ECONOMIC FEED SHRINK ANALYSIS OF A TEXAS DAIRY FARM

A Project Paper

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by

Preston David DeJong

ABSTRACT

The single largest expense that a dairy farm business incurs is the cost associated with feeding their dairy herd, at approximately 50 percent of its annual production cost (DePeters & Weiss, 2015). Due to feed being the largest single expense, proper or improper management of areas in which feed is stored and handled can have profound impacts on overall farm profitability.

Feed shrink on a dairy farm is defined as “the percentage of feed on a farm that is not accounted for by the rations by the animals for which it is intended”(Dutton, 1998). Feed shrink is said to represent 15-20% of the total feed cost (Brouk, 2009). Feed shrink can vary across the dairy industry based upon the type of storage structure, ingredient delivery method, weather, and much more.

For this problem-solving project, a farm in Texas agreed to have their business analyzed financially and operationally. The client farm has been in operation since 1994 and over the course of this time has grown to be approximately three times its original size. During this time, they have not monitored, measured, or documented the amount of shrink that they experience, although they have visually identified feed shrink.

The primary focus of the project is to determine the amount of feed shrink that is occurring on the client farm in all of their purchased feed ingredients, and its associated economic impact. Those ingredients included purchased corn silage and all grains and concentrates. From visual identification by the client, it was believed that significant shrink occurs in the farm’s purchased feed while stored in the feed center and during the creation of the Total Mixed Ration (TMR) batches. To understand the scope of the issue of feed shrink on this particular dairy, year-end financial statements, monthly and annual QuickBooks and FeedWatch

reports, and commodity purchasing contracts were utilized, all spanning the entirety of 2018 and 2019.

Monthly QuickBooks feed reports were compared to FeedWatch's "Ingredient Usage with Costs" report for each month, with cross referencing from commodity purchasing contracts. From that information, the amount shrink and its associated economic impact could be identified per month, year, and for particular ingredients.

The major findings of the feed shrink analysis were that shrink of all purchased feed amounted to be a total economic loss of $370,701 and a 4.3% shrink for 2018, while in 2019 the client farm experienced an economic loss of $209,446 and a 3.1% shrink. This totaled to be an economic loss of $580,147 and a 3.6% shrink across the two years, and an average economic loss due to feed shrink of $290,073 across for both 2018 and 2019.

The secondary focus of the project was the presentation of problem-solving solutions. In this case, solutions that would decrease feed shrink on the client farm. Through conversations with the owners of the client farm, their team members, and time spent observing their operation, three solutions to feed shrink were identified.

The first solution was the construction of a new feed center structure attached to the client farms current feed center designed to block the wind during the creation of TMR batches, an area where a large amount of feed shrink was identified through visual observation. A structure was designed and constructed and an analysis was performed upon its completion. The cost of the new feed center structure was $58,545.50. Per the partial budget analysis, the new feed center structure would result in an increase in net income of $140,579 for the client farm, a cost/benefit ratio of 32.5, and a net benefit/investment ratio of 2.4 if the new feed center structure decreases the client farm's feed shrink by 50%.

The second solution identified was moving feed ingredients to different bays based upon economic loss from the feed shrink analysis. From the feed shrink analysis, the level of shrink varied based upon ingredients. Nearly all ingredients experienced shrink to a certain degree, while others, according to the analysis, had a surplus. Due to this, based upon the economic loss of each ingredient, the bay in which the feed ingredient is stored could be changed to decrease the distance it is from the area in which the TMR is created, thus decreasing opportunities for shrink to occur.

The final solution identified pertained to limiting opportunities for there to be an oversupply of feed ingredients. The client farm utilizes a commodity management business that handles the logistics of their certain feed ingredients from various vendors. In the past, the commodity management company has ordered ingredients days earlier than needed. This would not be an issue for the client farm if they had an ample amount of storage for all of their feed stuffs, but this is not the case. Expensive grains and concentrates would arrive earlier than needed and feed center bays would not have enough storage capacity to store the ingredient, leaving the ingredient dumped on the apron outside of the feed center exposed to all of the various ways that feed can be lost due to shrink. By the client farm sharing the inventory of their feed ingredients with the commodity management company and encouraging an open line of communication between them and the client farm, feed shrink can again be reduced.

With the client farm recognizing feed shrink as an issue, making an effort to analyze it's effect, and following the recommendations that were presented, they will not only be in a position to decrease the negative effects of feed shrink in the future, but maximize their revenues and increase their operational efficiencies.

BIOGRAPHICAL SKETCH

Preston DeJong was born on September 18th, 1997 in Stephenville, Texas. He was raised on his family's dairy farm with his parents and siblings and from an early age developed a passion for the dairy industry. After completing high school, Preston attended Texas A&M University in College Station, Texas where he earned his Bachelor of Science in Plant and Environmental Soil Science, with a concentration in Soil and Crops Science in May of 2019. Following, Preston attended Cornell University to pursue a Master of Professional Studies in Animal Science, with a concentration in Dairy Business Management, where he graduated in August of 2020. Upon graduating, Preston began his career in the dairy industry where he works in dairy farm business management. Preston's primary interests include agronomy and crop production, dairy farm operational efficiency, and dairy business management.

DEDICATION

This project is dedicated to all of the past, present, and future agriculturalists, especially all of those within my own family and the families that I have been blessed to have learned from. Agriculture is a sector of society that is so desperately needed, yet largely undervalued. I appreciate all of those that have dedicated their lives to feeding and clothing us all.

ACKNOWLEDGEMENTS

I would like to thank the client farm that I served throughout the course of this project. I appreciate their cooperation, patience, and willingness to provide me with any and all information that I requested, both confidential and operational data. I would also like to acknowledge the support that I received from Dr. Thomas Overton (Cornell University) and Mr. Jason Karszes (Cornell PRO-DAIRY program) throughout the completion of this project, as well as others in the Cornell University Department of Animal Science.

