Differences Between High-, Medium-, and Low-Profit Cow-Calf Producers:

An Analysis of 2012-2016 Kansas Farm Management Association Cow-Calf Enterprise

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In 2016, cow-calf producers experienced slightly lower economic returns when compared to 2015. We saw record low returns to cow-calf producers in 2016 (figure 1). While livestock feeding operations typically reflect greater variability between years, returns to cow-calf producers can also fluctuate considerably over time. These year-to-year swings can be extreme, as we saw between 2014 and 2015 (see figure 1).[1] Figure 1 shows the returns over variable costs, on a per cow basis, for producers with cow-calf enterprises enrolled in the Kansas Farm Management Association (KFMA) between 1975 and 2016. Over the 42-year period, there were 137 producers, on average, participating in the enterprise analysis per year with a range from 64 to 258. Over the entire time period, annual returns over variable costs averaged $75.12 per cow with a low of -$76.40 per cow in 2009 to a high of $576.95 in 2014. That is a difference of more than $653 per cow in a six-year span. Sorting the returns in figure 1 from the high ("good years") to low ("bad years") and dividing into thirds, the average returns for the time periods are $189.19, $59.13, and -$32.53, for the top-, middle-, and bottom-periods, respectively. In other words, there is almost a $222 difference in the average returns per cow in the "good" years compared to the "bad" years in nominal terms.

This variability of returns over time is due to many factors, including the cattle cycle. Producers tend to reduce the size of their herd when cattle prices are lower, which in turn leads to smaller cattle supplies in the future. These smaller supplies lead to higher cattle prices, which then leads to expanding cattle herds resulting in larger supplies and lower prices (and the process starts over again). As cattle producers know, especially in Kansas and the Southern Plains, cattle cycles are not perfectly predictable because factors other than price also influence producers' decisions to expand or contract their herds (e.g., forage availability, input costs). For example, the declining returns in 2007 through 2009 were not the result of herd expansion, but were due more to increasing input costs and weakening beef demand. The record high average return in 2014 was a result of a drought and strengthening beef demand. Although beef demand has been relatively strong in 2015 and 2016, herd expansion has led to larger supplies and lower cattle prices. Given that some factors at the macro level (e.g., interest rates, consumer demand) are not controllable by producers, all producers are affected similarly. It stands to reason that variability of returns over time is inherent to the industry.

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[1] This paper is an update to Pendell and Herbel (2016) - "Differences Between High-, Medium-, and Low-Profit Producers: An Analysis of 2011-2015 Kansas Farm Management Association Cow-Calf Enterprise." Available at: http://agmanager.info/differences-between-high-medium-and-low-profit-cow-calf-producers-analysis-2011-2015-kansas-farm.

