Comparing income over feed costs in a protein premium market

by

Ashley Bliss

Bachelor of Science, Cornell University, 2016

A THESIS

Submitted in partial fulfillment of the requirements

for the degree

MASTER OF AGRIBUSINESS

Department of Agricultural Economics

College of Agriculture

KANSAS STATE UNIVERSITY

Manhattan, Kansas

2020

Approved by: Major Professor

Dr. Allen Featherstone

ABSTRACT

Because dairy producers are subject to market prices, they continually strive to manage input costs and milk output to capture the largest margin. For ABC dairy, the opportunity to sell milk into a high protein market was a decision to capitalize their current herd structure. After a year supplying milk to the higher protein market, the farm desired to examine the income over feed cost to determine how the high protein group compared to the rest of the herd.

The objective for this thesis is to observe the net milk income over feed cost monthly for 2019. Through understanding the milk value and feeding costs, the margin for each group was calculated on a per cow, per cow per day, and per hundredweight basis. Using daily, weekly, and monthly data from the farm's cow feeding software and milk records, this analysis compared the performance and income over feed cost for the two groups within the herd.

The results in this study showed the high protein group had a lower net milk income over feed cost of $9.13 per cow per day, compared to the rest of the herd at $9.68 per cow per day. The lower number is attributed to the different diets fed and the difference in milk price. While the high protein group shows a higher income over feed cost, this wasn't consistent across the year. Further research could examine the relationship between butterfat and protein price or class III markets of dairy to determine if changes in these variables will help predict when and if the high protein group would have a higher net milk income over feed cost than the rest of the herd.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGMENTS

Thank you to the MAB faculty and staff for the continuous support and encouragement throughout my time in the program. Thank you to the farm and their nutritionist for the use of their data and help in finding all the numbers needed to complete the analysis.

Thank you to my friends and family for the encouragement and support in continuing my education. Finally, thank you to my husband, Jared, for the countless hours of quiet and alone time you've given me to finish my work and the endless support through this journey.

CHAPTER I: INTRODUCTION

ABC Dairy is a 3,000-cow dairy operation with a mix of Holsteins, Jerseys, and crossbred cows. With recent growth in the Jersey herd and alternate milk marketing opportunities, the dairy would like to determine the income over feed costs between the Holsteins and non-Holsteins (Jerseys and crossbreeds). By calculating income over feed costs, management can gain a better idea of the Jersey's performance and whether the additional protein premium is due to different rations being fed and the difference in milk output between the two groups.

The farm's interest with Jerseys grew from a few cows to a full lactating pen on the farm. When the opportunity arose in the fall of 2018 to purchase eighty milking Jersey cows, the farm decided to take advantage of the Jersey cow's higher component value of milk. The largest difference between Holsteins and Jerseys is the milk content. Jerseys, on average, make less milk, but they have a higher percentage of butterfat and protein compared to other dairy breeds. The northeast uses the multiple component pricing model where the highest return per cow can be found in the animal that produces the highest volume of butterfat and protein in pounds, rather than the highest percentage. Holsteins produce the highest amount of milk compared to any breed, and while they aren't producing a high percentage of butterfat and protein, the total output of pounds for butterfat and protein is often higher than Jerseys. Other areas of the United States have other pricing models that are based on the milk's protein and butterfat value on a percentage basis which explains the differences in breed popularity across different regions of the U.S.

As ABC Dairy was considering the purchase of a group of eighty milking Jerseys, an opportunity to sell milk into a protein premium market occurred. The purchase of eighty cows gave the farm enough Jerseys to complete a full pen of roughly 240 milking cows with higher protein levels. With a separate system for on-farm milk storage available, there was zero marginal investment outside of purchasing cows to take advantage of the additional premiums.

With the decision to create a pen of lactating cows to produce high protein milk, a pen was filled with the purchased Jersey cows, the rest of the current Jersey herd and select high protein producing cows within the herd to reach a group average above the 3.45% minimum threshold of protein. Since the pen produces a higher protein milk percentage, the diet fed to the cows was adjusted to boost protein production. With the switch of cow groupings, income over feed cost changed but had not yet been analyzed to see how the high protein group and rest of the herd compared over time.

The data required for this project are segregated into two groups; the high protein group and Holstein group. For both groups, milk production, feed rations, feed costs, and cow numbers are obtained. These data were collected on a monthly total basis, as this is how milk check information is reported and the data were obtained during the 2019 year. Information received from the milk check include the total pounds of milk shipped, total pounds of butterfat and protein, as well as the income per category and any additional premiums or deductions. The focus is on the protein premium from the milk checks, as well as the quantity and income shipped from milk.

Beyond the milk check, the farm's ration creation and monitoring software, FeedWatch, reports the total pounds of feed fed for the different rations across the farm. This allows the makeup of the feed for the high protein group compared to the rest of the herd. Although FeedWatch has the capability of storing feed costs in the software, the farm doesn't input this data directly into the feeding program. Individual invoices from the month are obtained to determine the cost per ton for each feed ingredient of the rations so a total feed cost per pen can be calculated. The cow numbers for each pen are obtained from Dairy Comp 305, the cow management software used to track all animal information on the farm.