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INTRODUCTION

The single largest expense that a dairy farm business incurs is the cost associated with feeding their dairy herd, at approximately 50 percent of its annual production cost (DePeters & Weiss, 2015). Due to feed being the largest single expense, modifications to management and operations of the feed center can have profound impacts on the total costs that the farm incurs. Variability exists across the entirety of the dairy industry in feed center design, size, and effectiveness. To maximize feed center effectiveness, dairies utilize tools and precision technologies that assist them in collecting information that can drive increased efficiency, operational performance, and profitability, with the majority of the focus being feeding accuracy, feed shrink, and labor costs (Karszes and Howlett, 2016).

Shrink is liable to occur anywhere, across any industry and sector of society. Dutton (1998) defined shrink on a dairy farm as "the percentage of feed on a farm that is not accounted for by the rations by the animals for which it is intended". Shrink on dairy farms occurs in multiple forms including, field losses, storage, heating, wind, rain, rodents, birds, wet tires, and mixing errors (Hartschuh, 2016). Feed ingredients have varying particle densities and sizes, putting some ingredients at a higher risk of shrink than others (e.g., chopped hay, straw, wheat midd's).

Feed shrink is said to represent 15-20% of the total feed cost (Brouk, 2009). Feed shrink can vary across the dairy industry based upon the type of storage structure, ingredient delivery method, and weather. A traditional 3-sided bay feed center is said to have a normal shrink quantity of 8%, while closed bins typically experience 2% shrink (Harner, 2009). The type of trailer that the feed is delivered in (e.g., hopper bottom, live bottom, and dump trailer) also can impact feed shrink. Lastly, weather events like wind and/or rain increase feed shrink directly from feed loss from feed center bays and mixing the TMR due to feed blowing away or feed being rained on and spoiling prior to being fed.

Feed shrink is not a foreign concept to dairy farmers, but few dairy producers measure the amount of shrink that their operation experiences, keeping them from correctly managing it. By failing to track feed shrink, an opportunity for dairy producers to increase operational efficiency and increase profitability is missed. Michael Brouk of Kansas State University determined the cost of a corn silage-based ration equaled $5.49 per head per day with the assumption of zero shrink. Daily feed cost increased to $6.05/head when typical shrink values were applied to each feed ingredient in the diet. If shrink losses were reduced by 50 percent for each ingredient, daily feed costs were reduced to $5.75/head. The difference in daily feed cost of $0.30/head due to reduced shrink results in an annual savings of $100 per dairy cow over the course of the year. As stated earlier, modifications to management and operations of the feed center can have profound impacts on the total costs that the farm incurs. For many dairy farms across the country, this can be the difference maker in maximizing revenues and minimizing expenses, which can broaden the narrow margins commonly experienced by dairy farms.

In this analysis, the primary focus was to quantify the amount of shrink that is occurring on the client farm as well as its associated cost. Once identified, the secondary focus was to develop recommendations for the client farm with the intent of reducing feed shrink.

PROBLEM IDENTIFICATION

The client farm has been in operation since 1994 and over the course of this time has grown to be approximately three times its original size. During this time, they have not monitored, measured, or documented the amount of shrink that they experience, although they have visually identified feed shrink due to wind and/or rainfall, as seen in Illustrations 2 and 3. Because the client farm has failed to measure feed shrink, it has left them unable to effectively manage it. That said, the client farm has identified feed shrink as a problem and wishes to measure the amount of feed shrink that occurs on their farm so that they are able to quantify the financial impact that it has on their operation.

LIMITATIONS OF STUDY

As previously stated, the primary problem that the client farm identified is that of feed shrink. They wish to measure feed shrink on their operation and quantify its economic impact so that the scale of the issue is recognized and can be addressed. Unfortunately, measuring feed shrink across the entirety of the operation is not achievable due to discrepancies that exist in the value of self-grown forages (hay and silage) and the on-farm inventories. Purchased feeds, which include corn silage, fine ground corn, an assortment of minerals, dried distillers grains (DDG), cottonseed, soybean meal (SBM)/SoyPlus, and canola meal, were the only feed ingredients that possessed all of the criteria necessary to closely track shrink, including purchase price per ton from QuickBooks and commodity contracts. Therefore, the primary objective of the analysis was changed to measure the amount of shrink that is occurring in the client farm's purchased feed ingredients and the economic impact associated with it.

MATERIALS & METHODS

Information was gathered in order to begin measuring feed shrink and its associated financial impact on the client farms operation. Due to the limitation of not being able to quantitatively measure the expense and inventory status associated with the client farm's self-grown forage, purchased feed shrink was the only variable could be assessed. This information was obtained by requesting desired information from the owners of the client farm, as well as being granted access to management software that the client farm utilizes, procuring the desired information myself. The management software that the client utilizes includes DairyComp 305 (DC), FeedWatch (FW), both of which are software packages developed by of Valley Ag Software (VAS, Tulare, California), as well as QuickBooks from Intuit.

To ascertain the client farm's annual feed expense and the percentage of the operation's annual expenses it represents, year-end financial statements for 2018 and 2019 were used. Monthly accrual-based reports were generated from QuickBooks for all purchased feed expenses beginning January of 2018 and ending December of 2019. The QuickBook reports contained information that was used including ingredient and the total price paid for the ingredient for the month. Next, monthly "Ingredient Usage with Cost" reports were generated from FeedWatch for each month beginning January of 2018 and ending December of 2019. The information that the FeedWatch reports contained included the as fed tons for each ingredient per month. After gathering the information needed, it was transferred to a Microsoft Excel worksheet. Once the data from the monthly FeedWatch and QuickBooks reports were inputted into their respective Microsoft Excel worksheets, the feed shrink analysis began.

