. The addition of 45 tons would be well within the capacity in Kansas City and would also be enough increased tonnage that full trucks would continue to be shipped from Kansas City to Montgomery City.

The significance of only $9,710 dollars in savings on an annual basis is questionable. The savings generated in this scenario are most likely driven off of the availability of less expensive ingredients in Kansas City. These savings may or may not be sustainable. More research is needed in order to understand the sustainability of the savings associated with this scenario.

5.6 Scenario #4

The final scenario assessed in this study measures the cost savings associated with moving production of Sportsman's Choice ® Trophy Fish from the U.S. Aqua region in Franklinton, Louisiana to the Southeast region in LeCompte, Louisiana. Trophy Fish is an extruded product. Scenario #4 provides an opportunity for savings from decreased product price. As shown in Table 5.7, freight rates actually increase in Scenario #4. However, these increases are slight. The savings in product price are much more significant. As with Scenario #1, this analysis only includes savings generated by changes in product price, freight, and handling costs. Any additional margin earned in the southeast region is not included in this analysis. Because the scenario analysis shows a potential for almost $5,000 in savings without the addition of margin earned, this scenario would be deemed significant enough to warrant further analysis.

Table 5.7: Cost Analysis Trophy Fish – Scenario #4

	Supplier		Price		Freight	
Location	Scenario #1	Scenario #4	Scenario #1	Scenario # 4	Scenario #1	Scenario #4
Central Warehouse	Franklinton	Self	$672	$578	$2	$4
Byhalia	Franklinton	Central Warehouse	$686	$606	$27	$34
Montgomery	Franklinton	Central Warehouse	$686	$606	$32	$28

CHAPTER VI: CONCLUSION

6.1 Conclusion

The research and analysis above fulfill the objectives of this thesis. In the initial chapters, a complete and coherent overview of Cargill Animal Nutrition's supply chain was explained. The overview included a brief history of Cargill, Incorporated as well as Cargill Animal Nutrition. In depth descriptions of the facilities under the management of the southeast region of CAN were given. The nature of the existing relationships between facilities was also explored including the challenges faced due to these dependent relationships.

A tool was built in order to define and measure the costs associated with the design of the supply chain. Costs deemed pertinent to the research problem were included in the model and subsequent analysis. The result is a model that can be used to assess the feasibility of alternative supply chain designs.

This tool was successfully utilized to measure the cost associated with the current design of CAN SE's supply chain. The cost of alternative scenarios was also determined. Comparing the costs of the alternative scenarios provide a basis to be used by the Cargill Animal Nutrition Southeast Region Management Team to assess the feasibility of alternative supply chain designs.

As market conditions change, this tool can be used to manage product mandates by allowing the supply chain to be flexible. The impact of projected changes in market factors on the total cost of the supply chain can be analyzed before they are realized. With this model, a change in total cost of the supply chain due to sudden forced changes in supplier such as a supplier going out of business or a natural disaster destroying a manufacturing location can be analyzed easily and quickly, and informed decisions can be made about how to proceed.

6.2 Recommendations for Further Research

The focus of this research was the movement of finished feed throughout the southeast region. While finished feed is a very large component of overall supply chain costs, ingredients and packaging materials are also important. A model similar to the one built through this research could be built for the supply chain design regarding both micro ingredients (ingredients not bought in bulk quantities) and packaging material separately. Although each of these models does add value independently of the other, a model built to capture each of the three components of the supply chain would provide a comprehensive tool which could be used to assess the overall cost of the supply chain.

Margin earned by manufacturing locations was left out of this research. Inclusion in further research would provide a more complete picture of the overall net return from alternative supply chain designs.

The quantity used in this research was based on historical demand. Utilizing this model along with demand forecasting models would provide the company with the total cost of meeting that demand. This would allow the company to make marketing decisions that could potentially impact the actual quantity demand by leading the customer to products that are most beneficial to the supply chain design.

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