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Cost of Loading, Mixing, & Delivering Feed

New York State, 2014-2015



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Cost of Loading, Mixing, and Delivering Feed: Feed Center Activity Analysis

Jason Karszes¹ & Ashley Howlett¹

Feed is the largest single expense on dairy farms today. The operation and management of the feed center has a significant impact on overall costs of the farm in regard to feed shrink, labor costs and feeding accuracy. There is a large variability in feed center size and effectiveness across the dairy industry; each feed center presenting its own challenges with many differences in technology being used and information being collected by each farm. By looking at the feed center as its own entity, better ways to invest and manage feed centers can be focused on to ensure maximum efficiency and performance along with minimizing costs.

The feed center can be broken down into different aspects, each of which impact costs in different manners. The four areas that have been looked at are: feed in, feed out, investment, and shrink. The focus of this paper is on the feed out process and what the operating costs, ownership costs and operating characteristics are associated with the loading, mixing and delivering of feed only.

To understand differences in cost and efficiencies, data from 26 farms were collected to examine costs and investments of the feed out activity. The farms surveyed in this study were larger dairies with an average herd size of 1,199 mature cows. Data was collected during the summers of 2014 and 2015.

Study Methodology

To determine the costs associated with feed out activities, from loading TMR to delivering the feed, the participating farms completed a survey. The first section captured the farm characteristics. This included number of cows and heifers fed, total loads mixed and fed per day, and which type of mixing and delivery system these farms were using. The second section focused on the labor associated with the feed-out activities. These hours were broken down into different chores including: prep time, loading time, feeding time, shoveling bunkers, cleaning feed bunks, and other. The labor hours and total cost per hour were captured for each person working within the feed center. Information was tracked daily for a minimum of 7 days, with some farms tracking for longer periods of time.

The third section focused on equipment use and the associated costs. The hours of operation and fuel usage were tracked daily. Total investment, insurance, annual repairs and maintenance costs were collected by piece of equipment, along with the percent of time that the equipment was utilized in the feed-out activities. Depreciation expenses and opportunity costs were calculated from the salvage value and useful life provided by the farm. Other characteristics of equipment were recorded such as the size of a bucket for the loading equipment and the feed capacity of the mixing wagons. The total as-fed tons fed each day was also recorded. Investment in technology such as Feed Watch and TMR Tracker wasn't accounted for in this study. Investments in feed storage were also not accounted for in the investment of feed out activities. Costs associated with the actual feed ingredients, storage costs, and costs associated with shrink were also not included in this analysis.

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Cost per Ton to Load, Mix & Deliver TMR

Dairy Farms for this project had an average herd size of 1,199 cows and 870 heifers. These numbers ranged from 524 cows to 2,341 cows and heifers ranged from 140 to 1,877 animals. The costs of loading, mixing and delivering feed was based on tons of feed delivered; accounting for the tons associated with both heifers and cows. These farms averaged 88.38 wet tons loaded, mixed, and delivered per day with a range of 34.2 tons to 142.15 tons between the first and fourth quartile. The average total cost per ton to load, mix, and deliver feed was \$5.20 for these 26 farms (Table 1). The costs ranged from \$3.15 per ton for the lowest quartile to \$8.16 for the highest quartile.

Table 1

Total Cost per Ton: Loading, Mixing & Delivering TMR						
26 Farms, Each Row Sorted Independently						
2014-2015						
	Average	Percent of Total	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Tons Fed per Day	88.38	-	34.20	49.67	84.95	142.15
Labor	\$2.34	44%	\$1.23	\$1.80	\$2.36	\$4.16
Fuel & Utilities	\$0.99	19%	\$0.54	\$0.72	\$0.95	\$1.83
Repairs	\$0.57	11%	\$0.29	\$0.42	\$0.66	\$0.93
Total Operating Expense	\$3.90	74%	\$2.27	\$2.99	\$4.04	\$6.55
Depreciation	\$0.81	16%	\$0.40	\$0.66	\$0.87	\$1.37
Interest	\$0.44	9%	\$0.22	\$0.40	\$0.50	\$0.67
Insurance	\$0.04	1%	\$0.00	\$0.02	\$0.04	\$0.12
Total Ownership Expense	\$1.30	26%	\$0.65	\$1.13	\$1.45	\$2.04
Total Cost, Loading, Mixing & Delivering Feed, per Ton	\$5.20	100%	\$3.15	\$4.48	\$5.31	\$8.16

Operating costs made up 74% of the total costs, with labor being the single largest expense, averaging \$2.34 per ton of feed delivered and representing 44% of the total cost per ton. The range for labor costs was \$1.23 to \$4.16 with a spread of \$2.93 between the lowest and highest quartiles. Fuel and utilities were the second largest expense of feed out activities at 19%. The average for 26 farms was \$0.99 per ton fed with a range of \$0.54 to \$1.83. The difference between these farms comes primarily from fuel usage, as the price per gallon for on-road and off-road fuel was standardized across all farms, utilizing \$2.00 per gallon for off-road and \$2.10 for on-road. Utilities captures the costs of electricity associated with electric motors in the grain facilities. The third operating cost was repairs², which averaged \$0.57 per ton and 11% of the total cost.

Ownership costs represented 26% of the total costs, with depreciation expense being the single largest ownership cost, averaging \$0.81 per ton and 14% of the total cost for feed-out activities. Depreciation expense ranged from \$0.40 to \$1.27 per ton. Opportunity interest costs

averaged \$0.44 per ton and 9% of the total. Insurance costs is the smallest expense, representing only 1% of the total cost and averaging \$0.04 per ton fed.

Feed Delivery: Summary Statistics

Aside from costs of loading, mixing and delivering feed, timing, fuel usage, and other various parameters were calculated for the participating farms (Table 2). The total tons fed per labor hour averaged 8.30 tons and ranged from 4.60 to 12.82. Labor hours includes all times spent performing all the tasks associated with the feed-out activities.