Using information provided by the FeedWatch reports, an Excel worksheet was created that contained ingredient name and "As Fed" tons for each month of 2018 and 2019. From there, the "SUM" command in Excel was used to calculate the total "As Fed" tons for the entirety of 2018 and 2019. Using information provided by the QuickBooks reports, an Excel worksheet was created that contained ingredient name and the price paid for each ingredient per month. The cost per ton or the quantity of each ingredient had not been obtained or calculated, both of which were needed to calculate the shrink occurring on the client farm. Because of this, more information that the client farm possessed was needed, the most accessible being the commodity purchasing contracts. Once the past commodity purchasing contracts were obtained, from January of 2018 to December of 2019, a monthly "cost per ton" for each purchased ingredient was identified and inputted into the QuickBooks Excel worksheet. Using the total monthly expense per ingredient from QuickBooks and the monthly cost per ton from the commodity contracts, the total tons of each feed ingredient for each month from January 2018 to December 2019 was calculated by dividing the monthly expense per ingredient by its associated cost per ton. The results of this calculation were then inputted into the QuickBooks Excel worksheet.

From there, the "SUM" command in Excel was used to calculate the total tons of each feed ingredient according to QuickBooks for 2018 and 2019. Similarly, the "AVERAGE" command was used to calculate the average cost per ton of each ingredient according to the commodity contracts for 2018 and 2019. Following, the average cost per ton of each ingredient for 2018 and 2019 were averaged, resulting in the same cost per ton used for 2018 and 2019. The reasoning for this methodology of averaging the 2018 and 2019 cost per ton for each ingredient is to create a fixed cost per ton that is would be accurate for the time period and could be used to assess the economics of feed shrink based solely upon feed shrink itself as opposed to the effects of a changing feed price.

Moving forward, the resulting data of the various calculations were compiled as Tables 1 and 2. The total "As Fed Tons" for each ingredient for 2018 was subtracted by the "QuickBooks Purchased Tons" for each ingredient for 2018. The result of the calculation was the "Difference" (Tons) between the two for each ingredient. Following, the "Difference" (Tons) for each ingredient was multiplied by the fixed cost per ton for each ingredient, resulting in the

“Difference” ($) for each ingredient. Thereafter, the “Difference” (Tons) for each ingredient was divided by the “QuickBooks Purchased Tons” for each ingredient, resulting in the “Shrink” (% Tons) for each ingredient. The same was done for the calendar year 2019.

ANALYSIS DATA

The resulting data from the 2018 feed shrink analysis, as seen in Table 1, shows that over the course of the 2018 calendar year, the client farm’s total purchased feed according to “FeedWatch ‘As Fed’ Tons” recorded 35,068 tons, whereas “QuickBooks Purchased Tons” was 36,626 tons. This resulted in a ‘Difference” of 1,558 tons across all of the purchased feed ingredients, with a total economic loss of $370,701 and a total purchased feed shrink of 4.3%. The client farm’s total purchased grain and concentrates expense, according “FeedWatch ‘As Fed’ Tons” was 20,892 tons, while “QuickBooks Purchased Tons” was 22,082 tons. This resulted in a ‘Difference” of 1,191 tons across all of the purchased grain and concentrates ingredients, with a total economic loss of $345,038 and a total purchased grain and concentrates shrink of 5.4%. As seen in the feed shrink analysis, nearly all ingredients experienced some shrink over the course of 2018. Prep+ experienced the largest shrink in proportion to the tons purchased and fed with 10.5% shrink and an economic loss of $30,780, followed by Soybean Meal/SoyPlus with 8.1% shrink and an economic loss of $83,747. XME Meal experienced 6.7% shrink and $55,576 in economic loss, Cottonseed experienced 6.0% shrink and $39,568 in economic loss, and Nugget had 5.4% shrink and an economic loss of $30,688. Ground Corn recorded a 4.8% shrink in proportion to the tons purchased and fed, but had the largest economic loss of any need ingredients with $96,221. Purchased Corn Silage and DDG experienced 2.5% shrink, but Purchased Corn Silage had an associated economic loss of $25,663, whereas DDG had an economic loss of $11,762. Mineral 1974 was the only purchased feed ingredient that did not experience any feed shrink, the results showing an 8.0% increase and an economic gain of $3,303.

Table 1: "2018 Feed Shrink Analysis Table"

2018 Feed Shrink Analysis Table						
Ingredients	FeedWatch "As Fed" Tons	QuickBooks Purchased Tons	Difference (Tons)	Cost/Ton ($)	Difference2 ($)	Shrink (% Tons)
Purchased Corn Silage	14,176	14,544	(368)	$ 70	$ (25,663)	-2.5%
Cottonseed	2,901	3,086	(185)	$ 214	$ (39,568)	-6.0%
Prep+	486	543	(57)	$ 537	$ (30,780)	-10.5%
DDG	2,243	2,300	(58)	$ 204	$ (11,762)	-2.5%
Ground Corn	10,538	11,066	(528)	$ 182	$ (96,221)	-4.8%
Mineral 1974	65	60	5	$ 692	$ 3,303	8.0%
Nugget	700	739	(40)	$ 770	$ (30,688)	-5.4%
SBM/SoyPlus	2,668	2,903	(235)	$ 357	$ (83,747)	-8.1%
XME Meal	1,293	1,385	(92)	$ 601	$ (55,576)	-6.7%
Total Purchased Feed	35,068	36,626	(1,558)		$ (370,701)	-4.3%
Total Purchased Grain & Concentrates	20,892	22,082	(1,191)		$ (345,038)	-5.4%