CHAPTER II: LITERATURE REVIEW

It's known that feed costs are the largest expense to a dairy farm, accounting for roughly 40-60% of production costs. "The current volatility of milk and feed prices may increase this 70 percent" (Beck, et al. 2016). With feed being such a large percentage of a dairy operation's margin, income over feed cost is an important measure in the operational performance of the dairy.

When discussing income over feed costs, it's important to recognize the impact feed efficiency has on the income over feed cost margin. Penn State's online resource about income over feed cost provides examples and ways to calculate feed efficiency and how feed efficiency can be affected. Forages, stage of lactation, lactation number, and cow comfort are all mentioned as having an impact (Heinrichs, Ishler and Maulfair 2016). Using calculation methods from this resource, suggestions can be given to improve the operational performance in the herd and help increase the overall margin of the dairy.

A similar analysis on a California dairy occurred where a comparison was made between a Jersey herd and a Holstein herd within the same dairy operation. Although California has a different pricing structure than what occurs in the northeast, a basis for a model to conduct this project was found (Kasbergen 2013). The availability of benchmarks makes analyzing the data for the current study easy as there are few Jersey herd benchmarks in the northeast. With an entire analysis of all breed differences in this resource, there is a lot of information that could be included in this project, however, by focusing on income over feed cost, a focus is placed on net milk income and feed expenses.

2.1 Milk Pricing Structure

Multiple component pricing (MCP) in the commodity milk market is used in the northeast to determine the milk revenue for producers each month. For a comparison of Holstein and Jersey cows, the economic returns for herds were analyzed to determine if a higher return came primarily from one breed or another. Under the MCP structure, it's desired for producers to maximize the pounds of butterfat and protein per cow, than to ship a higher percentage of components in milk (Bailey, Jones and Heinrichs 2005). Through this finding, Holsteins created greater returns than Jerseys because of the higher amount of component pounds shipped, as opposed to component percentage.

2.2 Income over Feed Cost

When looking at income over feed cost, it must be recognized that different pricing structures impact the margin the farm obtains. With different conditions across the United States, there are regions that pay for a higher margin for Jersey milk, or high protein milk, as opposed to Holstein milk (Schmidt and Pritchard 1988). Other management factors and breed characteristics were considered in this study to provide a broader scope of which dairy breed had the best return. The overall results from Schmidt and Pritchard concluded that Holsteins created the highest income over feed cost compared to non-Holstein breeds.

CHAPTER III: DATA

For this analysis, twelve months of data from January 2019 through December 2019 were used to assess the income over feed costs for two lactating groups: the high protein group and the rest of the herd. Recognizing that seasonality occurs in dairies with heat stress challenges and forage changes, using twelve months in this analysis provides an opportunity to capture an annual depiction of the true herd performance.

3.1 Herd Information

Cow numbers for each group were collected from the feed monitoring program, FeedWatch. To look at the actual performance of the lactating herd, both dry cows and treated cows were omitted from the cow numbers in the study. Only salable milk was accounted for in the milk numbers, and while the treated pen does produce milk, the milk is unfit for sale and is pasteurized for calves.

3.2 Milk Information

Milk checks are received by the farm twice each month and were used to calculate the milk sold and the income it provided for the farm. Income includes the revenue from pounds of butterfat produced, pounds of protein produced, pounds of other solids produced, additional quality premiums, and adjustments based on location. Milk checks also showed deductions for hauling, marketing, and balancing costs.

Beyond the milk checks, the farm uses some salable milk to feed to calves. The pounds of milk used for calves was accounted for and included in the analysis as well.

3.3 Feed Information

Feed ration information was taken from the farm's feed management software, FeedWatch. The monthly total of all feed ingredients was found for the high protein group and the rest of the herd. From this information, the farm and nutritionist were able to use contracted prices and invoices to estimate a cost per ton for ingredients. For forages produced by the farm, the cost to grow haylage and corn silage per ton was used.

CHAPTER IV: METHODS

4.1 Milk and Income Calculation

Data from milk checks, on farm records, and lab results provided the information to calculate the income from the sale of milk. The dairy cooperative provided milk weights shipped and the percentages of fat, protein, and other solids of the milk sold. From there, the salable milk used for calves was calculated and valued at the same prices that milk was sold for the month. Although this milk was used in the calf program, the value of it was used in the study to compare the performance of the rest of the herd.

Specific information from the high protein group wasn't segregated in the milk check information, so lab results from each tank weight were used to determine the fat and protein levels in the high protein group milk and then subtracted from the whole value of the milk check to get the rest of the herd information.

To calculate milk income, the value of butterfat, protein, other solids, quality premium, volume premium, protein premium, and producer price differential was totaled. The deductions were summed from the marketing adjustment, advertising and promotion fees, cooperatives working together fee, marketing fees, hauling fees, fuel and stop charges. The difference between the two is the total net milk income.

Table 4.1 is January 2019 data obtained from the milk check. From the milk check, total pounds, pounds of butterfat, protein, and other solids, and premium levels were gathered. Under multiple component pricing, income is generated by the number of pounds for each solid shipped by the farm. Beyond component income, the producer price differential values to milk that is closer to a population center. This is extremely variable, as it is

determined by the use of milk within the milk market. Its purpose is to even out imbalances of milk price that could be caused between producers that ship to class I processors, or class IV processors. The producer has no control over what price this will be.