Table 2

Feed Delivery Summary Statistics					
26 Farms, Each Row Sorted Independently					
2014-2015					
	Average	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Tons Fed per Labor Hour	8.30	4.60	7.30	8.97	12.84
Loads per Labor Hour	1.31	0.77	1.08	1.37	2.07
Cows Fed per Labor Hour	119.09	76.90	107.19	130.12	167.37
Total Cost Per Labor Hour	\$37.81	\$28.95	\$35.39	\$39.55	\$48.53
Fuel per Load, Gallons	2.89	1.63	2.21	2.86	5.07
Fuel per Ton, Gallons	0.45	0.27	0.35	0.43	0.77
Average Load Size, Tons	6.99	3.75	5.48	7.80	11.34
% Of Mixer Capacity	65.34%	50.36%	59.43%	68.49%	85.05%
Cost per Worker Equivalent	\$44,623	\$37,297	\$41,329	\$45,340	\$55,626
Calculated Length of Feeding, 1 Person, Hours	10.2	4.6	8.3	11.0	17.9
Time per Load, Minutes	45	25	36	49	70
Cost per Gallon, Fuel	\$2.06	\$2.00	\$2.00	\$2.05	\$2.19
Loader Size, Average, Yards	3.77	1.93	3.39	4.44	5.50
Investment per Ton Fed	\$9.75	\$4.57	\$8.19	\$11.01	\$15.88
Truck/Tractor & Mixer	\$5.35	\$2.75	\$4.26	\$6.12	\$8.56
Loader	\$4.40	\$1.82	\$3.93	\$4.89	\$7.32

Fuel used per load ranged from 1.63 gallons to 5.07 gallons, averaging 2.89 gallons used per load. When looking at fuel use per ton, there is a range of .27 gallons to .77 gallons, the average being .45 gallons. The average load size was 6.99 tons but this varied with capacity, the lowest being 3.75 tons and the largest at 11.34 tons. The capacity differences and load sizes are due to various mixer sizes which are to be expected with the various farm sizes in this analysis. The average mixer capacity was 65% but ranged from 50 to 85% between the 1st and 4th quartile.

The average length of feeding if one person was to perform all tasks was 10.2 hours but had a range of 4.6 to 17.9 hours. To calculate one person feeding, the total hours spent per day in the feed center was summarized as one person in total hours. The cost per worker equivalent averaged \$44,623 and ranged from \$37,297 to \$55,626. The cost per worker equivalent was

based on 2,760 hours worked in a year for one person and the cost was based on the hourly wage plus all benefits and other costs associated with the hired labor that farms submitted.

Investments per ton only included the feeding equipment such as loaders, facers, tractors & mixing wagons, mixing trucks, and skid steers, which ranged from \$4.57 to \$15.88 per ton. The investment is based on the initial investment associated with all the equipment and machinery. For these farms, all equipment was owned and none was leased.

Relationships of Key Benchmarks and Cost per Ton

Table 1 and 2 report the range associated with the various costs and summary statistics associated with the feed-out activities of the feed center. With each of these rows sorted independently, relationships between cost per ton can't be seen. To look at the relationship between total cost per ton and the various parameters associated with the feed-out activities, the data set was sorted by cost per ton, keeping the farm's data in the same column. Table 3 and 4 report the cost by expense category and the summary statistics by quartile for the farms sorted by cost per ton. These tables, along with the following graphs, highlight some of the relationships found between different measures and cost per ton on the participating farms.

Table 3

Total Cost per Ton: Loading, Mixing & Delivering TMR						
26 Farms, Sorted by Cost per Ton, Same Farms per Column						
2014-2015						
	Average	Percent of Total	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Tons Fed per Day	88.38	-	153.01	64.56	82.57	36.02
Labor	\$2.34	44%	\$1.27	\$1.86	\$2.30	\$4.14
Fuel & Utilities	\$0.99	19%	\$0.62	\$0.80	\$1.09	\$1.49
Repairs	\$0.57	11%	\$0.41	\$0.56	\$0.45	\$0.89
Total Operating Expense	\$3.90	74%	\$2.30	\$3.22	\$3.83	\$6.52
Depreciation	\$0.81	16%	\$0.51	\$0.84	\$0.96	\$0.97
Interest	\$0.44	9%	\$0.33	\$0.41	\$0.48	\$0.57
Insurance	\$0.04	1%	\$0.02	\$0.02	\$0.04	\$0.09
Total Ownership Expense	\$1.30	26%	\$0.85	\$1.26	\$1.48	\$1.64
Total Cost, Loading, Mixing & Delivering TMR, Per Ton	\$5.20	100%	\$3.15	\$4.48	\$5.31	\$8.16

The total costs for the farms ranged from \$3.15 to \$8.16 as the previous tables have shown. As mentioned before, the operating costs account for 74% of the total cost, on average with the largest portion of operating costs being labor. Breaking down each category into quartiles give an overview of how the lowest cost farms break down some of these costs compared to farms in the middle or lower quartiles. Compared to the Table 1 which sorted data independently, this table keeps the same data set per farm and shows that many of these individual costs rise as the total costs rise; reflecting that each of these categories does play a larger part in the costs of the feed center. As the total costs rise, the tons fed per day fluctuates between quartiles. Farms in the

first quartile, with the lowest costs, fed the most tons per day, on average. Farms in the fourth quartile feeding the least amount of feed per day. The second and third quartile change the decreasing trend with the third quartile feeding more than the second (Table 3).

Sorting these farms by cost per ton shows the tons fed per labor hour increase as cost per ton decreases. Total cost also decreases as efficiency measures such as cows fed per labor hour and percent mixer capacity increase. The farms that are maximizing the use of equipment through larger loads and feeding more animals are diluting the costs through more cows, loads, and tons fed (Table 4).