The resulting data from the 2019 feed shrink analysis, as seen in Table 2, shows that over the course of the 2019 calendar year, the client farm's total purchased feed according to "FeedWatch 'As Fed' Tons" recorded 36,948, whereas "QuickBooks Purchased Tons" was 38,112. This resulted in a 'Difference" of 1,164 tons across all of the purchased feed ingredients, with a total economic loss of $209,446 and a total purchased feed shrink of 3.1%. The client farm's total purchased grain and concentrates expense, according "FeedWatch 'As Fed' Tons" was 23,896, while "QuickBooks Purchased Tons" was 24,416. This resulted in a 'Difference" of 520 tons across all of the purchased grain and concentrates ingredients, with a total economic loss of $164,557 and a total purchased grain and concentrates shrink of 2.1%. As seen in the feed shrink analysis, nearly all ingredients experienced some shrink over the course of 2019. Canola Meal experienced the largest shrink in proportion to the tons purchased and fed with 11.4% shrink and an economic loss of $9,236, followed by XME Meal with 5.2% shrink and an economic loss of $50,869. Purchased Corn Silage experienced 4.7% shrink and $44,889 in economic loss, Prep+ experienced 3.8% shrink and $12,688 in economic loss, and Soybean Meal/SoyPlus had 2.7% shrink and an economic loss of $37,458. Ground Corn recorded a 2.4%

shrink in proportion to the tons purchased and fed, but had the largest economic loss of any need ingredients with $56,771. Nugget experienced 1.6% shrink and had an associated economic loss of $7,328, while Mineral 1974 had 0.9% shrink and an economic loss of $696. Cottonseed and DDG were the only purchased feed ingredients that did not experience any feed shrink, 0.7% and 1.7%, with an economic gain of $4,065 and $6,364.

Table 2: "2019 Feed Shrink Analysis Table"

2019 Feed Shrink Analysis Table						
Ingredients	FeedWatch "As Fed" Tons	QuickBooks Purchased Tons	Difference (Tons)	Cost/Ton ($)	Difference2 ($)	Shrink (% Tons)
Purchased Corn Silage	13,052	13,695	(644)	$ 70	$ (44,889)	-4.7%
Cottonseed	2,624	2,605	19	$ 214	$ 4,065	0.7%
Prep+	601	624	(24)	$ 537	$ (12,688)	-3.8%
DDG	1,862	1,831	31	$ 204	$ 6,364	1.7%
Ground Corn	12,546	12,858	(311)	$ 182	$ (56,711)	-2.4%
Mineral 1974	115	116	(1)	$ 692	$ (696)	-0.9%
Nugget	601	610	(10)	$ 770	$ (7,328)	-1.6%
SBM/SoyPlus	3,735	3,841	(105)	$ 357	$ (37,458)	-2.7%
XME Meal	1,535	1,620	(85)	$ 601	$ (50,869)	-5.2%
Canola Meal	277	313	(36)	$ 260	$ (9,236)	-11.4%
Total Purchased Feed	36,948	38,112	(1,164)		$ (209,446)	-3.1%
Total Purchased Grain & Concentrates	23,896	24,416	(520)		$ (164,557)	-2.1%

The resulting data from the total feed shrink analysis, as seen in Table 3, shows that over the course of 2018 and 2019 calendar years, the client farm's total purchased feed according to "FeedWatch 'As Fed' Tons" recorded 72,015, whereas "QuickBooks Purchased Tons" was 74,738. This resulted in a 'Difference" of 2,722 tons across all of the purchased feed ingredients, with a total economic loss of $580,147 and a total purchased feed shrink of 3.6%. The client farm's total purchased grain and concentrates expense, according "FeedWatch 'As Fed' Tons" was 44,788, while "QuickBooks Purchased Tons" was 46,499. This resulted in a 'Difference" of 1,711 tons across all of the purchased grain and concentrates ingredients, with a total economic loss of $509,595 and a total purchased grain and concentrates shrink of 3.7%. As seen in the feed shrink analysis, nearly all ingredients experienced some shrink over the course of the two years that the analysis spanned. Canola Meal experienced the largest shrink in proportion to the tons purchased and fed with 11.4% shrink and an economic loss of $9,236, followed by Prep+

with 6.9% shrink and an economic loss of $43,468. XME Meal experienced 5.9% shrink and $106,445 in economic loss, Soybean Meal/SoyPlus experienced 5.0% shrink and $121,205 in economic loss, and Nugget had 3.7% shrink and an economic loss of $38,016. Purchased Corn Silage had 3.6% shrink and $70,552 in economic loss. Ground Corn recorded a 3.5% shrink in proportion to the tons purchased and fed, but had the largest economic loss of any need ingredients with $152,932. Cottonseed experienced 2.9% shrink and had an associated economic loss of $35,502 while DDG had shrink of 0.6% and an economic loss of $5,398. Mineral 1974 was the only purchased feed ingredient that did not experience any feed shrink during the two years the analysis spanned, experiencing a 2.1% increase and an economic gain of $2,607.

Table 3: "Total Feed Shrink Analysis Table"

Total Feed Shrink Analysis Table

Ingredients	FeedWatch "As Fed" Tons	QuickBooks Purchased Tons	Difference	Cost/Ton	Difference2	Shrink
			(Tons)	($)	($)	(% Tons)
Purchased Corn Silage	27,228	28,239	(1,011)	$ 70	$ (70,552)	-3.6%
Cottonseed	5,525	5,691	(166)	$ 214	$ (35,502)	-2.9%
Prep+	1,086	1,167	(81)	$ 537	$ (43,468)	-6.9%
DDG	4,105	4,131	(26)	$ 204	$ (5,398)	-0.6%
Ground Corn	23,084	23,923	(840)	$ 182	$ (152,932)	-3.5%
Mineral 1974	179	176	4	$ 692	$ 2,607	2.1%
Nugget	1,300	1,350	(49)	$ 770	$ (38,016)	-3.7%
SBM/SoyPlus	6,403	6,743	(340)	$ 357	$ (121,205)	-5.0%
XME Meal	2,828	3,005	(177)	$ 601	$ (106,445)	-5.9%
Canola Meal	277	313	(36)	$ 260	$ (9,236)	-11.4%
Total Purchased Feed	72,015	74,738	(2,722)		$ (580,147)	-3.6%
Total Purchased Grain & Concentrates	44,788	46,499	(1,711)		$ (509,595)	-3.7%

DISCUSSION

The problem that the client farm has identified is feed shrink. Measuring the amount of feed shrink that is occurring on the farm, as well as its associated financial impact is the primary focus of the project. Using the monthly "Ingredient Usage with Cost" report from FeedWatch, monthly accrual-based reports from Quickbooks of all purchased feed ingredients, and commodity contracts, the feed shrink analysis was performed. Comparison reports were created and include purchased feed ingredients, "As Fed" Tons according to FeedWatch, "Purchased Tons" according to QuickBooks, the difference between the FeedWatch and QuickBooks ingredient tonnage, the fixed cost per feed ingredient, the associated economic difference between FeedWatch and QuickBooks, and the percent shrink per ingredient.