Quality is influenced by the somatic cell count within the milk. The lower the somatic cell count, the easier it is to process milk into yogurts and cheeses. If the farm meets certain thresholds, they're able to capture a higher quality premium for their milk. The volume premium is an additional premium to incentivize producers to produce a quantity of milk that is efficient in regards to the hauling and logistics of the milk. The fewer stops a milk hauler has to make, the more efficient the supply chain is. This example is pulled from the rest of the herd data, so there is no protein premium shown here.

Deductions in the milk check include a market adjustment cost. This adjustment covers the balancing costs when milk has shifted from one processor to the other. The advertising and promotion fees are a dairy checkoff program that takes $0.15/cwt from every producer in the U.S. for dairy promotion. Cooperatives working together is an additional, voluntary checkoff program to promote dairy through the National Milk Producers Federation (NMPF). Marketing, hauling, fuel, and stop charges are all additional costs from the cooperative to cover administrative fees, lab testing, and milk hauling.

Table 4.1: Summary of Milk Information- January 2019, Rest of Herd

	January
Pounds Shipped	6,703,370
Butterfat Pounds	278,028
Protein Pounds	214,495
Other Solids Pounds	386,164
Butterfat $	$ 694,542.88
Protein $	$ 255,828.70
Other Solids $	$ 111,910.23
Butterfat %	4.15
Protein %	3.20
Other Solids %	5.76
Producer Price Differential	$95,187.83
Quality	$36,868.58
Volume	$8,295.70
Marketing Adjustment	$26,143.14
Protein Premium	$0.00
Advertising & Promotion Fees	$10,055.05
Coops. Working Together	$2,681.35
Marketing Fees	$4,717.55
Hauling Fees	$25,472.79
Fuel Charge	$9,384.69
Stop Charge	$932.96
Income	$1,202,633.94
Deductions	$79,387.53
Net Milk Income	$1,123,246.41

4.2 Feed Calculation

Feed data were exported from FeedWatch. The data exported provided a monthly total of each feed ingredient fed per pen and its dry matter percentage. After obtaining the cost per ingredient, the model in Table 4.2 calculated the total cost of the ration for both groups. Ingredients that were produced on farm, including brown midrib (BMR) corn silage, corn silage, haylage, high moisture shell corn (HMSC), heifer haylage, and 3rd cutting were assigned a value based on an estimate cost of growing each ton of the specified feed. The rest of the ingredients shown in Table 4.2 were purchased feeds, with cost per ton being obtained from invoices and contract purchase agreements.

Table 4.2: Example of Feed Calculation, June 2019

Ingredient	Lactating Cows	High Protein Group	DM%	Cost per Ton	Total Cost per Ingredient, ROH	Total Cost per Ingredient, HPG
BMR	2,012,683	718	34.22%	$ 45.00	$ 45,285.36	$ 16.15
Low Mix	71,148		90.93%	$ 301.00	$ 10,707.75	$ -
Canola	56,924	32,050	90.20%	$ 250.00	$ 7,115.47	$ 4,006.21
Corn Meal	44,419	33,579	89.00%	$ 170.00	$ 3,775.62	$ 2,854.25
Corn Silage	2,078,653	325,867	36.17%	$ 40.00	$ 41,573.06	$ 6,517.34
Corn Silage	481,788		41.51%	$ 40.00	$ 9,635.76	$ -
Grain Mix	972,336	7,557	89.50%	$ 206.64	$ 100,461.71	$ 780.82
Haylage	1,822,167	194,499	36.50%	$ 50.00	$ 45,554.18	$ 4,862.47
High Cow Mix	474,370	39,128	92.70%	$ 678.00	$ 160,811.34	$ 13,264.44
HMSC	702,524	41,842	72.33%	$ 120.00	$ 42,151.45	$ 2,510.52
Low cow	71,148	0	91.07%	$ 300.00	$ 10,672.17	$ -
Soy	44,477	0	90.00%	$ 334.00	$ 7,427.62	$ -
Straw	20,773	0	93.80%	$ 225.00	$ 2,336.98	$ -
Wheat Midds	6,618	6,618	89.00%	$ 115.00	$ 380.52	$ 380.52
Oat Hulls	16,482	0	90.00%	$ 119.00	$ 980.68	$ -
Heif Haylage	176,475	0	35.29%	$ 50.00	$ 4,411.86	$ -
3rd Cutting	0	0			$ -	$ -
Total Pounds	9,052,984	681,858			$ 493,281.54	$ 35,192.72

Table 4.2 only shows June's feed ingredient usage. All ingredients in the table were used at some point during the year, and a value of zero, for ingredients like 3rd cutting, indicates no consumption of that ingredient for the month. Purchased feeds include low mix and high

cow mix which are a pre-mixed grain blend made specifically for the farm's high production and low production groups.