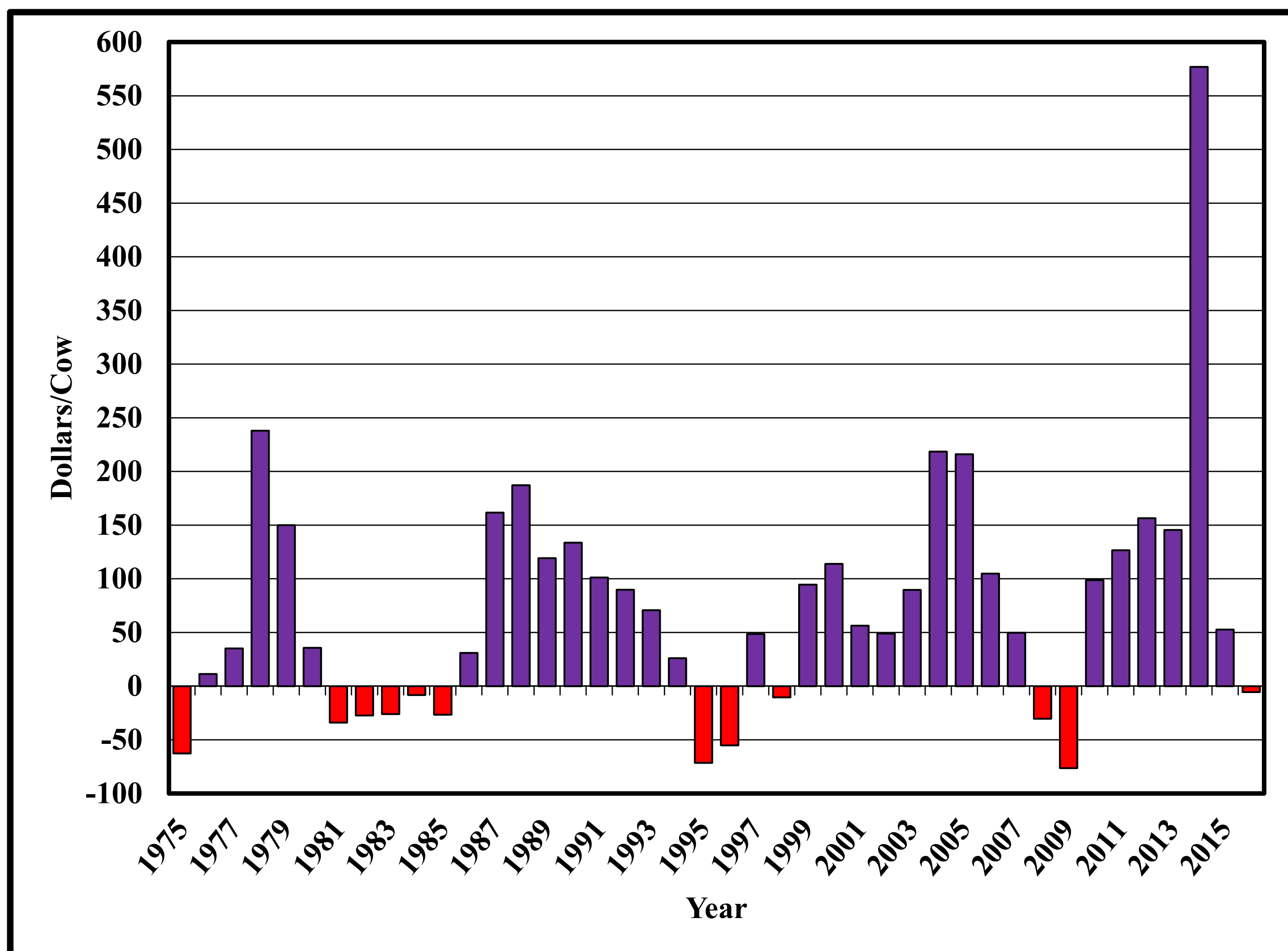

Figure 1. Returns over Variable Cost for Cow-Calf Enterprise, 1975-2016

Figure 2, on the following page, shows the returns over total costs rather than returns over variable costs (as seen above in figure 1). That is, fixed costs (i.e., depreciation, real estate taxes, unpaid operator labor and an interest charge on assets) have been added to the variable costs. Over the 42-year time frame, the average returns over total costs are -$96.50 per cow with a low of -$311.70 and a high of $226.35 (returns over total costs were only positive in 6 of the 42 years). Given that average returns over total costs are only positive 14% of the time, one might ask why anybody is in the cow-calf business. However, it is important to recognize that the cost for unpaid labor and the interest charge on assets used in the operation reflect opportunity costs and these vary significantly between operations. Regardless of how we might measure returns (e.g., returns over variable costs vs. returns over total costs vs. returns to management vs. returns to labor and management), they are highly variable across time (as seen in figure 2). Because the returns over total costs are highly variable across years, we sorted the 42-year returns over total costs into thirds, similar to returns over variable costs. This resulted in averages per cow of -$19.08, -$95.03, and -$213.57 for the top-, middle-, and bottom-third of years, respectively. In other words, there is a large difference of $233 in the average returns over total costs per cow between the “good” years and the “bad” years.