The major findings of the feed shrink analysis were that shrink of all purchased feed amounted to be a total economic loss of $370,701 and a 4.3% shrink for 2018, while in 2019 the client farm experienced an economic loss of $209,446 and a 3.1% shrink. As for the shrink that occurred in purchased grain and concentrates, an economic loss of $345,038 and a 5.4% shrink for 2018 was found, while in 2019 an economic loss of $164,557 and 2.1% shrink was recorded. Feed shrink occurred in virtually every ingredient category with the exception of Mineral 1974 in 2018 and DDG and Cottonseed in 2019. These findings show that during the time period in which this analysis took place, feed shrink is occurring on the client farm. Although the percent shrink that was identified during this analysis was considerably less than the 8% average shrink for a 3-sided commodity building, opportunities are undoubtedly present to decrease shrink on the client farm (Harner, 2009).

The results of the feed shrink analysis allows us the opportunity to grasp a better understanding of the impact of feed shrink on the client farm. The results quantify the amount of feed shrink that is occurring for each ingredient, as well as the negative economic impact that feed shrink has. The cost per ton of ingredients and the quantity fed and purchased for each ingredient varies, but from the results, we are better able to understand which feed ingredients are more or less prone to being lost. The form in which feed shrink is occurring is not absolutely clear, but the client farm owners agree that wind is the largest contributor. The feed ingredient that had the largest combined economic loss over the course of 2018 and 2019 was ground corn with $153,932. The following ingredients all experienced an economic loss of a lesser value than ground corn and is stated as such; SBM/SoyPlus, $121,205; XME Meal, $106,445; Purchased

Corn Silage, $70,552; Prep+, $43,468; Nugget, $38,016; Cottonseed, $35,502; Canola Meal, -$9,236; and DDG, $5,398.

By being able to quantify the amount of shrink for each ingredient, the client farm will be able to make individual ingredient-based decisions as to how to limit feed shrink. This can come in the form of deciding to pelletize a feed ingredient if possible, rather than feeding the ingredient in the form of a meal, moving ingredients to different bays, or the construction of a facility to decrease feed shrink.

Based upon the total feed shrink analysis, the only ingredient that did not fall victim to an economic loss over the course of 2018 and 2019 was Mineral 1974, which had an economic gain of $2,607. Although this is doubtful, Mineral 1974 differed from all of the other purchased feed ingredients in its delivery and storage form. Mineral 1974 is a feed ingredient that is sold in 50-pound bags and a very small quantity is used. Because the ingredient is stored in this way, it is less susceptible to feed shrink prior to being used. Also, due to the small quantity that is fed in relation to other feed ingredients, when it is fed, the "feeder" will open the bags, pour them into the payloader bucket, and then put the ingredient into the mixer wagon. The payloader bucket is never completely full due to the small quantity required, also decreasing the likelihood for shrink to occur.

RECOMMENDATIONS

The major findings of the feed shrink analysis were that shrink of all purchased feed amounted to be a total economic loss of $370,701 and a 4.3% shrink for 2018, while in 2019 the client farm experienced an economic loss of $209,446 and a 3.1% shrink. This totaled an economic loss of $580,147 and a 3.6% shrink. This is a substantial amount of money that the client farm is spending annually, but unfortunately is not making it to its intended use. By making careful adjustments and implementing various management practices intended to measure and manage shrink, the client farm will be better suited to decrease shrink and increase annual savings across their operation.

FEED SHRINK REDUCTION SOLUTION #1

When the client farm was built in 1994, a 3-sided feed center was built for the original 1,200 lactating cows and 400 dry cows that the operation had. Today, the farm has grown to be approximately three times its original size, with 3,700 lactating cows, 500 dry cows, and 500 springing heifers on site, all while utilizing the original feed center. During that time, minor modifications have been done to the existing structure including a new apron where the "feeder" travels when gathering ingredients and the fortification of supports and push wall. Like most commercial dairy farms, the client farm utilizes a front-end loader and a pull-behind mixer wagon for ration formulation, mixing, and delivery. The "feeder" dumps ingredients of specified quantities into the mixer wagon based upon what is prompted by the feed management software, trying to get as close to the target weight as possible. The client farm does utilize incentives for feeder accuracy, rewarding the "feeder" when within a certain range of the target weight.

The feed center was designed such that the back wall of the structure blocks the prevailing wind, which in the case of the client farm is typically from the northwest. The feed center is surrounded by structures including two hay barns to the east and the west and a freestall barn for their close-ups to the south, all of which provide relief from the wind coming from those directions.

Illustration 1: Aerial photo of the client farms feed center with the direction depicted.

However, the client farm is no stranger to wind and it is not uncommon for wind to exceed 15 miles per hour, while the annual wind speed average is 8 miles per hour. Hartschuh (2016) suggested that winds blowing at 10 mph vs. 5 mph increase feed shrink losses by 8%. At 15 mph, the losses increase by 27%. Unfortunately for the client farm, these winds are common and the effects of them are largely seen during the creation of the TMR batches. On the east side of the client farm's feed center is where the loading and mixing process occurs. This is also an area that lacks any protection from the wind and other environmental elements. Due to this, when ingredients are being dumped into the mixer wagon, they are susceptible to being influenced by the wind and becoming airborne, as seen in Illustration 2.

Illustration 2: Ground corn being transferred from payloader into mixer wagon during feed batch creation. Ground corn particulates can be seen becoming airborne due to wind.