Table 4

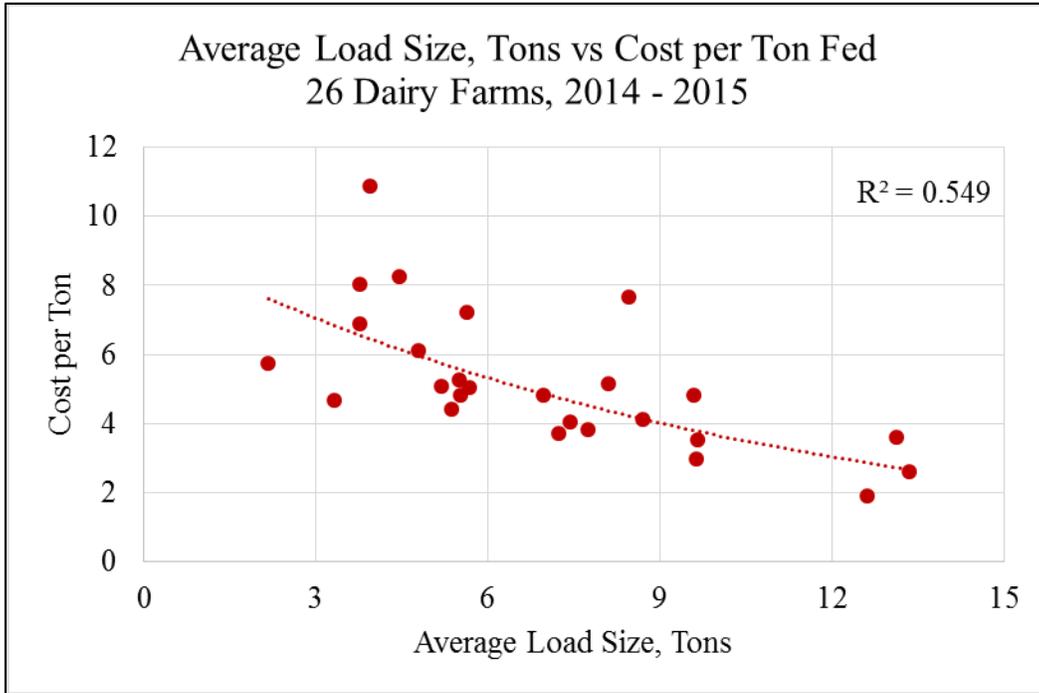
Feed Delivery Summary Statistics					
26 Farms, Sorted by Cost per Ton, Same Farms per Column					
2014-2015					
	Average	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Tons Fed per Labor Hour	8.30	12.07	8.64	7.54	4.46
Loads per Labor Hour	1.31	1.21	1.47	1.58	0.93
Cows Fed per Labor Hour	119.09	152.49	125.89	113.40	79.97
Total Cost Per Labor Hour	37.81	37.52	38.30	39.92	35.19
Fuel per Load, Gallons	2.89	3.23	2.37	2.24	3.76
Fuel per Ton, Gallons	0.45	0.31	0.39	0.39	0.73
Average Load Size, Tons	6.99	10.49	6.22	5.86	5.01
% Of Mixer Capacity	65.34%	76.50%	67.54%	59.94%	56.42%
Cost per Worker Equivalent	\$44,623	\$41,594	\$42,247	\$47,921	\$46,685
Calculated Length of Feeding, 1 Person, Hours	10.24	13.11	8.14	10.56	8.63
Time per Load, Minutes	44.62	43.21	35.07	39.07	62.30
Cost per Gallon, Fuel	\$2.06	\$2.02	\$2.05	\$2.13	\$2.02
Loader Size, Average, Yards	3.77	4.73	3.81	3.79	2.58
Total Investment per Ton Fed	\$9.75	\$7.14	\$9.41	\$10.79	\$11.92
Truck/Tractor & Mixer	\$5.35	\$4.55	\$4.76	\$5.02	\$7.24
Loader	\$4.40	\$2.59	\$4.65	\$5.78	\$4.68

Average Load Size, Mixer Capacity, and Cost per Ton

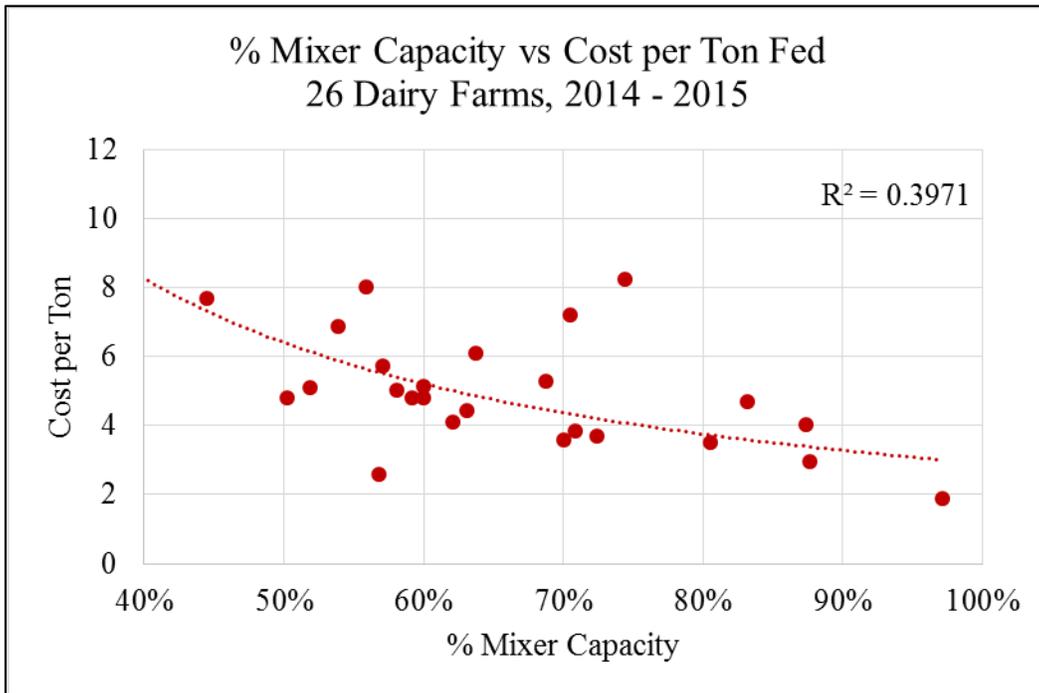
To look at some efficiencies in loading, mixing, and delivering feed, the utilization of equipment is important in spreading out overhead costs. As the average load size increased, total cost per ton decreases (Graph 1) with an R-squared value of .549. The R-squared value shows how close the data points are to the regression line, which dictates the variance in the data set. For this graph, 54.9% of the data variation can be explained by the relationship. An R-squared value of 1 represents a perfect relationship between the data and trend line. Although looking at the average load size shows an interesting relationship, it doesn't take the individual mixer size

for each farm into account. Comparing farms by % mixer capacity gives an accurate depiction of how farms are utilizing their mixers (Graph 2). This graph shows how costs can decrease as mixers are filled closer to maximum capacity. The farm utilizing their mixer at the highest capacity (97%) on this graph had the lowest cost per ton (\$1.89) in this analysis.