4.3 Net Milk over Feed Cost Calculation

Income over feed cost (IOFC) is calculated on both a total dollar basis and as a dollars per head per day basis, based off Penn State Extension's online management education website (Ishler 2015). This study calculates both the total dollars per cow, per cow per day, and a per hundredweight income over feed cost. Of the three values in the study, the IOFC per cow per day is thought to provide the best comparison. On a per cow basis, an easier comparison is made between the average high protein group cow and average cow in the rest of the herd. Although milk and expenses are commonly discussed on a per hundredweight basis, the two groups have a larger difference when comparing values on a per hundredweight basis. Due to the high component value of the high protein milk, the per hundredweight value of milk is larger than the rest of the herd. The per cow basis offers insight on the profitability of the animal in regards to output.

CHAPTER V: RESULTS

5.1 Results

The overall results for this study showed that the high protein group produced a lower net milk income per cow per day on average for 2019. Month to month information in Figure 5.1illustrates that the high protein group outperformed the rest of the herd consistently until the later spring and summer months. During the summer, changes in heat stress and other nutritional factors resulted in the high protein group not reaching the minimum 3.45% protein and caused the farm to miss out on the protein bonus.

Figure 5.1: Income over Feed Cost for 2019

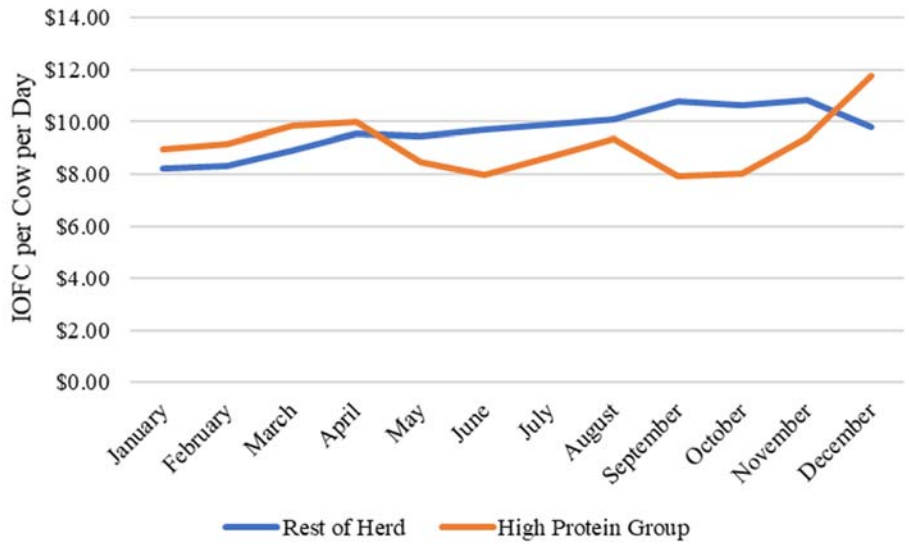

Figure 5.2: Net Milk Income and Feed Expense Comparison

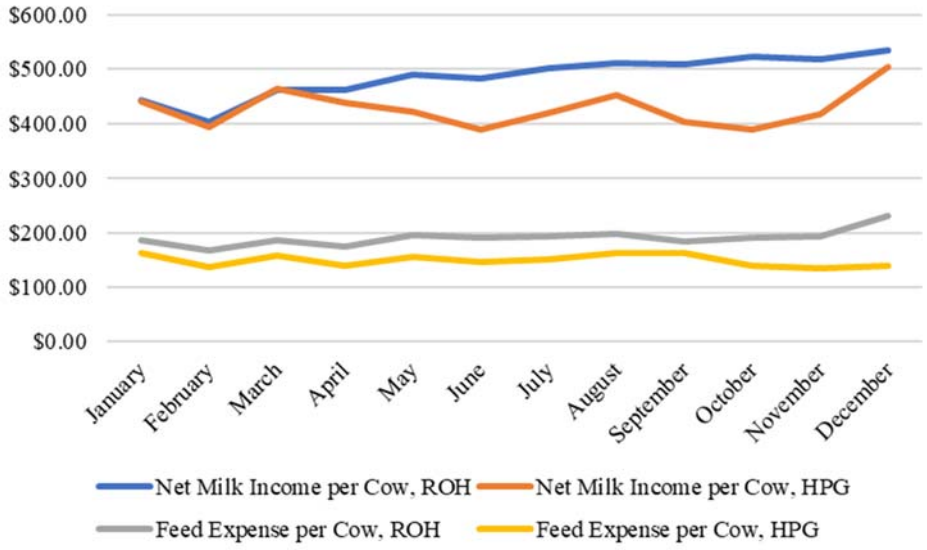

Figure 5.2 shows both the net milk income and feed expense for both groups of cows. The decreased value in the high protein group's income over feed cost shows more of a variance caused by the milk income than the feed expense. For both groups, feed expense stays more consistent in comparison to milk income. Changes in milk income could be attributed to changes in the milk price that can have a large variance month to month, or changes in production.

The summary of results shows all data points for 2019, as well as the average or totals for the year (Table 5.1). Milk produced, net milk income, feed expense, and IOFC are all calculated on both a per cow and a per cow per day basis. Items are on a per cow basis and show the revenue or expense per cow for the business. When comparing these, different days can slightly skew the per cow numbers in comparison, so the per cow per day values determined for a more comparable analysis.