Although the client farm has not measured the feed shrink that is occurring during feed batch creation, both the owners and the two “feeders” believe the majority of the feed that is being lost, occurs in this phase of the feeding process. After becoming airborne, the feed blows away from the feed center and accumulates on the ground and water tank as seen, as seen in Illustration 3.

Illustration 3: Feed covering the ground and water tank from being wind-blown and becoming airborne during feed batch creation process.

As a solution to the feed that is lost due to wind during batch creation, I believe that it would be a worthwhile investment to construct a windbreak that will hinder the winds ability to interfere during this process. By blocking the wind on the east side of the feed center, the client farm will be able to decrease the amount of shrink that they experience and therefore, reducing their annual expenses. This structure could also serve as a building that is capable of storing and sheltering feeding equipment, specifically the feeding tractor and mixer-wagon, which has not been stored in the past. By storing the feeding equipment, the useful life of the said equipment should be extended, also proving economically beneficial to the client farm.

When discussing the possibility of a wind block/storage structure with the client farm, they were very receptive to the idea, especially after learning of the results of the feed shrink analysis. The owners of the farm and I began designing a structure that would not only decrease the amount of shrink that is occurring, but also shelter their feeding equipment, could easily be added onto the current feed center, and not interrupt the current flow of traffic of the farm. The client farm also wished to minimize the ways that the structure could alter the “feeders” routine.

Following a multitude of conversations and joint design sessions with the owners of the client farm, a design which we believed would sufficiently address the client farm’s issue of feed shrink as well as their other desires, was created as seen in Illustration 4.

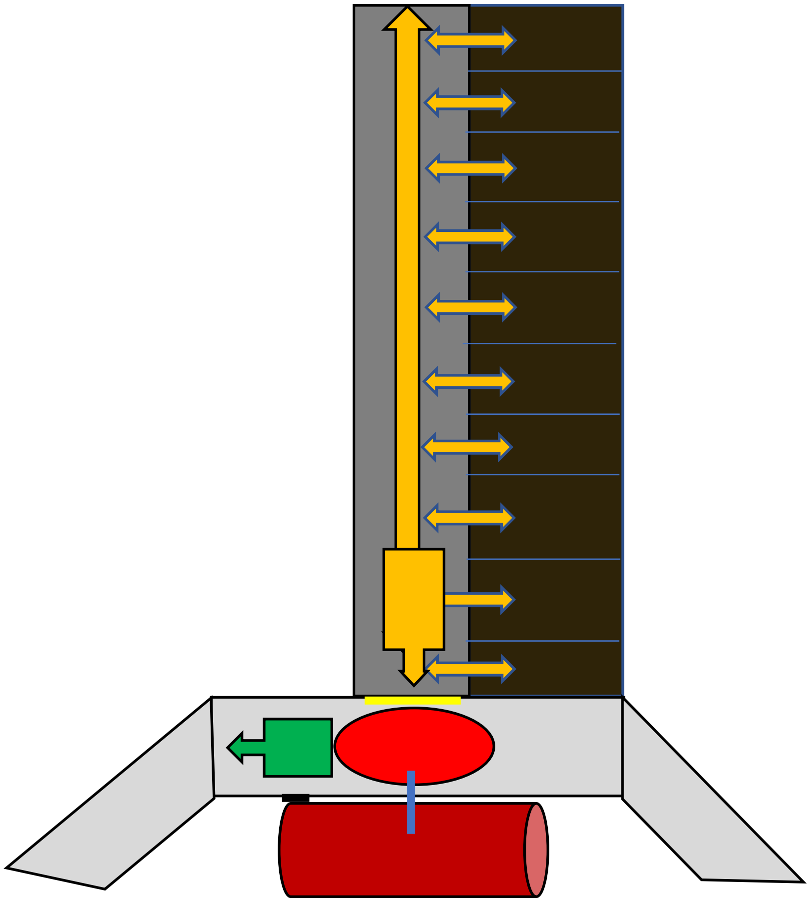

Illustration 4: The original design of the feed center structure designed to decrease feed shrink and store feeding equipment.

The design would continue to utilize the driveway that the “feeder” traveled in the past, as well as the area in which ingredients have historically been brought to the mixer wagon. The new feed center structure would operate in a way that is similar to a drive-through. The “feeder” would enter the structure from the north end and slowly pull through and park the tractor and mixer-wagon in a position to where both the payloader and the water spout are able to reach the mixer-wagon. A small door is positioned such that when the “feeder” exits the tractor, he is able to go through the door and turn on the water pump located at the water tank. Passing through the same door, the feeder will be able to walk beside the mixer-wagon and up a small ladder, then being on the same platform where the payloader and feed ingredients are located.

Following the completion of the design, the client farm hired a crew that have done maintenance and various other projects for the client farm over the years. Construction of the structure began on February 15, 2020 and finished on April 1, 2020. In Illustration 5 and 6, the new structure can be seen.

Illustration 5: Overhead image of the client farms feed center with the new wind block structure added on.

Illustration 5: Arial image of the frontside of the client farms feed center with the new wind block structure.

After calculating the cost of the materials and labor from the receipts and invoices, the total cost for the construction of the structure amounted to $58,545.50. Further financial analysis was then performed in the form of a partial budget with the intent of identifying the potential profitability of the structure for the client farm. The partial budget is strictly analyzing the "New Feed Center Structure" versus "No Structure", or the client farm original feed center with no intervention. The assumptions included in the partial budget are as follows; feed shrink used for the analysis is an average of the total purchased feed for 2018 and 2019, and the new structure reduced feed shrink by 50% of recorded shrink ($) for 2018 & 2019.

When looking at the "Items that add to Net Income" no added returns were identified. However, by the client farm building the new feed center structure, reduced costs were identified. For the sake of this partial budget, I elected to assume a 50% decrease in total purchased feed shrink with averaging the 2018 and 2019 years according to the initial feed shrink analysis. By taking the 2018 and 2019 total purchased feed shrink ($), averaging it for the two years, and then decreasing shrink by 50% with the new feed center structure, the client farm has the potential to reduce costs by $145,037. This results in a gross addition to net income of $145,037.