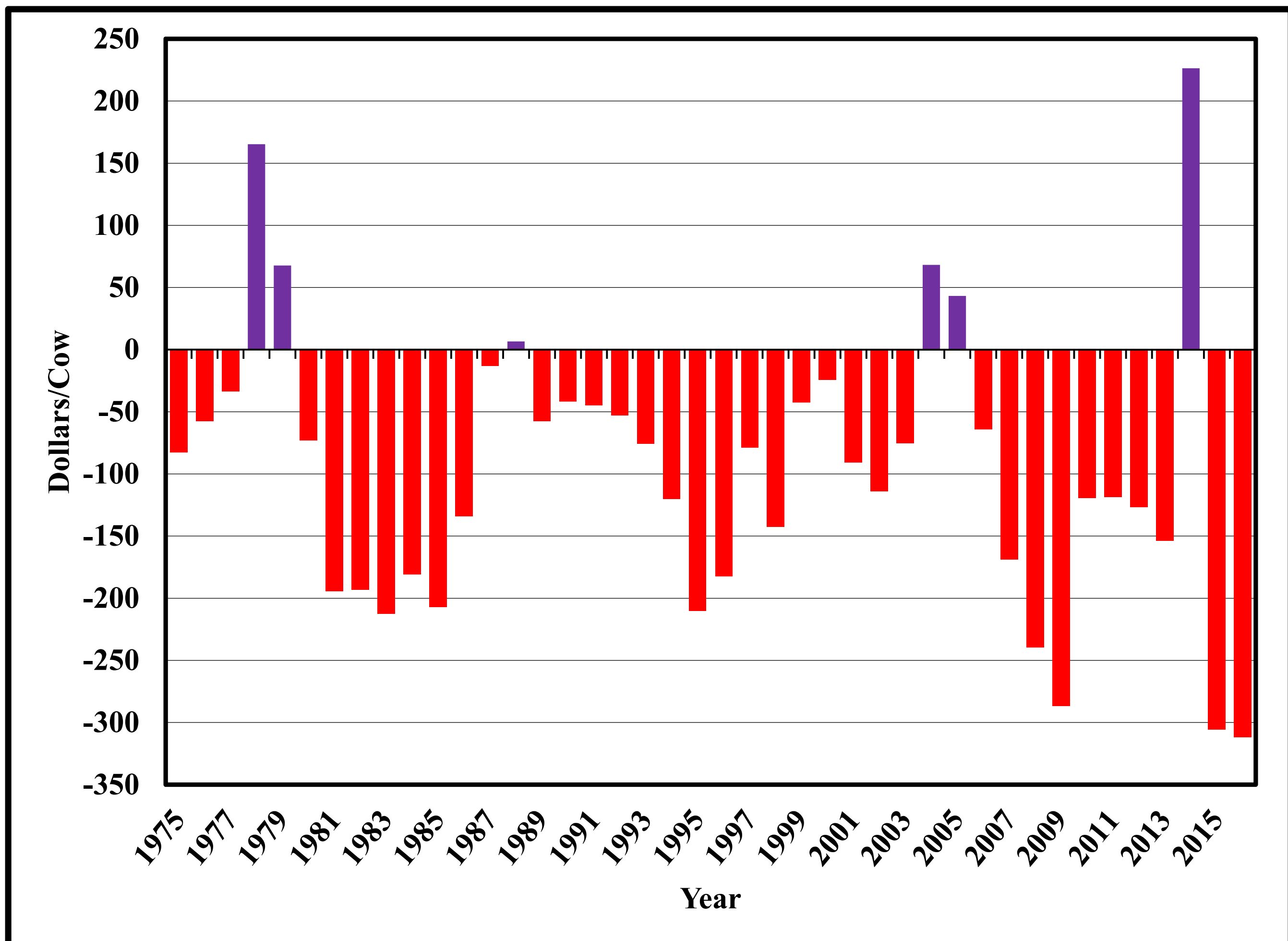

Figure 2. Returns over Total Cost for Cow-Calf Enterprise, 1975-2016

Figures 1 and 2 show the variability in annual average returns across time, where the annual averages are calculated across a group of producers. Some of this variability across time is due to macro-economic factors that producers have limited ability to manage. However, an important question for producers to ask is what do the returns for individual producers look like at a point in time? That is, how much variability is there in the returns across individual producers in good or bad years? The answer to this question is important from a management perspective because, while producers might not be able to influence overall market conditions, they do have opportunity to control profitability at the farm level relative to other producers. While numerous factors beyond the producer's control impact the *absolute* level of profitability, producers' management abilities impact their *relative* profitability. In a competitive industry that is consolidating, such as production agriculture, relative profitability will dictate which producers will remain in business in the long run. Thus, it is important to recognize which characteristics determine relative farm profitability between producers. Specifically, it is important to be able to answer questions like: Does size of operation impact profitability? Do profitable farms sell heavier calves or receive higher prices? Do they have lower costs? If they have lower costs, in what areas are their costs lower? Answering these questions, and others related to why some producers are more (or less) profitable than average provides valuable information for decision makers.

To address these questions, cow-calf enterprise costs and returns data from the Kansas Farm Management Association (KFMA) Enterprise Analysis for individual producers were divided into three profitability groups, high, middle, and low, based on the per cow return to management.[2] A potential problem with analyzing the returns from a group of producers in a given year is that differences could be due more to chance than management. For example, if producers in one part of the state received little or no summer rain, they might have lower weaning weights or higher feed costs (due to supplemental feeding) and hence have below average returns due to weather conditions as opposed to poor management. To reduce the problem of random differences in returns across producers in a given year, a multi-year average is used for each producer. Specifically, producers that had a minimum of three years of cow-calf enterprise data over the 2012-2016 five-year time period were included in the analysis.[3]

In addition to being excluded because of insufficient years of data (i.e., less than three years from 2012-2016), operations also were excluded from the analysis if they had less than 10 cows, if they had not recorded production, if their cattle purchases were greater than 25% of their herd in any one year, or if their net sales (sales less purchases) of breeding stock were greater than 25% in any one year. Operations with an average calf selling weight greater than 750 pounds were also excluded from the analysis to minimize the influence of backgrounding calves prior to selling. After these "filters" were applied, there were 61 operations with multi-year average returns to analyze (10 had five years of data, 19 had four years of data, and 32 had three years of data). These multi-year averages of individual producers' returns should do a better job of characterizing profitability differences that are due to management abilities as opposed to random returns, which might be the case if only a single year were considered.

To allow for comparisons, a number of the income and expense categories reported in the KFMA cow-calf enterprise report were aggregated. Gross income per cow is the sum of cattle (calves and breeding stock) sales and other miscellaneous income less cattle purchases. Expense categories considered were feed, pasture, vet, marketing, labor, depreciation, machinery, interest, and other.[4] In addition to the variables from the cow-calf enterprise analysis, a variable from the KFMA whole-farm database was used to represent the percentage of labor used for the cow-calf enterprise. This percentage variable is for all livestock, not just beef cows. The percent of labor variable provides an indication as to the relative importance of the cow-calf enterprise to the total farm. A high percentage indicates a farm specializes in beef cow-calf, whereas, a low percentage indicates the operation relies relatively more on crop enterprises.

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[2] The words profitability and profit used in this paper refer to the Net Return to Management measure reported in the Kansas Farm Management Association Enterprise *PROFITCENTER* Summary reports (see Enterprise Reports at www.agmanager.info/kfma/). Net Return to Management is gross income less total costs, which includes unpaid labor, depreciation and an interest charge for assets used in the enterprise.

[3] It would be preferred to have examined the returns for all producers having three or five years of continuous data; however, when that stipulation was used the sample size dropped significantly because not all cow-calf producers conduct an enterprise analysis every year. For example, there were only 10 operations that had data each year from 2012-2016.

[4] Disaggregated income and expense categories in the enterprise reports can be seen in historical reports available at www.agmanager.info/kfma/.

Multi-year averages were calculated for all variables for each of the 61 operations that had a minimum of three years of data. The operations were sorted from high to low based on the average return to management (return over total costs) and then classified as high-, mid-, and low-profit farms. Table 1 reports average returns and costs for all 61 operations and for each of the three profit categories. Also, the differences between the high- and low-1/3 profit groups both in absolute terms and percentages are provided. High-profit farms had larger herds on average and had slightly heavier calves.[5] The number of calves sold per cow in the herd averaged 0.91 across all operations and was similar for each of the three profit categories. High-profit farms had a slightly higher percentage of their farm labor allocated to livestock compared to the low-profit farms (i.e., high-profit farms were more specialized in livestock than low-profit farms). This is not unexpected given that the average herd size for the high 1/3 category is slightly more than double the size of the low 1/3 category (223 versus 105 cows). The high-profit farms received a slightly lower price for calves as compared to both the low- and mid-profit operations. High-profit operations generated about $136.03 (+15%) more revenue per cow than the low-profit operations.