While milk income resulted the most variation, feed expense was significantly lower per cow for the high protein group. The high protein group averaged $1,802.60 per cow for 2019, with a cost per head per day of $4.94. The rest of the herd averaged $2,115.65 per cow for the year, with the per head per day cost of $5.80. The difference in costs occurs from different intake levels and cost of feed. The rest of the herd had an average dry matter intake for the year of 60.93 pounds per cow, while the high protein group was 47.84. The feed cost per pound of dry matter for the rest of the herd was $0.1115, while the high protein group was $0.1030. While the feed cost wasn't largely different on a per dry matter pound basis, the difference in feed expenses per group was driven by the intakes.

Table 5.1: Summary of Results

		January	February	March	April	May	June	July	August	September	October	November	December	Total
Number of Cows	ROH	2,537	2,605	2,664	2,609	2,580	2,570	2,622	2,605	2,702	2,742	2,654	2,675	2,630
	HPG	226	231	231	238	236	237	232	237	234	235	236	235	234
Total Milk Produced	ROH	6,703,370	6,199,878	7,124,282	6,956,538	7,210,917	7,023,247	7,249,284	7,359,858	7,408,409	7,595,220	7,002,083	7,356,933	85,190,019
	HPG	428,767	400,693	443,391	442,394	471,776	448,641	457,443	481,229	465,426	479,207	451,846	469,883	5,440,696
Milk per Cow per Day	ROH	85.23	85.00	86.27	88.88	90.16	91.09	89.19	91.14	91.39	89.35	87.94	88.72	88.70
	HPG	61.20	61.95	61.92	61.96	64.49	63.10	63.60	65.50	66.30	65.78	63.82	64.50	63.68
Net Milk Income	ROH	$1,123,246.41	$1,048,718.98	$1,232,693.91	$1,206,894.69	$1,267,423.38	$1,241,748.74	$1,313,700.16	$1,330,644.48	$1,372,623.79	$1,432,389.90	$1,377,369.00	$1,430,443.59	$15,377,897.04
	HPG	$99,796.92	$91,174.29	$107,187.53	$104,554.06	$99,329.03	$91,988.30	$97,613.75	$107,511.28	$94,128.19	$91,435.02	$98,457.20	$118,488.42	$1,201,663.99
Net Milk Income/Cow	ROH	$442.75	$402.58	$462.72	$462.59	$491.25	$483.17	$501.03	$510.80	$508.00	$522.39	$518.98	$534.75	$5,841.01
	HPG	$441.58	$394.69	$464.02	$439.30	$420.89	$388.14	$420.75	$453.63	$402.26	$389.09	$417.19	$504.21	$5,135.74
Feed Expense	ROH	$475,599.79	$440,277.04	$496,909.84	$459,867.22	$509,386.67	$493,281.54	$509,639.73	$515,552.44	$499,500.54	$527,495.94	$516,534.84	$619,275.24	$6,063,320.81
	HPG	$37,145.88	$32,056.59	$36,740.25	$33,196.92	$37,166.69	$35,192.72	$35,366.51	$38,669.42	$38,503.50	$32,811.76	$31,868.80	$32,934.83	$421,653.87
Feed Exp./Cow	ROH	$172.13	$155.25	$171.29	$161.53	$180.89	$175.73	$178.57	$181.40	$170.13	$177.19	$178.73	$212.81	$2,115.65
	HPG	$164.36	$138.77	$159.05	$139.48	$157.49	$148.49	$152.44	$163.16	$164.54	$139.62	$135.04	$140.15	$1,802.60
IOFC Total	ROH	$647,646.62	$608,441.94	$735,784.08	$747,027.47	$758,036.70	$748,467.20	$804,060.43	$815,092.05	$873,123.25	$904,893.96	$860,834.17	$811,168.35	$9,314,576.22
	HPG	$62,651.04	$59,117.71	$70,447.28	$71,357.14	$62,162.35	$56,795.58	$62,247.24	$68,841.86	$55,624.69	$58,623.26	$66,588.40	$85,553.59	$780,010.12
IOFC/Cow	ROH	$255.28	$233.57	$276.20	$286.33	$293.81	$291.23	$306.66	$312.90	$323.14	$330.01	$324.35	$303.24	$3,536.72
	HPG	$277.22	$255.92	$304.97	$299.82	$263.40	$239.64	$268.31	$290.47	$237.71	$249.46	$282.15	$364.06	$3,333.13
IOFC/Cow/Day	ROH	$8.23	$8.34	$8.91	$9.54	$9.48	$9.71	$9.89	$10.09	$10.77	$10.65	$10.81	$9.78	$9.68
	HPG	$8.94	$9.14	$9.84	$9.99	$8.50	$7.99	$8.66	$9.37	$7.92	$8.05	$9.41	$11.74	$9.13