Graph 1



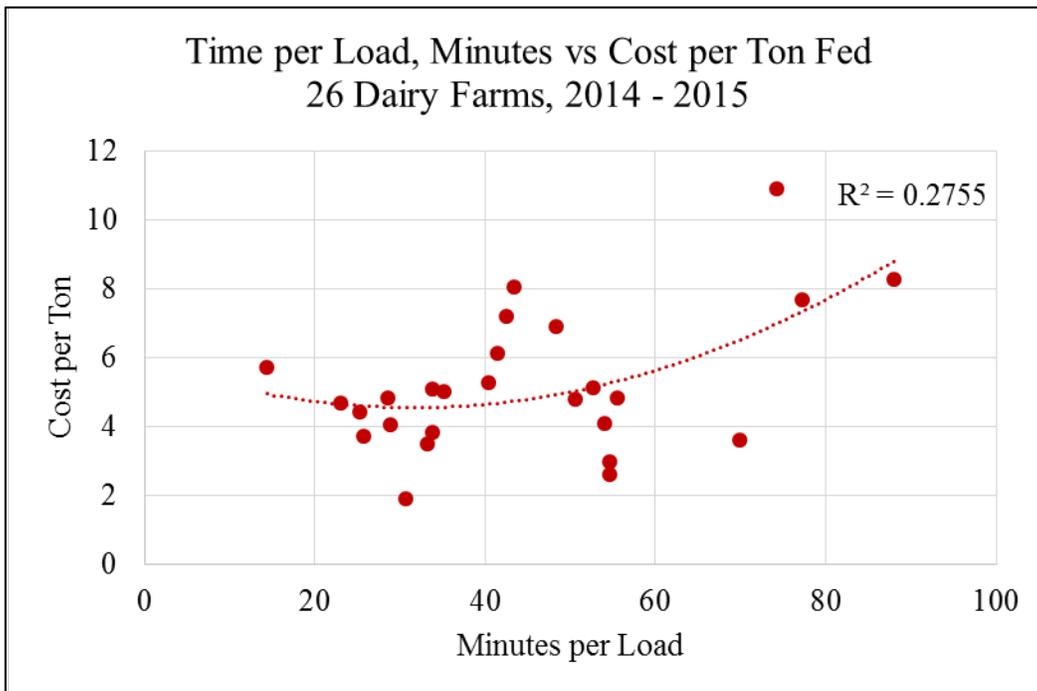
Graph 2



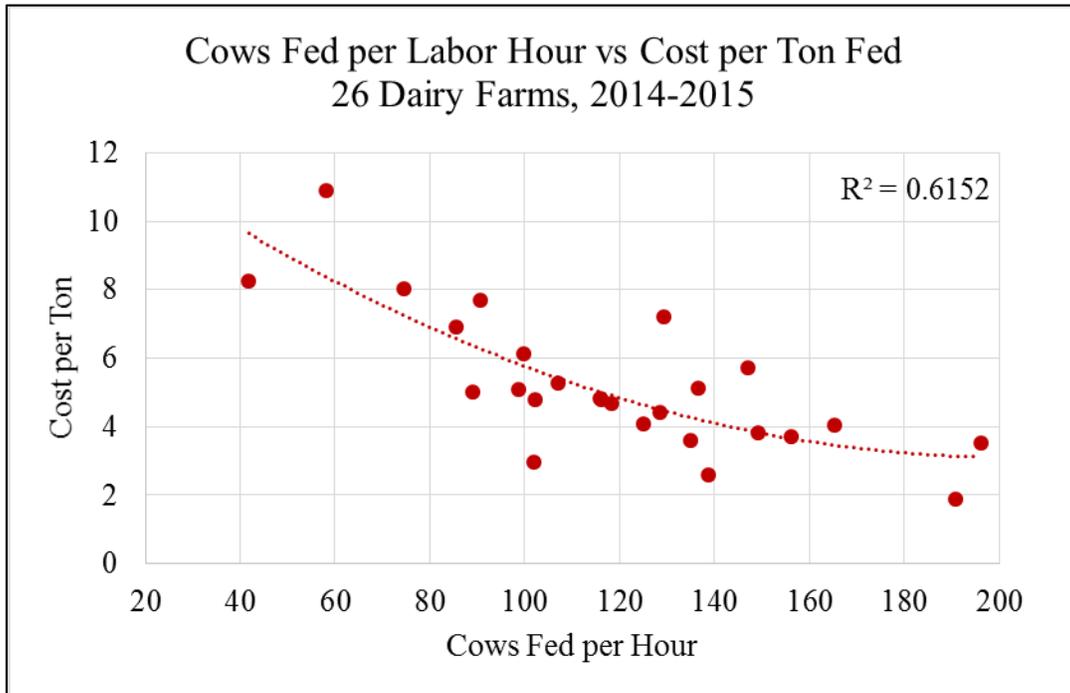
Length of Feeding

Feed-out activities require significant hours of labor each day. The time per load, size of loads, and number of loads all impact the total hours spent feeding. Most farms averaged between twenty and sixty minutes per load, from the time it took to prepare for mixing until the feed was delivered. The costs per ton values for these farms were fairly scattered but the three outliers, taking more than seventy minutes per load, have a significantly higher cost per ton average than the rest of the farms (Graph 3). As mentioned earlier, the farms that participated in this study had larger than average herd sizes. With larger herds in this analysis, more efficiency is shown through more tons fed per hour which can be done so with larger equipment (Graph 4).