When compared to the revenue differences, the differences in costs between operations were larger. High-profit operations had a $198 per cow cost advantage over low-profit farms (16% advantage) and a $46 (4%) cost advantage over the mid-profit farms. High-profit operations had a cost advantage in every cost category compared to the low-profit operations, except for pasture. When compared to mid-profit operations, high-profit operations had a cost advantage in every category except for pasture, depreciation and machinery.

Since we are looking at the enterprise data across a period of years, with each operation not necessarily having data in each year, it could be asked if there is any impact of this “year effect” on the comparisons. The average year for the high-, middle- and and low-profit operations were 13.85, 14.09, and 14.20, respectively, where 2012=12, 2013=13, and so on. These averages were statistically different from each other at the 5% level between the high- and low-profit farms, suggesting that profit differences likely were driven by specific years in which producers had data for (remember not all farms have data in all years). This year effect is discussed more in a later section – *Characteristics Impacting Profit and Cost Differences*.

Combining the gross income and cost advantages for the high-profit farms results in a net return advantage of $334.13 and $169.55 per cow compared to the low-profit and mid-profit farms, respectively. Thus, even though figure 2 suggests that the average cow-calf producer participating in the KFMA enterprise analysis rarely covers their total costs, the information in table 1 indicates that some producers might consistently earn positive returns. That is, even when the macroeconomic conditions led to an average loss of $132.70 per cow over this 5-year time period, the top third of the producers fared much better than the average (average gain of $35.22). Furthermore, 14 of the 61 producers realized a positive return over total costs (average of $63.67 per cow) over this time period. In other words, even though cow-calf enterprise returns are highly variable over time due to hard-to-manage macro-economic factors, the variability across producers at a point in time is even larger. These larger differences across individual operation can potentially be managed and therefore represent opportunities.

[5] While the objective of this analysis is to focus strictly on the cow-calf enterprise by excluding operations with average weights greater than 750 pounds, it is possible that operations with heavier weights fed their calves for a short time period (i.e., preconditioned their calves). However, given that the weight differences are relatively small, the heavier weights could also be due to management and genetics.

Table 1. Beef Cow-Calf Enterprise Returns over Total Costs, 2012-2016 (minimum of 3 years)*

		Profit Category			Difference between High 1/3 and Low 1/3	
	All Farms	High 1/3 Head / $	Mid 1/3 Head / $	Low 1/3 Head / $	Absolute	%
Number of Farms	61	20	21	20		
Labor allocated to livestock, %	31.6	34.1	33.2	27.4	7	25%
Number of Cows in Herd	155	223	137	105	118	112%
Number of Calves Sold	141	203	127	95	109	115%
Calves Sold per Cow in Herd	0.913	0.912	0.925	0.899	0.01	1%
Weight of Calves Sold, lbs.	617	652	608	590	62	10%
Calf Sales Price / Cwt	$174.73	$171.25	$174.66	$178.30	-$7.05	-4%
Gross Income	**$972.05**	**$1,059.17**	**$935.66**	**$923.14**	**$136.03**	**15%**
Feed	$363.63	$309.11	$357.38	$424.72	-$115.61	-27%
Pasture	$173.75	$185.84	$164.22	$171.66	$14.18	8%
Interest	$156.30	$152.78	$155.89	$160.25	-$7.47	-5%
Vet Medicine / Drugs	$31.50	$29.59	$32.17	$32.70	-$3.11	-10%
Livestock Marketing / Breeding	$21.46	$11.27	$28.59	$24.17	-$12.90	-53%
Depreciation	$53.62	$48.40	$46.46	$66.35	-$17.95	-27%
Machinery	$87.61	$90.86	$81.36	$90.91	-$0.05	0%
Labor	$169.25	$155.31	$161.61	$191.21	-$35.90	-19%
Other	$47.64	$40.78	$42.33	$60.07	-$19.30	-32%
Total Cost	**$1,104.75**	**$1,023.95**	**$1,069.99**	**$1,222.05**	**-$198.10**	**-16%**
Net Return to Management	**-$132.70**	**$35.22**	**-$134.33**	**-$298.91**	**$334.13**	

*Sorted by Net Returns over Total Costs per Cow

Table 2 shows similar information as reported in table 1 except the analysis only considers variable costs (i.e., data similar to that shown in figure 1). In this case, the difference in returns between the high- and low-1/3 operations are $321.86 per cow (compared to $334.13 with total costs). Similar to table 1, high-profit operations have the larger number of cows in the herd when compared to low-profit operations. The operation size for the different groups is different between the two analyses (i.e., tables 1 and 2) because that the producers in each profit category are not the same in both tables. That is, a producer that receives a high return over variable costs does not guarantee that this same producer will have a high return over total costs. However, there is a strong correlation (r=0.86) between the producers' return over total costs and their return over variable costs. This high correlation suggests that producers that fare well with one measure tend to fare well with the other as well. For example, of the 20 high-profit operations in table 1, 15 were in the high-1/3 category in table 2. While the total difference between the high-1/3 and low-1/3 operations is less when only including variable costs, the conclusion reached earlier still holds. That is, there is more variability between producers at a point in time than there is on average for the industry across time.