Table 5.2: Summary of High Protein Group

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Number of Cows	226	231	237	238	236	237	232	237	234	235	236	235	235
Total Milk Produced	428,767	400,693	443,391	442,394	471,776	448,641	457,443	481,229	465,426	479,207	451,846	469,883	5,440,696
Milk per Cow per Day	61.20	61.95	61.92	61.96	64.49	63.10	63.60	65.50	66.30	65.78	63.82	64.50	63.68
Butterfat %	4.79%	4.87%	4.81%	4.78%	4.69%	4.58%	4.57%	4.49%	4.71%	4.51%	4.63%	4.74%	4.68%
Protein %	3.53%	3.53%	3.50%	3.50%	3.47%	3.39%	3.34%	3.35%	3.44%	3.45%	3.56%	3.59%	3.47%
Net Milk Income	$99,796.92	$91,174.29	$107,187.53	$104,554.06	$99,329.03	$91,988.30	$97,613.75	$107,511.28	$94,128.19	$91,435.02	$98,457.20	$118,488.42	$1,201,663.99
Net Milk Income/Cow	$441.58	$394.69	$464.02	$439.30	$420.89	$388.14	$420.75	$453.63	$402.26	$389.09	$417.19	$504.21	$5,135.74
Feed Expense	$37,145.88	$32,056.59	$36,740.25	$33,196.92	$37,166.69	$35,192.72	$35,366.51	$38,669.42	$38,503.50	$32,811.76	$31,868.80	$32,934.83	$421,653.87
Feed Exp./Cow	$164.36	$138.77	$159.05	$139.48	$157.49	$148.49	$152.44	$163.16	$164.54	$139.62	$135.04	$140.15	$1,802.60
IOFC	$62,651.04	$59,117.71	$70,447.28	$71,357.14	$62,162.35	$56,795.58	$62,247.24	$68,841.86	$55,624.69	$58,623.26	$66,588.40	$85,553.59	$780,010.12
IOFC/Cow	$277.22	$255.92	$304.97	$299.82	$263.40	$239.64	$268.31	$290.47	$237.71	$249.46	$282.15	$364.06	$3,333.13
IOFC/Cow/Day	$8.94	$9.14	$9.84	$9.99	$8.50	$7.99	$8.66	$9.37	$7.92	$8.05	$9.41	$11.74	$9.13

Table 5.2 contains data from the high protein group. This group produces a smaller amount of milk but has a higher percentage of butterfat and protein. The annual average for milk production was 63.68 pounds per cow per day with a butterfat percentage of 4.68% and protein percentage of 3.47%. As mentioned earlier, a few summer months did not have production that resulted in a protein percentage higher than 3.45, which caused the farm to miss out of the protein premium. Those months were June, July, August, and September.

Table 5.3 contains data from the rest of the herd. Made up of mostly Holsteins, the milk per cow per day for this group was much higher with an 88.70 average for the year. Butterfat and protein percentages were lower than the high protein group, 4.01 and 3.12, respectively.

Table 5.3: Summary of Non- High Protein Group (Rest of Herd)

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Number of Cows	2763	2836	2901	2847	2816	2807	2854	2842	2936	2977	2890	2910	2865
Total Milk Produced	6,703,370	6,199,878	7,124,282	6,956,538	7,210,917	7,023,247	7,249,284	7,359,858	7,408,409	7,595,220	7,002,083	7,356,933	85,190,019
Milk per Cow per Day	85.23	85.00	86.27	88.88	90.16	91.09	89.19	91.14	91.39	89.35	87.94	88.72	88.70
Butterfat %	4.15%	4.11%	4.05%	4.02%	3.95%	3.88%	3.86%	3.81%	3.99%	4.10%	4.14%	4.07%	4.01%
Protein %	3.20%	3.19%	3.19%	3.14%	3.10%	3.05%	3.01%	2.98%	3.06%	3.12%	3.18%	3.17%	3.12%
Net Milk Income	$1,123,246.41	$1,048,718.98	$1,232,693.91	$1,206,894.69	$1,267,423.38	$1,241,748.74	$1,313,700.16	$1,330,644.48	$1,372,623.79	$1,432,389.90	$1,377,369.00	$1,430,443.59	$15,377,897.04
Net Milk Income/Cow	$442.75	$402.58	$462.72	$462.59	$491.25	$483.17	$501.03	$510.80	$508.00	$522.39	$518.98	$534.75	$5,841.01
Feed Expense	$475,599.79	$440,277.04	$496,909.84	$459,867.22	$509,386.67	$493,281.54	$509,639.73	$515,552.44	$499,500.54	$527,495.94	$516,534.84	$619,275.24	$6,063,320.81
Feed Exp./Cow	$172.13	$155.25	$171.29	$161.53	$180.89	$175.73	$178.57	$181.40	$170.13	$177.19	$178.73	$212.81	$2,115.65
IOFC	$647,646.62	$608,441.94	$735,784.08	$747,027.47	$758,036.70	$748,467.20	$804,060.43	$815,092.05	$873,123.25	$904,893.96	$860,834.17	$811,168.35	$9,314,576.22
IOFC/Cow	$255.28	$233.57	$276.20	$286.33	$293.81	$291.23	$306.66	$312.90	$323.14	$330.01	$324.35	$303.24	$3,536.72
IOFC/Cow/Day	$8.23	$8.34	$8.91	$9.54	$9.48	$9.71	$9.89	$10.09	$10.77	$10.65	$10.81	$9.78	$9.68

CHAPTER VI: SENSITIVITY ANALYSIS

Beyond the initial results of this study, further analysis was performed to determine how the different groups could perform given the sensitivity to milk production and the protein premium. A model was created using Excel and the goal seek function to determine how production and IOFC would be affected if certain factors in this study were changed.