Graph 3

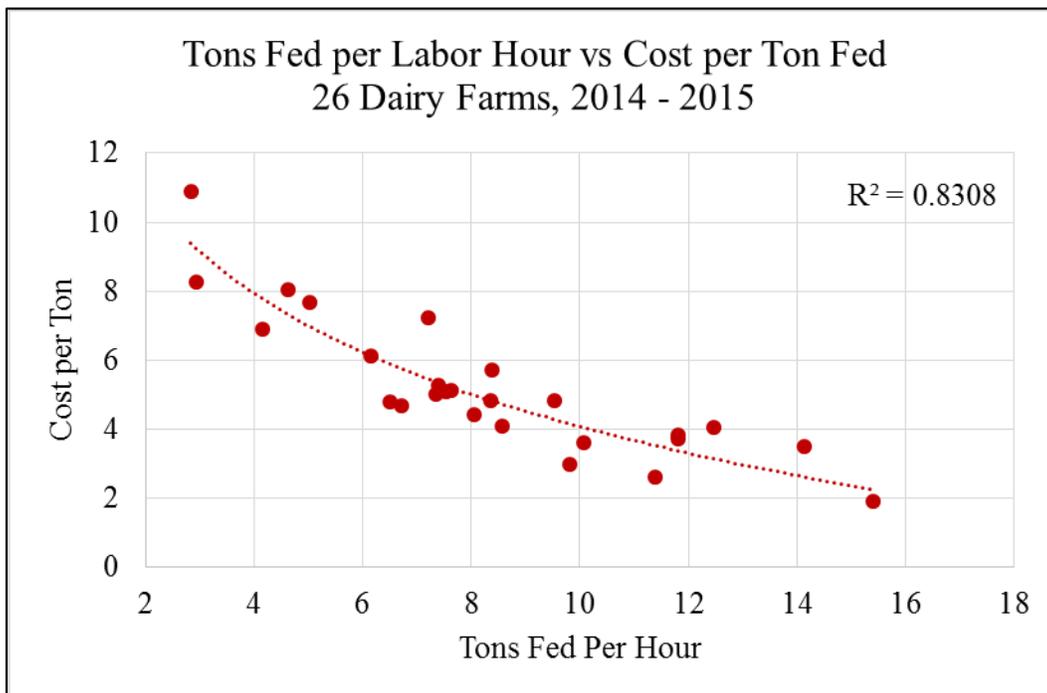


Graph 4



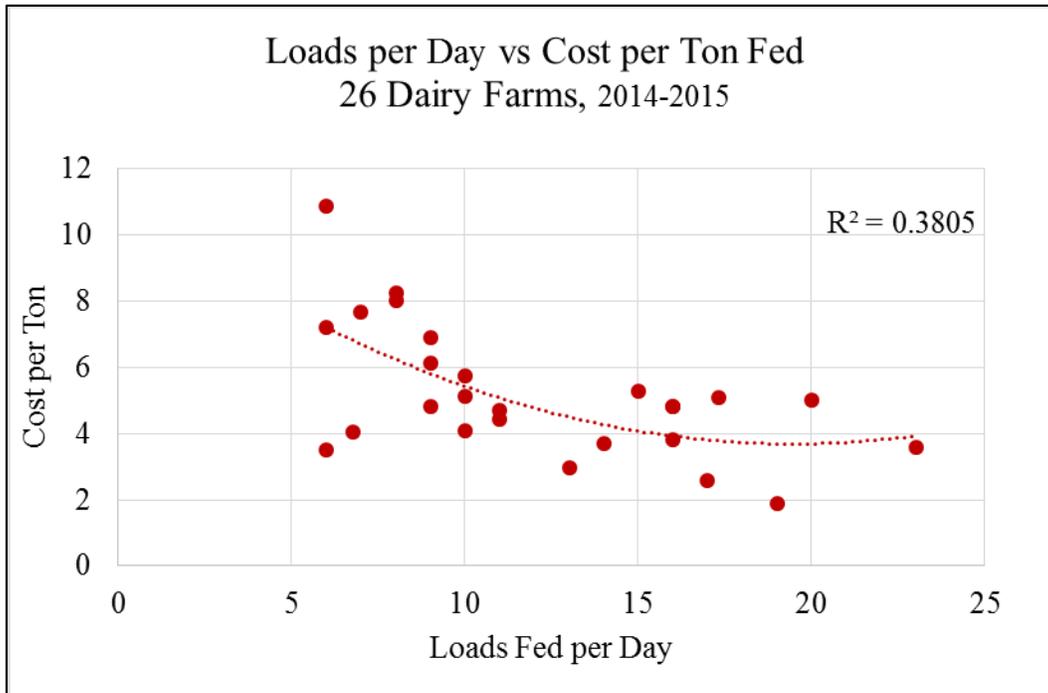
When looking at the labor efficiency compared to cost per ton, there is a strong relationship between tons fed per labor hour and cost per ton. With labor being the largest expense in loading, mixing and delivering feed, it is no surprise that the cost per ton decreases as more tons are fed per labor hour (Graph 5). Feeding more tons per labor hour can be achieved through a larger mixer, accommodating more cows fed per hour.

Graph 5



While farms may maximize their tons fed per hour or total tons fed in a day, they may be reaching a higher mixing capacity but using a small mixer, creating more loads per day. The greatest reduction in cost per ton is seen in farms that are utilizing their mixing equipment through multiple loads per day (Graph 6).

Graph 6



Feed Center Labor

Farms participating in this study tracked every labor hour within the feed center by category. The categories of labor hour's farms recorded were prep time, loading time, delivery time, shoveling bunkers, cleaning feed bunks, and other.