Table 2. Beef Cow-Calf Enterprise Returns over Variable Costs, 2012-2016 (minimum of 3 years)*

		Profit Category			Difference between	
	All	High 1/3	Mid 1/3	Low 1/3	High 1/3 and Low 1/3	
	Farms	Head / $	Head / $	Head / $	Absolute	%
Number of Farms	61	20	21	20		
Labor allocated to livestock, %	31.6	33.8	33.2	27.7	6	22%
Number of Cows in Herd	155	150	194	119	31	27%
Number of Calves Sold	141	138	178	107	30	28%
Calves Sold per Cow in Herd	0.913	0.917	0.915	0.906	0.01	1%
Weight of Calves Sold, lbs.	617	659	597	595	64	11%
Calf Sales Price / Cwt	$174.73	$172.94	$174.59	$176.68	-$3.74	-2%
Gross Income	**$972.05**	**$1,063.55**	**$959.93**	**$893.28**	**$170.27**	**19%**
Feed	$363.63	$307.81	$349.67	$434.11	-$126.29	-29%
Pasture	$173.75	$180.83	$181.44	$158.60	$22.24	14%
Interest	$20.93	$15.05	$15.32	$32.70	-$17.64	-54%
Vet Medicine / Drugs	$31.50	$29.80	$29.62	$35.18	-$5.38	-15%
Livestock Marketing / Breeding	$21.46	$14.05	$18.31	$32.18	-$18.13	-56%
Machinery	$87.61	$89.33	$96.09	$76.97	$12.36	16%
Labor	$20.84	$16.72	$20.41	$25.41	-$8.69	-34%
Other	$47.64	$43.80	$45.36	$53.86	-$10.06	-19%
Total Variable Cost	**$767.35**	**$697.40**	**$756.20**	**$849.00**	**-$151.59**	**-18%**
Return over Variable Costs	**$204.70**	**$366.15**	**$203.72**	**$44.29**	**$321.86**	

*Sorted by Net Returns over Variable Costs per Cow

Given the large differences in returns across producers, a reasonable question is, what are the factors that lead to these differences? Looking at the data in table 1, one can see that the cost differences represent a much larger portion of net return differences than differences in income. In fact, 59.3% of the average difference in net return to management between high- and low-profit farms is due to cost differences. The other 40.7% is due to differences in gross income per cow, which is primarily because the high-profit farms had heavier calves. This is not unexpected in a commodity market where producers are basically price takers, i.e., the ability to differentiate oneself financially from the average is typically done through cost management.

Relationships between key economic and productivity variables

Figures A1-A17 in Appendix A are scatter graphs showing the relationship between different sets of variables for all 61 operations. The focus is on returns over total costs again (i.e., the data summarized in table 1). The high-, mid-, and low-profit operations are identified with different symbols in all figures (green circles are the top 1/3, blue squares are the middle 1/3, and red triangles are the bottom 1/3). The

correlation between the two variables is reported in the figure title.[6] Scatter plots and correlations are important as it can help give a general feel for what might be going on. However, it is important not to place too much weight on these results as they do not account for other factors that also might be impacting the results. The following is a brief discussion of the different figures.

Gross Income

As expected, profit and gross income are positively correlated (figure A1) indicating that operations generating greater income tend to be more profitable. However, with a correlation of 0.38, having a higher gross income does not guarantee a higher profit. This can also be seen where several of the bottom 1/3 operations had relatively high gross income. Likewise, some of the most profitable operations had low gross income levels. Remembering that gross income was a compilation of all income, it still stands to reason that it will be heavily influenced by price and weight. The data for gross income versus price and gross income versus weight are plotted in figures A2 and A3, respectively. While there is a positive relationship between price and gross income, the relationship is not particularly strong (r=0.07). On the other hand, there is a stronger positive relationship between gross income and average selling weight of calves (r=0.48). That is, producers selling more pounds tend to generate more income, but those getting higher prices may or may not actually have higher income. Thus, strictly from a gross income standpoint, this would suggest producers would be better off to focus on production (i.e., pounds sold per cow) than on price. However, it is also important to remember that the relationship between gross income and return over total costs (profit) was not particularly strong, and thus, there are likely even more important variables, such as cost variables, to focus management efforts on.

Total Costs

Figure A4 shows the relationship between profit and total costs. As one would expect, this relationship is negative (i.e., higher costs lead to lower profits, and the relationship is relatively strong; r=-0.64). This is consistent with what was shown in table 1 – the majority of the differences in returns are due to costs and not due to income. Given that cost management is so important, the next question is what drives differences in costs across operations? Figure A5 shows total costs versus total feed costs[7]. These costs have a strong positive correlation as would be expected (r=0.72). While total feed costs represent 48.3% of the total costs, it is clear that other costs are important as some of the top 1/3 operations have higher feed costs than some of the bottom 1/3 operations. As we would expect, operations that market calves at heavier weights have higher total feed costs per cow (r=0.09; figure A6). Figure A7 shows there is a small and negative relationship between total feed costs and the size of the cow herd (r=-0.14). This suggests the larger operations have lower total feed costs per cow; however, this analysis would not show economies of size to be present related to cowherd feed costs. The data used in this analysis do not allow us to know exactly why there is little relationship between feed costs and size of cow herd. While larger operations likely receive volume discounts on the feed they do purchase, it is also likely they rely

[6] Correlation is defined as a measure of the strength of the relationship between two variables. In other words, it is a statistical measure of how well two variables move together and is bounded by -1.0 and 1.0. A value of -1.0 would indicate the two variables move together perfectly, but in opposite directions. A value of 1.0 indicates two variables move up and down together proportionately. Values close to zero indicate the two variables have little relationship to each other.