In the notes to the client farm's financial statements, under the summary of significant accounting policies, within the dairy farm and equipment section, it is said that, "Depreciation is computed on a straight-line method over approximately 25 years for all buildings with a 25% salvage value." The client farm has also historically financed buildings at a 4.65% opportunity interest rate, doing the same for the new feed center structure. When looking at the "Items that reduce Net Income" no reduced returns were identified. However, added costs were identified in the form of annual depreciation at $1,756 over the 25-year useful life, annual opportunity interest of $1,702, and an annual routine maintenance of $1,000. This results in a gross reduction to net income of $4,458.

When subtracting the gross reduction to net income of $4,458 from the gross addition to net income of $145,037, it results in a net income of $140,579 for the client farm. By dividing the gross addition to net income of $145,037 by the gross reduction to net income of $4,458, the construction of the new feed center structure results in a cost/benefit ratio of 32.5 and a net benefit/investment ratio of 2.4 when dividing the change in net income of $140,579 by the original investment of $58,545.50. The results of partial budget can be seen in illustration 7.

PRO DAIRY

PROFITABILITY PARTIAL BUDGET ANALYSIS OF

New Feed Center Structure vs **No Structure**

Assumptions

Feed shrink used for analysis is average of 2018 and 2019 years

New structure reduces feed shrink by 50% of recorded shrink for 2018 &

#	ITEMS THAT ADD TO NET INCOME			#	ITEMS THAT REDUCE NET INCOME		
	Added Returns:				Reduced Returns:		
1		$0		1		$0	
2		$0		2		$0	
3		$0		3		$0	
4		$0		4		$0	
5		$0		5		$0	
6		$0		6		$0	
7		$0		7		$0	
8		$0		8		$0	
		Total	$0			Total	$0
	Reduced Costs:				Added Costs:		
1	50% Decrease in "Total" Feed Shrink (2018 & 2019 Average)	$145,037		1	Annual Depreciation	$1,756	
2	(2018 total feed shrink + 2019 total feed shrink) /2 *50%	$0		2	Annual Opportunity Interest	$1,701	
3		$0		3	Routine Annual Maintnence	$1,000	
4		$0		4		$0	
5		$0		5		$0	
6		$0		6		$0	
7		$0		7		$0	
8		$0		8		$0	
		Total	$145,037			Total	$4,458
	TOTAL ADDED RETURNS & REDUCED COSTS (A)		**$145,037**		**TOTAL REDUCED RETURNS & ADDED COSTS (B)**		**$4,458**

CHANGE IN NET INCOME (A - B) **$140,579** (C)

BENEFIT/COST RATIO(A ÷ B) **32.5** **NET BENEFIT/INVESTMENT RATIO(C÷D)** **2.4**

Calculations	Original Investment (D)		Salvage Value	Value to Be Depreciated		Useful Life	Annual Deprec.	Average Value	Opportunity Interest Rate	Annual Interest
Depreciation	$58,546	--	$14,636.38	$43,909	÷	25	$1,756	----------	----------	----------
Opportunity Interest	$58,546	+	$14,636	$73,182	÷	2	----------	$36,591	4.65%	$1,701

Illustration 7: Profitability partial budget analysis of the client farm’s new feed center structure.

A sensitivity analysis was performed to help determine the riskiness of the client farms investment in the new feed center structure. For the sensitivity analysis, the average economic value associated with the feed shrink from 2018 and 2019 were used, similar to in the original partial budget. The amount of shrink that new feed center structure was estimated to reduce in the original partial budget was 50%, whereas in the sensitivity analysis the reduced shrink estimate was given a value of +/-25%.

In the sensitivity analysis where the reduced feed shrink is decreased to 25%, the change in net income was $69,061. The benefit/cost ratio was 21.0 and the net benefit/investment ratio was 1.2. For the sensitivity analysis where the reduced feed shrink is was increased to 75%, the change in net income was $214,097. The benefit/cost ratio was 62.9 and the net benefit/investment ratio was 3.7. The results of the sensitivity analysis and the original partial budget can be seen in Table 4.

Profitability Partial Budget Analysis/Sensitivity Analysis – Comparison Table			
Partial Budget	**Net Income**	**Benefit/Cost Ratio**	**Net Benefit/Investment Ratio**
25% Shrink Reduction	+ $69,061	21.0	1.2
50% Shrink Reduction	+ $145,037	41.9	2.4
75% Shrink Reduction	+ $214,097	62.9	3.7

Table 4: "Profitability Partial Budget Analysis/Sensitivity Analysis – Comparison Table"

As seen in Table 4, despite varying the amount of shrink that is reduced due to the addition of the new feed center structure, it remains a profitable investment for the client farm. The new feed center structure remains to be a profitable investment for the client farm up until the reduced shrink is lowered to 1%. The client farm has already experienced positive results from the construction of the new feed center structure in the form of positive feedback from their team members and visually identifying less feed shrink. I believe through continued analysis and monitoring of feed shrink on their farm, they will continue to experience positive results in the form of decreased feed shrink and reduced costs.

FEED SHRINK REDUCTION SOLUTION #2

The client farms feed center has ten bays, eight of which are 15 feet in width, while two are 30 feet in width. Because of the design of the feed center, ingredients that have higher inventory requirements are stored in the larger sized bays, bay #7 and #8, while the other ingredients are stored in the smaller bays. Other than the size of the bay and the inventory requirements for certain ingredients influencing the bay that they will be stored in, there is not a particular reason for an ingredient with a smaller inventory requirement to be in a particular bay. All of the bays are similar in the protection that they have from wind and rain, regardless of their position. Although the feed center is not very large, the further the ingredient is from the mixer wagon, the more opportunities are present for feed to be lost in transit. Whether this is due to wind, bumps on the feed apron causing the payloader to bounce and lose feed, or the "feeder" making an abrupt change to the payloaders bucket position and angle, all of these affect feed shrink and can be minimized.