An average of 44% of the feed center's cost is devoted to labor. Table 5 shows a breakdown of that 44% to understand which activities have the largest cost on farms. Amongst the activities listed above, the most time spent in the feed center is on loading feed. Labor associated with loading feed accounted for 19.9% of the total cost of loading, mixing, and delivering feed. When comparing the breakdown of hours and all other areas of cost, this represents the largest cost to dairy farms in regard to feed out activities.

Table 5

Percent of Total Cost by Labor Task					
Sorted by Cost per Ton, Same Farms per Column					
26 Dairy Farms, 2014-2015					
<u>Task</u>	Average	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Loading Time	19.9%	17.4%	20.2%	20.5%	21.8%
Delivering Time	11.2%	11.1%	8.4%	11.1%	14.5%
Shoveling Bunkers	4.3%	3.9%	5.8%	4.6%	3.0%
Cleaning Feed Bunks	2.6%	3.7%	2.5%	1.8%	2.3%
Prep Time	3.1%	3.4%	2.6%	2.8%	3.5%
Other	2.9%	2.0%	1.8%	2.7%	5.1%
Total	44.0%	41.4%	41.3%	43.6%	50.2%

The labor cost associated with the delivery of feed represented 11.2% of total cost of loading, mixing, and delivering feed but had an even higher correlation with the total cost per ton. (Graph 7 & 8) For both loading and delivery, the percentage of total cost increased as the cost associated with each of the areas increased. Farms in the fourth quartile had labor as 50.2% of their costs with 21.8% devoted to loading time and 14.5% devoted to delivering time (Table 5).

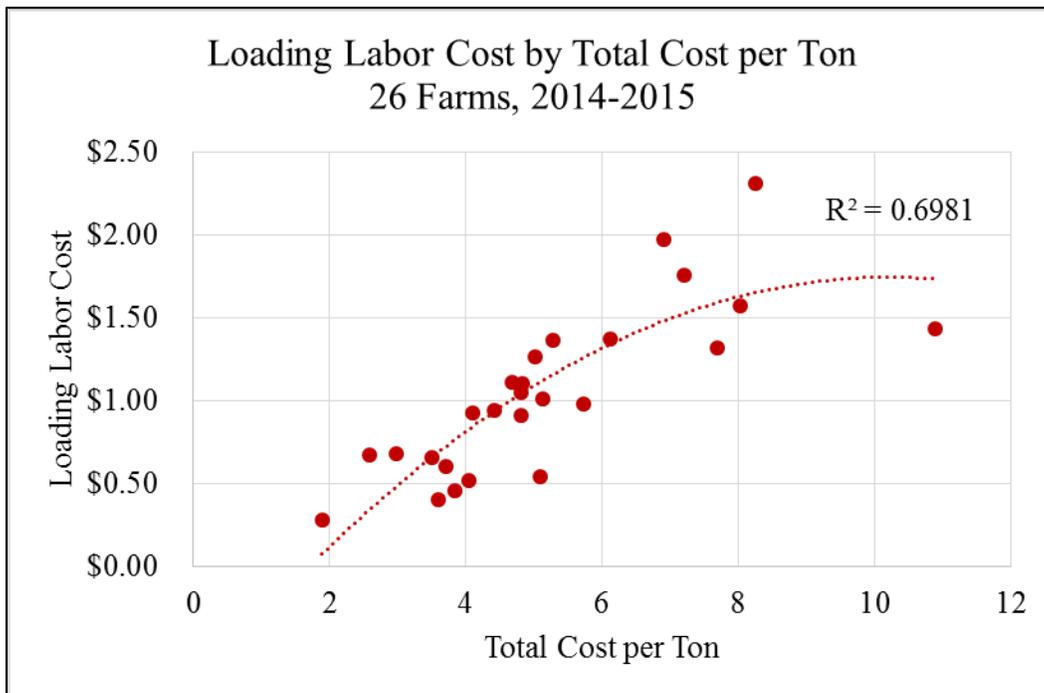
The variation in these costs is due to the hours devoted to each task. Table 6 provides a percentage of the time spent at each task on the farm. These percentages encompass all labor hours in the feed center related to the particular task, rather than the percent of time in one day that task is being performed.

Table 6

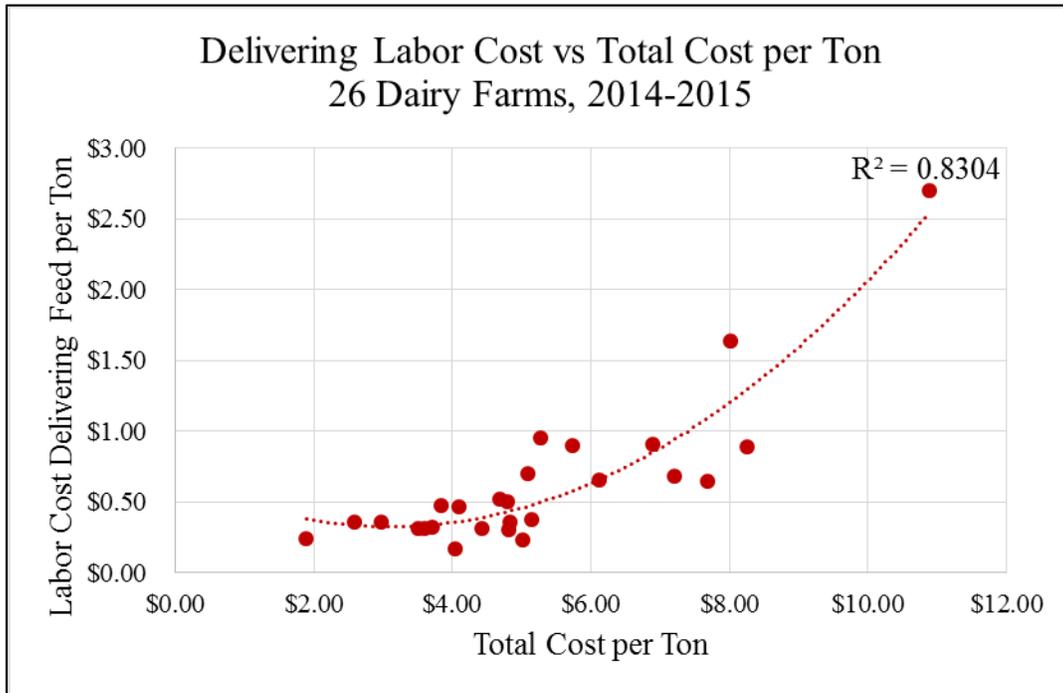
Percent Total Labor Hours by Task					
Sorted By Cost per Ton, Same Farms per Column					
26 Dairy Farms, 2014-2015					
<u>Task</u>	Average	1st Quartile	2nd Quartile	3rd Quartile	4th Quartile
Loading	45.8%	40.5%	48.5%	46.7%	44.5%
Feeding Time	24.4%	26.0%	19.5%	26.5%	28.7%
Cleaning	10.9%	10.9%	14.4%	10.8%	6.7%
Prep Time	6.8%	8.6%	6.1%	6.3%	6.2%
Shoveling Bunkers	6.5%	9.3%	6.7%	4.5%	5.1%
Other	5.6%	4.8%	4.8%	5.3%	8.7%