[7] Total feed costs include the value of all purchased feed and all raised feed, along with owned and rented pasture costs.

less on purchased feeds.[8] Figure A8 shows the very strong relationship between total feed costs and non-pasture feed costs (r=0.84). The producers that are able to control their non-pasture feed costs also have lower total costs, which is expected given 58% of the total costs are due to non-pasture feed costs. Figure A9 shows the negative relationship between non-pasture feed costs and pasture costs (r=-0.52). That is, as non-pasture feed costs go up (down), pasture costs go down (up). Figures A10 and A11 show the relationship between total costs versus pasture costs and pasture costs versus total feed costs, respectively. Both of these relationships are weak (r=0.09 and r=0.03, respectively). With pasture costs representing a small percent of total costs and having a negative correlation with non-pasture feed costs, this suggests producers could be making "tradeoffs" between pasture and non-pasture feed costs.

As would be expected, higher labor costs per cow, and higher depreciation and machinery operating costs[9] per cow, are associated with higher total costs per cow (figures A12 and A14). Furthermore, the relationship between depreciation and machinery operating costs and total costs is quite strong (similar to feed costs). Both labor and depreciation and machinery operating are negatively related to cowherd size (figures A13 and A15). That is, operations with larger cow herds tend to have lower costs per cow in both of these categories. The somewhat stronger negative relationship between operation size and labor costs (compared to feed costs and operation size) is likely due to the "fixed cost" nature of available labor. Feed costs per cow are generally variable costs and thus will not vary as much with operation size, on a per cow basis, compared to costs which tend to be fixed at the whole-farm level.

Figure A16 plots the total costs against the number of cows in the herd. Although the negative relationship suggests that economies of size exist (i.e., producers with larger operations tend to have lower costs per cow), several points should be made. First, there are only three herds in this analysis with over 300 cows so we cannot say much about the costs for very large operations. That is, while it appears that costs decrease, on average, as herd sizes increase from 50 to 250 cows, we cannot say what they might be for herds with 1,000+ cows. Second, there is a tremendous amount of variability in costs for a given herd size. This suggests that simply being a "large" operation does not guarantee one of having low costs. For example, as seen in figure A16 there are smaller operations that compete quite well with larger operations. Figure A17 plots the percentage of labor allocated to livestock (measure of specialization) against total costs (r=-0.43). The negative relationship indicates that those producers that specialize in livestock (i.e., have a higher percent of their total farm labor allocated to livestock) tend to have lower costs, and hence, be more profitable compared to operations who have relatively more of their labor allocated to crops.

Characteristics Impacting Profit and Cost Differences

Figures A1 through A17, and table 1, provide some indication as to the factors impacting profit and costs; however, correlations only reflect relationships between two variables rather than accounting for multiple factors simultaneously. Additionally, while it is interesting to examine relationships such as gross income versus herd size, it is more important to think about causal relationships. That is, what characteristics of an operation lead to it being more profitable? Accordingly, the following equation was statistically estimated using multiple regression to identify factors affecting profit differences between operations:

[8] More study should be given to gain an understanding of this relationship.

[9] Machinery operating costs include machinery repairs, gas, fuel and oil, auto expense and custom hire.

$$Profit_i = A_0 + A_1 * Cows_i + A_2 * Cows_i^2 + A_3 * Weight_i + A_4 * Price_i + A_5 * Feed\%_i + A_6 * Labor\%_i + A_7 * Wean\%_i + A_8 * Year_i, \quad (1)$$

where *Profit* is the profit (return over total costs) per cow, *Cows* is the number of cows in the herd (head), $Cows^2$ is the number of cows squared, *Weight* is the average weight produced (lbs. per cow), *Price* is the average selling price ($ per cwt.), *Feed%* is the percentage of total costs represented as total feed costs (%), *Labor%* is the percentage of total farm labor allocated to livestock (%), *Wean%* reflects weaning percentage (calves sold per cow in herd), *Year* is the average of the years included in the multi-year average,[10] i is an index for individual operations, and A_0 through A_8 are parameters to be estimated. All variables are multi-year averages based on the number of years of data each operation had over the 2012-2016 period. It is expected that the coefficients on *Cows* and $Cows^2$ will be positive and negative, respectively, as the profit will increase as the herd size increases, but at a decreasing rate. *Weight* and *Price* are expected to be positive, as well. *Feed%* should be positive because operations that have total feed costs as a high percent of total costs are doing a good job of minimizing non-feed costs and thus are expected to have higher profits. Based on data in figure A17, it is expected that the coefficient on *Labor%* will be positive. *Year* is included to account for the different time periods included in the multi-year averages between the operations.

Similar to equation (1), the following equation was estimated to identify factors leading to cost differences between operations:

$$Cost_i = B_0 + B_1 * Cows_i + B_2 * Cows_i^2 + B_3 * Weight_i + B_4 * Feed\%_i + B_5 * Labor\%_i + B_6 * Wean\%_i + B_7 * Year_i, \quad (2)$$

where *Cost* is the multi-year average total cost per cow, the other variables are as previously defined, and B_0 to B_6 are parameters to be estimated. *Price* is not included in equation (2) because there is no reason to expect that price received for cattle would have any impact on costs per cow.