6.1 Production Analysis

With the rest of the herd creating a higher IOFC per head per day, analysis was done to determine at which production level the high protein group should make to meet the same IOFC as the rest of the herd. The model created assumes no changes to milk price or feed expense were needed. Table 6.1 shows the 2019 performance of the two groups with no sensitivity analysis performed. The actual performance shows the rest of the herd made an IOFC of $9.68 per head per day at a production level of 88.70 pounds per head per day. The high protein group made an IOFC of $9.13 per head per day at a production level of 63.68 pounds per head per day.

Table 6.1: 2019 Actual Performance

Rest of Herd		High Protein Group	
Pounds Produced:	85,190,018.90	Pounds Produced:	5,440,695.55
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$22.12
Total Milk Income:	$15,354,313.16	Total Milk Income:	$1,203,240.94
Average Cows:	2,630	Average Cows:	234
Average Production (Lbs/Cow/Day):	88.70	Average Production (Lbs/Cow/Day):	63.68
Feed Expense:	$6,061,245.88	Feed Expense:	$421,809.41
Total IOFC:	$9,293,067.27	Total IOFC:	$781,431.53
IOFC/Head/Day:	$9.68	IOFC/Head/Day:	$ 9.13

In Table 6.2, a model in Excel was created using the goal seek function to determine at what production per head per day the high protein group would need to meet the same IOFC per head per day as the rest of the herd. Based on 2019 performance, the high protein group would need to produce an additional 2.45 pounds of milk per cow per day to create an additional 209,076.97 pounds of milk shipped for the year. Assuming there is no change in feed cost or intakes, this would make their IOFC/head/day the same as the rest of the herd, $9.68. By increasing intakes, considerations regarding protein percentage levels need to be considered. If a drop in protein percentage should occur, an even greater difference in IOFC would be a result of losing the protein premium.

Table 6.2: Breakeven Analysis Model

Rest of Herd		High Protein Group	
Pounds Produced:	85,190,018.90	Pounds Produced:	5,649,772.52
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$22.12
Total Milk Income:	$15,354,313.16	Total Milk Income:	$1,249,479.51
Feed Expense:	$6,061,168.59	Feed Expense:	$422,710.71
Total IOFC:	$9,293,144.56	Total IOFC:	$826,768.80
IOFC/Head/Day:	$9.68	IOFC/Head/Day:	$9.68

6.2 No Protein Premium

The high protein group's market premium helps contribute to the IOFC level it maintains. Without this premium, the IOFC per head per day for this group would be $8.59, $0.54 lower than the original IOFC with the premium. As mentioned in the breakeven analysis, an increase in milk production could result in a lower protein percentage. In the event the protein premium was lost, an additional analysis was performed to determine a breakeven milk production based on IOFC without the premium.

Table 6.3 demonstrates what the milk price without the protein premium would be $0.87 per hundredweight lower than 2019's milk price for the high protein group. The missing income without the protein premium would be $47,065.11.

Table 6.3: No Protein Premium Results

Rest of Herd		High Protein Group	
Pounds Produced:	85,190,018.90	Pounds Produced:	5,440,695.55
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$21.25
Total Milk Income:	$15,354,313.16	Total Milk Income:	$1,156,175.83
Feed Expense:	$6,061,168.59	Feed Expense:	$422,710.71
Total IOFC:	$9,293,144.56	Total IOFC:	$733,465.12
IOFC/Head/Day:	$9.68	IOFC/Head/Day:	$8.59

If the protein premium did go away and the high protein group had to meet the IOFC levels of the rest of the herd, the model in Table 6.4 shows the high protein group would have to increase production by 439,065.49 pounds for the year, an average of 5.12 additional pounds per cow per day based on 2019 production.

Table 6.4: Equal IOFC without Protein Premium

Rest of Herd		High Protein Group	
Pounds Produced:	85,190,018.90	Pounds Produced:	5,879,761.04
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$21.25
Total Milk Income:	$15,354,313.16	Total Milk Income:	$1,249,479.51
Feed Expense:	$6,061,168.59	Feed Expense:	$422,710.71
Total IOFC:	$9,293,144.56	Total IOFC:	$826,768.80
IOFC/Head/Day:	$9.68	IOFC/Head/Day:	$ 9.68

The changes in this model assumes there are no changes to the ration costs, feed intake, component structure, or milk pricing structure.

6.3 Production Changes

Table 6.5: Two Percent Decrease in ROH Production

Rest of Herd		High Protein Group	
Pounds Produced:	83,486,218.52	Pounds Produced:	5,440,695.55
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$22.12
Total Milk Income:	$15,047,226.89	Total Milk Income:	$1,203,240.94
Feed Expense:	$6,061,245.88	Feed Expense:	$421,809.41
Total IOFC:	$8,985,981.01	Total IOFC:	$781,431.53
IOFC/Head/Day:	$9.36	IOFC/Head/Day:	$ 9.13
ROH		HPG	
Change in Milk Production: Change in Milk Price	-2%		0%
Production Increase:	(1,703,800.38)		-
Per Cow Per Day:	(1.77)		-

Should changes in production occur, a model was created to demonstrate the effect that might have on total IOFC by group. By observing a two percent decrease in the rest of the herd production, Table 6.5 shows there would be an decrease per cow per day of 1.77 pounds. The resulting IOFC would be $9.36 per head per day, $0.23 higher than the 2019 performance of the high protein group. This assumes there is no change in milk price, feed price, or ration changes.