When looking at the percent labor hours allocated per task, 45.8% of farm labor associated with feed-out activities is devoted to loading feed (Table 6). Following this, feeding time took 24.4% of the total time. Cleaning feed bunks, removing refusals and weigh backs accounted for 10.9% of the time while prep time, shoveling bunker silos and other uncategorized labor were around 6 % each. As loading feed is the highest labor task of the feed center feed out operations, it has a large impact on the total cost of loading, mixing and delivering feed.

Graph 7



Graph 8

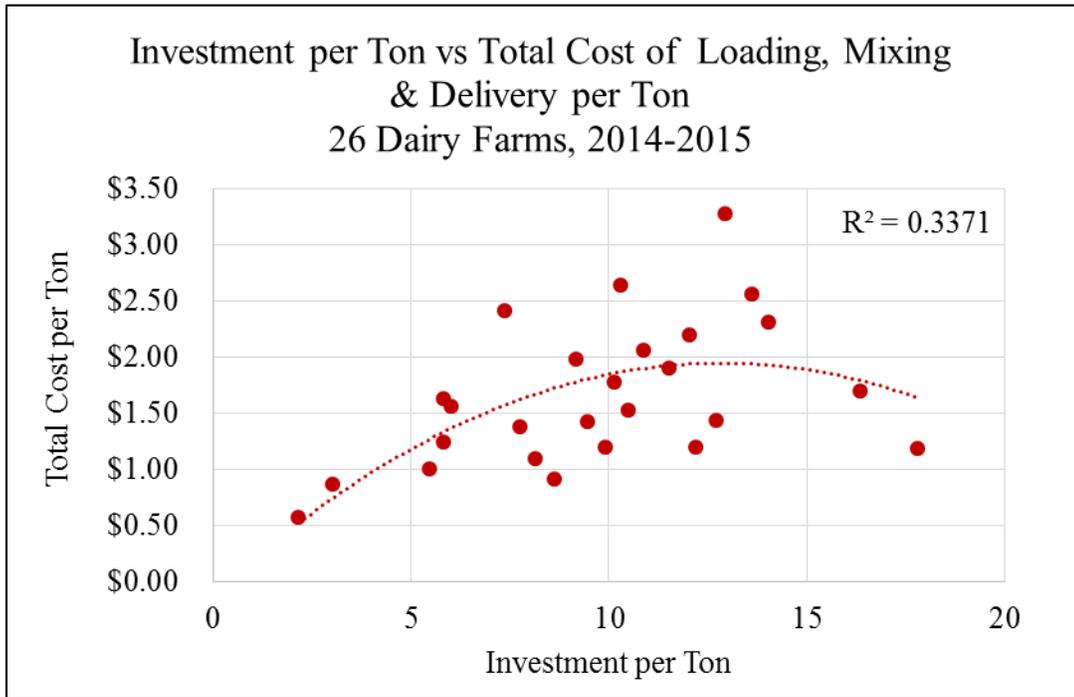


Equipment Investment per Ton

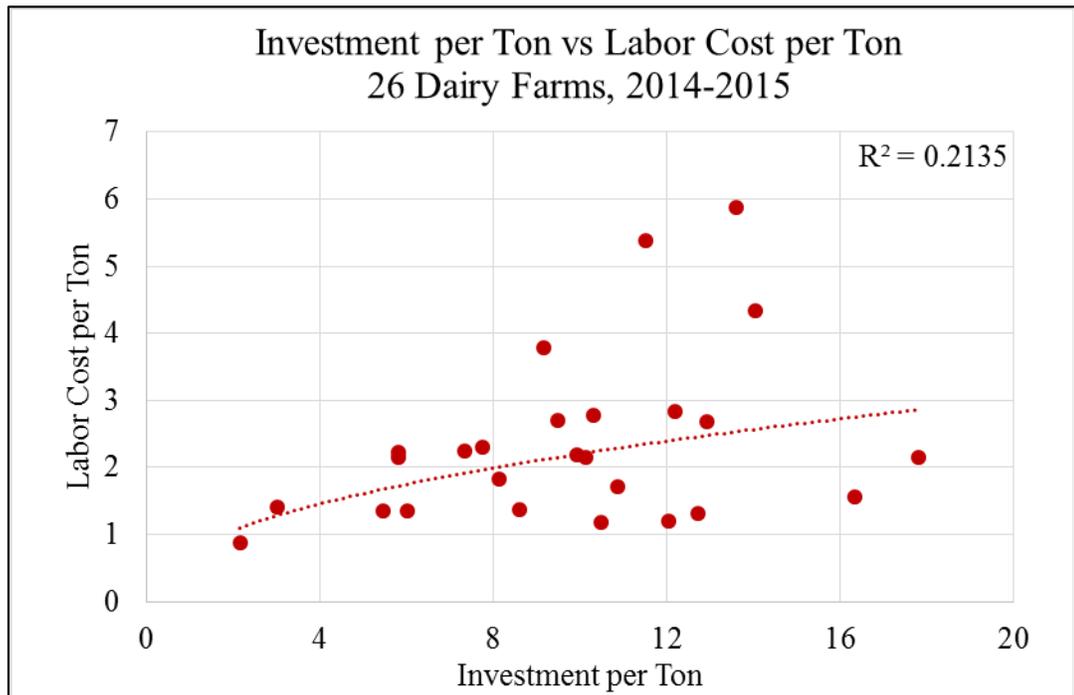
Aside from operating costs, the investment in feed center equipment is important to the efficiency of feed outs. Investment numbers gathered in the study only included loaders, skid steers, facers, mixing wagons & feed tractors, and mixing trucks. There were no farms in this study that leased feed out equipment.