Table 3 reports the results of estimating equations (1) and (2). In the profit model, equation (1), the coefficients on *Cows*, *Weight*, and *Year* were statistically significant. The coefficients on *Labor%* and *Wean%* were positive as expected, but were not statistically significant. The *Cows*^2, *Price*, and *Feed%* coefficients were negative, but not statistically significant. *Year* is statistically significant in the profit model. For example, an operation with data from 2013, 2014, and 2015 (*Year*=14) would have had $56.41in lower profit than an operation with data from 2012, 2013, and 2014 (*Year*=13) and $112.82 in lower profit than an operation with data from 2011, 2012, and 2013 (*Year*=12). The R-square value for equation (1) was 0.393 implying that roughly 39% of the variation in the dependent variable (profit per cow) was explained by variability in the independent variables included in the model.

[10] *Year* is calculated as follows: 2012=12, 2013=13,…, and 2016=16. Next, an average of the years an operation conducts an enterprise analysis is calculated. *Year* is bounded by 13.0 (3-year average including years 2012, 2013, and 2014) and 15.0 (3-year average including years 2014, 2015, and 2016). If a producer had data for all five years, the *Years* variable would take on a value of 14.0 (average of 2012, 2013, 2014, 2015, and 2016). The average value of *Years* across all 61 operations was 14.05.

Table 3 also lists regression output from the cost model (equation (2)). *Labor%* is negative, as expected, and statistically significant. This indicates as the percentage of labor allocated to livestock goes up, the costs per cow decreases. This negative coefficient is consistent with figure A17. The R-square value for equation (2) was 0.230 implying that roughly 23% of the variation in the dependent variable (cost per cow) was explained by variability in the independent variables included in the model.

Table 3. Regression Results for Profit and Cost Models (Equations (1) and (2))

	Profit ($/cow)		*Cost ($/cow)*	
Variable	Coefficient	p-value*	Coefficient	p-value*
Intercept	43.100	0.938	1,329.489	0.039
Cows	0.742	0.046	-0.229	0.586
Cows²	0.000	0.232	0.000	0.871
Weight	0.797	0.011	0.089	0.776
Price	-0.165	0.902	n/a	n/a
Feed%	-3.473	0.229	-3.129	0.344
Labor%	1.093	0.314	-2.998	0.020
Wean%	2.159	0.603	-0.860	0.860
Year	-56.417	0.092	5.538	0.872
R-square**	0.393		0.230	

*p-values associated with hypothesis test that coefficient is significantly different from zero. A value of 0.05 would imply we are 95% confident that value is significantly different from zero (0.01 implies 99% confidence, and so on).

**R-square represents the proportion of variability in the dependent variable (*Profit* and *Cost)* that is explained by variation in the independent variables.

Summary

There are some important conclusions to be drawn from the information in this paper. The economic returns to beef cow-calf producers vary considerably over time due to a number of factors, including the cattle cycle. For example, over the last 42 years there has been an average $233 difference in returns per cow, depending on how returns are calculated, between the good (top 1/3) and the bad (bottom 1/3) years. This is a significant amount of variability, but unfortunately this risk is difficult to manage because much of it is due to macro-economic factors and conditions that are typically beyond the control of individual producers. However, what is much more important is that the variability across producers at a point in time is much larger than the variability over time. In other words, even in the "good years" some producers are losing money and even in the "bad years" some producers are making money. This is important because it indicates there are management changes producers can make to seek to improve their operations.

This analysis suggests that while both production (weight) and price do impact profit, they are much less important in explaining differences between producers than costs. In the data analyzed here, economies

of size exist such that larger operations tend to have lower costs and hence are more profitable than smaller operations. However, it is important to point out that being a large operator does not guarantee low costs and high profits, as a number of mid-sized to smaller operations were cost competitive. Operations that specialized in the cowherd enterprise, relative to crop enterprises, based on their labor allocation, tended to have lower costs and be more profitable. The factor that is important regarding profit and cost differences between producers is how well they manage their non-pasture feed costs. Producers that had a lower percentage of their total costs as feed (i.e., a higher percentage as non-pasture feed) had significantly lower costs and hence significantly higher profits. One of the ways to manage these non-feed costs is operation size, as larger operations tended to have lower costs per cow for labor and especially for machinery operating costs and depreciation.

As the data reported here clearly show, there is tremendous variability across producers, which means there is room for producers to improve their relative situations. However, before one can improve they need to know where they stand relative to other producers. Thus, benchmarking and identifying an operation's strengths and weaknesses is the first step to deciding where to focus management efforts.

Appendix A. Scatter Plots of Various Variables for 61 Beef Cow-Calf Operations.