With the intent of reducing the economic impact of feed shrink on the client farm, I recommend moving feed ingredients to different bays based upon economic loss from the feed shrink analysis. This will decrease the distance from bay to feed mixing wagon, decreasing the opportunity for feed to be lost in transit. In Figure 3, one can see the position feed ingredients are were in prior to the feed shrink analysis and recommendation. The listed ingredients were stored in the depicted bays during the entirely of the time period in which the feed shrink analysis took place, 2018 and 2019.

Bay 1:	Bay 2:	Bay 3:	Bay 4:	Bay 5:	Bay 6:	Bay 7:	Bay 8:	Bay 9:	Bay 10:
Mineral 1974	Canola Meal	XME Meal	Nugget	Cotton-seed	SBM/ SoyPlus	Ground Corn	Corn Silage	DDG	Grass Silage

Figure 3: Position of feed ingredients during the duration of the feed shrink analysis.

Based upon the results of the feed shrink analysis, ground corn experienced the largest amount of economic loss due to shrink, with an average of -$76,466 during 2018 and 2019, followed by SBM/SoyPlus with an average of -$60,603. Due to ground corn having a large inventory requirement, it is recommended that it be stored in “Bay #8”, while SBM/SoyPlus should be stored in “Bay #10”. XME Meal averaged a loss of $53,222 and should be moved to “Bay #9”. Next was Purchased Corn Silage with an average loss of $35,276 and I recommend it is moved to “Bay # 7”, Prep+ averaged a loss of $21,734 and should be moved to “Bay #6”, Nugget followed with an average loss of $19,008 and should be moved to “Bay #5”, Cottonseed had an average loss of $17,751 and should be move to “Bay #4”. Canola Meal had an average loss of $4,618 and should be move to “Bay #3”. DDG had an average loss of $2,699 and should be move to “Bay #2”. Mineral 1974 experienced no shrink during the feed shrink analysis so it is recommended that it remain in “Bay #1”. In Figure 4, one can see the recommended position of feed ingredients after the feed shrink analysis.

Bay 1:	Bay 2:	Bay 3:	Bay 4:	Bay 5:	Bay 6:	Bay 7:	Bay 8:	Bay 9:	Bay 10:
Mineral 1974	DDG	Canola Meal	Cotton-seed	Nugget	Prep+	Corn Silage	Ground Corn	XME Meal	SBM/ SoyPlus

Figure 4: Recommended position of feed ingredients based upon the results of the feed shrink analysis.

By moving feed ingredients from the commodity bays that they were in during the course of the feed shrink analysis to the ones that have been recommended, feed shrink has the potential to be decreased, especially for ingredients that were moved to a bay that is within closer proximity to the mixer-wagon. The potential for shrink to increase in some ingredients is a likely occurrence, but the client farm should continue to make decisions on the cost of the ingredient per ton and its likelihood to be lost due to its particle size or density. By monitoring and managing the ingredients this way, the client farm can decrease the economic impact of the feed shrink that does occur by managing ingredients based of cost and 'shrink-ability'.

FEED SHRINK REDUCTION SOLUTION #3

Due to the client farms growth and continued utilization of their original feed center, over a dozen feed trucks containing various ingredients deliver feed to the client farm each day. Numerous vendors are used for the nine purchased feed ingredients that the dairy utilizes for their TMR. Because of the undersized feed center and the multitude of vendors used for the different ingredients, this can cause logistical issues for the dairy farm. The primary logistical issue is the oversupply of ingredients when commodity bays are at capacity, allowing for more opportunities for feed shrink. Due to the finite amount of storage space in the existing feed center, when feed is delivered prior to being needed, it will be unloaded on the concrete apron as seen in Illustration 7 This feed is unprotected from wind and rain, as well as in the direct path of which the "feeder" travels when gathering ingredients for the TMR. This has negative implications on the "feeder's" efficiency in respect to both the time it takes to create a load, and increased opportunities for feed shrink to occur.

Illustration 7: Feed ingredients (ground corn, cottonseed, and XME meal) delivered on concrete apron outside feed center due to oversupply in designated bays.

The client farm utilizes a commodity management business that handles the ordering of feed ingredients based upon select information that FeedWatch shares with them and the expected use of an ingredient. The commodity business will then contact the ingredient vendor and order the projected quantity of the ingredient needed. The client farm is happy with the commodity management business and the various vendors that supply the feed ingredients, but the oversupply of ingredients in more recent years has created issues that were mentioned above.

With the issue of oversupply of feed ingredients stated, it would be in the best financial and management interest of the client farm to communicate with both the commodity management business and the feed ingredient vendors when the issue of oversupply occurs and try to obtain an answer as for why the feed ingredient was delivered prior to being scheduled. Systems are in place that the client farm has invested in that are designed to help avoid the issue of oversupply of feed, similar to how the client farm utilizes a “just-in-time” system for milk retrieval. By communicating effectively with the commodity management company and the feed ingredient suppliers when the avoidable issue of oversupplied ingredients occurs, the client farm will decrease the opportunities for feed shrink to occur, while increasing the efficiency of the feed center.

CONCLUSION

As previously stated, the major findings of the feed shrink analysis were that shrink of all purchased feed amounted to a total economic loss of $580,147 and a 3.6% shrink for 2018 and 2019. This amounted to an average economic loss of $290,074 per year over the course of the analysis. With the client farm recognizing feed shrink as an issue, analyzing its effect, and following the recommendations of building an additional feed center structure, moving feed ingredients to certain bays based upon their economic loss, and managing their relationship and inventories of ingredients with their commodity management business, they will not only be in a position to decrease the negative effects of feed shrink in the future, but maximize their revenues and increase their operational efficiencies. Overall, these modifications will contribute to the client farm becoming more resilient during years of adverse economic conditions, broadening the client farms margins and increasing their ability to operate into the future.

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