As initial investment per ton of equipment increases, the total cost per ton also tended to increase (Graph 9). The labor costs compared to investment per ton (Graph 10) doesn't show a strong relationship but looking at total investment of the feed center as a whole, may show a different scenario.

Graph 9



Graph 10



Summary

Through tracking labor hours and equipment information in the feed center, total costs can be found for the process of loading, mixing, and delivering feed. While this doesn't depict the total feed center costs or investments, this captures the costs associated with key daily activities. The efficiency of labor within the feed center has a large impact of the cost for loading, mixing, and delivering feed.

While costs of the feed-out activities is important, the quality of job that is done has a large impact on the overall performance of the feed center and the dairy herd. The quality of the TMR loading, mixing, and delivery was not assessed in this study but is recognized as being the primary goal for the feed-out process. Key points in this study showed the farms with the lowest cost in feed out activities were maximizing load size to the best of their ability while feeding the least amount of loads per day. Labor has the highest effect on feed out costs with the most time being spent on loading the mixer. Farms achieving more cows or tons fed per labor hour had the lowest total costs.

Understanding the costs through this analysis has pinpointed certain areas that do effect feed center costs. By maximizing the capacity of feed center equipment, total costs of loading, mixing, and delivering feed are lowered. Data regarding feed storage investment, feed quality, shrink, and feed costs could also be used towards future analyses for feed centers on farms.

Glossary

- **Average Load Size, Tons** – Calculated by the dividing total tons fed for the period by the total number of loads delivered for the period. Does not include any pre-mix loads in the total number of loads.
- **Calculated Length of Feeding** – The total time for one person to perform all feed-out activities for the day. This may include things not done every day but done during the week.
- **Cleaning feed bunks** - Time spent removing refusals including the time of weighing those refusals and any recordkeeping involved with feed clean up.
- **Cost per Gallon, Fuel** – Provided by farms. For this project, all farms were standardized to \$2.00 per gallon for off-road fuel and \$2.10 for on-road fuel.
- **Cost per Worker equivalent** – The annual cost for one worker equivalent, which is based on 2,760 hours per year. This is an average for all employees performing tasks associated with feed out-activities.
- **Depreciation** – Calculated from the total investment/purchase price of equipment, salvage value, and useful life provided by the farm, adjusted to the percent usage of the equipment in the feed-out activities.
- **Delivering Time** - Labor hours to drive to and from the pen and deliver feed.
- **Fuel & Utilities** – Calculated from the cost of fuel per gallon multiplied by the total fuel used for the period. For electric motors, electrical costs were included in utilities.
- **Fuel per Load, Gallons** – Total gallons of fuel used for the period divided by number of loads fed for the period. Pre-mix loads not included in the number of loads.
- **Fuel per Ton, Gallons** – Total gallons of fuel used for the period divided by total tons fed for the period.
- **Insurance Costs** – Insurance expense adjusted to the percent of time the equipment was used in the feed-out activities.
- **Investment per Ton Fed** - Based on the initial purchase price of loaders, facers, skid steers, tractors, mixers and mixing trucks. Adjusted for percent of time allocated to feed-out activities. On the participating farms, all equipment was owned and none was leased.
- **Labor Cost** – Per employee, total hours for the period times total hourly wage, which was provided by the farm. Total hourly wage includes base pay, benefits, and all other costs associated with having the employee on the farm.
- **Loader Size, Average Yards** – Provided by farms. Size of bucket being used to load feed. Doesn't include any other loaders or skid steers that may be used to clean feed bunks, deface, or perform other activities associated with feed-out that isn't the direct loading of the mixer.
- **Loading Time** - Includes the time spent loading the mixer wagon, moving the mixer and loader(s) around to different loading areas, defacing bunks, and preparing pre-mix loads.
- **Loads Fed per Labor Hour** – Total number of loads fed for the period divided by total number of labor hours for the period.
- **Opportunity Interest** – Calculated at 7% of the average value of the equipment over the useful life performing that activity. Adjusted for percent of time allocated to feed-out activities.
- **Other** – Hours that did not fall in the other categories but were still associated with feed-out activities

- **Percent (%) of Mixer Capacity** – Calculated from the maximum load size as provided by the farm and the calculated average load size for the period, not including pre-mix loads.
- **Prep time** - The time spent maintaining feed equipment, updating feed center software and recordkeeping of the feed center.
- **Repairs** – Average annual repairs/maintenance recorded by farms, adjusted to the percent of time the machinery is used in the feed center.
- **Shoveling bunkers** – Removal of plastic and tires, cleaning/shoveling the tops and sides of bunks, and removing spoiled feed.
- **Time per Load, Minutes** – Total labor minutes for the period divided by total loads for the period.
- **Tons** – All tons mentioned in this study are on a wet ton basis, including the cost per ton and were tracked each day by participating farms.
- **Tons Fed per Labor Hours** – Total as fed tons fed per labor hour.
- **Total Cost per Labor Hour** – The sum of each employee's total labor expense divided by the total labor hours.

OTHER A.E.M. EXTENSION BULLETINS

EB No	Title	Fee (if applicable)	Author(s)
2016-09	The Economic Contributions of Agriculture in New York State (2014)		Schit, Todd M.
2016-08	Dairy Farm Business Summary, Northern New York Region, 2015	(\$16.00)	Knoblauch, W., Dymond, C., Karszes, J., Howland, B., Murray, P., Manning, J. and Kimmich, R.
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