Table 6.6: Two Percent Increase in HPG Production

Rest of Herd		High Protein Group	
Pounds Produced:	85,190,018.90	Pounds Produced:	5,549,509.46
Milk Price/Cwt:	$18.02	Milk Price/Cwt:	$22.12
Total Milk Income:	$15,354,313.16	Total Milk Income:	$1,227,305.76
Feed Expense:	$6,061,245.88	Feed Expense:	$421,809.41
Total IOFC:	$9,293,067.27	Total IOFC:	$805,496.35
IOFC/Head/Day:	$9.68	IOFC/Head/Day:	$ 9.43

ROH		HPG
Change in Milk Production:	0%	2%
Change in Milk Price		
Production Increase:	-	108,813.91
Per Cow Per Day:	-	1.27

Table 6.6 demonstrates the changes if the high protein group had a two percent increase in their performance. If this occurred, the high protein group would have an addition of 108,813.91 pounds annually, equating to 1.27 pounds per cow per day in production. The increase in production would also increase the group's IOFC to $9.43 per head per day, still lower than the rest of the herd's 2019 production. This assumes there are no changes to milk price, feed costs, or ration changes.

CHAPTER VII: CONCLUSION

Overall, the rest of the herd offers a higher income over feed cost than the high protein group on a per cow per day basis. If the rest of the herd continues to surpass the high protein group, it may not make sense financially to continue supplying the protein premium market.

Should the high protein group increase production while maintaining the minimal protein threshold, an additional 2.45 pounds per cow per day would need to be achieved the compete with the rest of the herd for income over feed cost per head per day.

Further research could be done to determine how the farm may be able to predict when the high protein group's income over feed cost is expected to be higher or lower than the rest of the herd. Comparisons could be made to butterfat or protein price per pound, class III prices, or fluid milk sales. This study did not look into the feed conversion between the two groups, as the focus was on the additional cash flow from IOFC.

Moving forward, there are no specifics in the contract as to how long this protein premium may last. While this does offer a way to diversify milk income, other considerations like investment in cows, cow comfort, or other management differences between the two could be observed for a more detailed financial analysis of these two groups.

WORKS CITED

Bailey, Kenneth W, Coleen M Jones, and Arlyn J Heinrichs. 2005. "Economic Returns to Holstein and Jersey herds Under Multiple Component Pricing." *Journal of Dairy Science* 88 (6): 2269-2280. Accessed August 30, 2019. doi:https://doi.org/10.3168/jds.S0022-0302(05)72903-9.

Beck, Timothy, Virginia A Ishler, Erica Cowan, and Ken Bailey. 2016. *Dairy Risk-Management Education: Managing Income Over Feed Costs.* September 8. Accessed September 7, 2019. https://extension.psu.edu/dairy-risk-management-education-managing-income-over-feed-costs.

Buza, M H, Virginia A Ishler, Lisa A Holden, and Rebecca A White. 2014. "Evaluating the effect of ration composition on income over feed cost and milk yield." *Journal of Dairy Science* 97 (5): 3073-3080. Accessed September 1, 2019. doi:https://doi.org/10.3168/jds.2013-7622.

Heinrichs, Jud, Virginia A Ishler, and Daryl Maulfair. 2016. *Feed Efficiency in Lactating Cows and Relationship to Income Over Feed Costs.* May 5. Accessed September 8, 2019. https://extension.psu.edu/feed-efficiency-in-lactating-cows-and-relationship-to-income-over-feed-costs.

Ishler, Virginia A. 2015. *Income Over Feed Cost.* The Pennsylvania State University. August 14. Accessed August 30, 2019. https://extension.psu.edu/income-over-feed-cost.

Kasbergen, Caitlin. 2013. *Comparison of Profitability Jerseys vs. Holsteins, Including Benchmarks Comparisons for Production, Reproduction, Health, and Costs of Production.* Senior Project, Dairy Science, California Polytechnic State University, San Luis Obispo, San Luis Obispo, California: California Polytechnic State University, San Luis Obispo. Accessed August 31, 2019. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?referer=https://www.google.com/&httpsredir=1&article=1080&context=dscisp.

Schmidt, Glen H, and D E Pritchard. 1988. "Effect of Milk Pricing Systems on Income over Feed and Variable Costs of Dairy Cattle Breeds." *Journal of Dairy Science* 71 (4): 1097-1103. Accessed August 31, 2019. doi:https://doi.org/10.3168/jds.S0022-0302(88)79658-7.

Wolf, Christopher A. 2010. "Understanding the milk-to-feed price ratio as a proxy for dairy farm profitability." *Journal of Dairy Science* 93 (10): 4942-4948. Accessed August 30, 2019. https://www-sciencedirect-com.er.lib.k-state.edu/science/article/pii/S0022030210005254?via%3Dihub#!