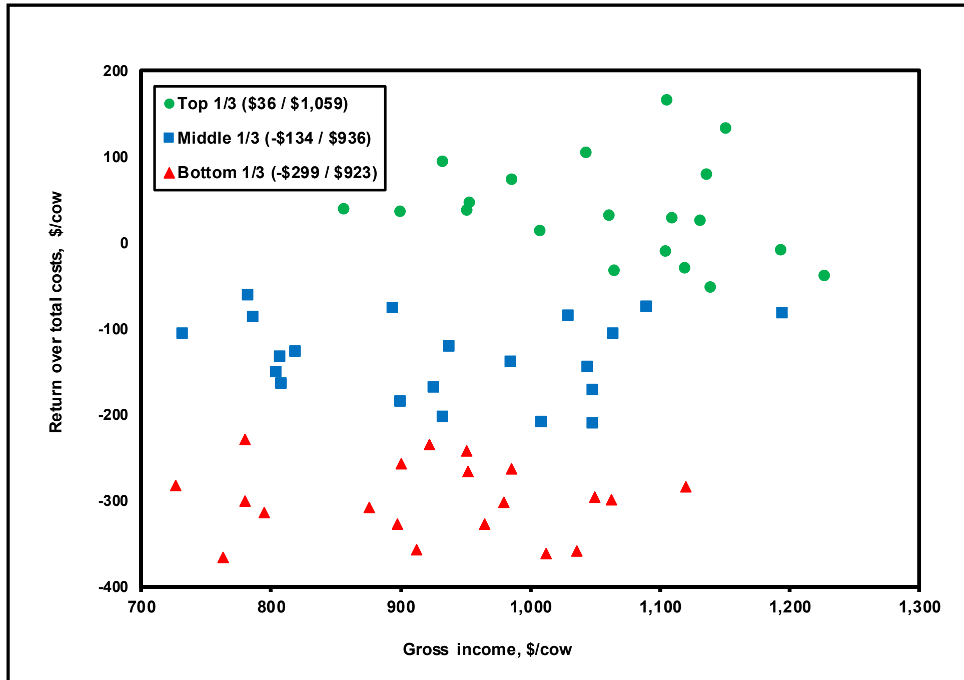

Figure A1. Profit vs. Gross Income (correlation = 0.38)

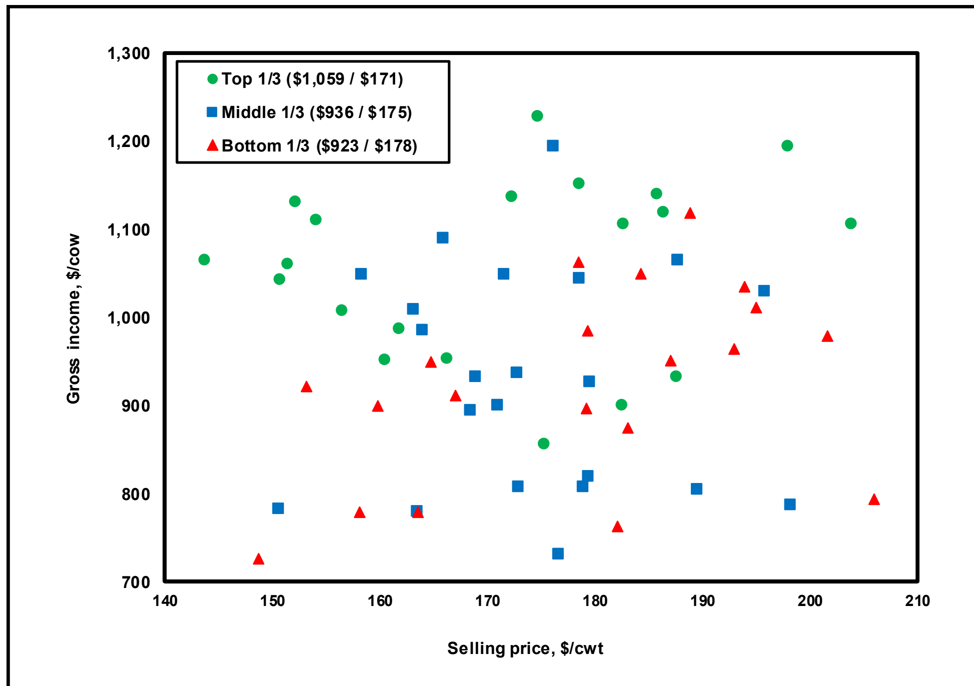

Figure A2. Gross Income vs. Selling Price (correlation = 0.07)

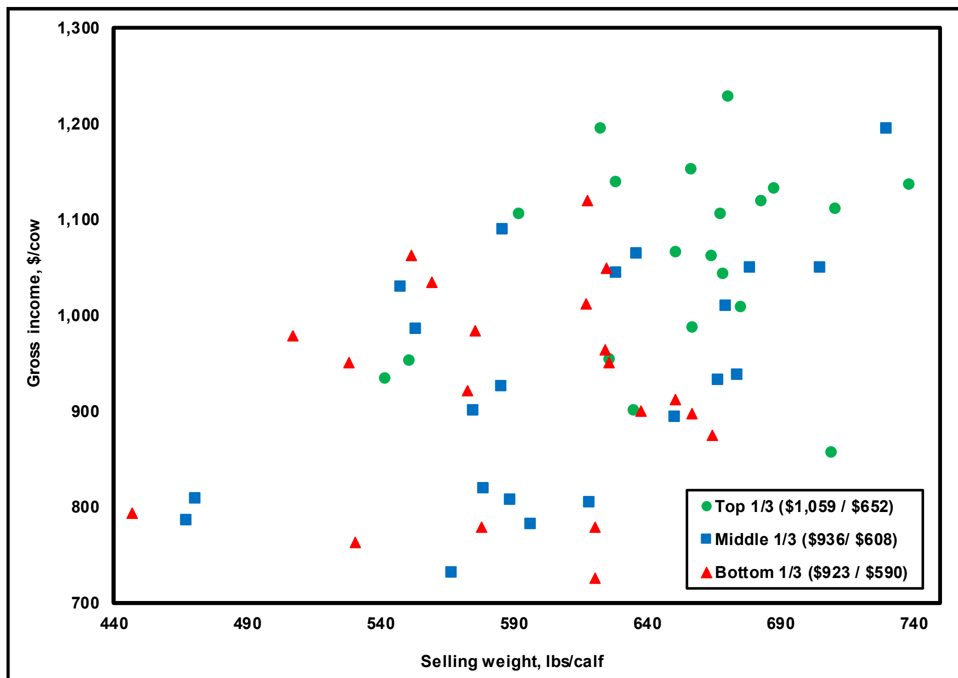

Figure A3. Gross Income vs. Calf Selling Weight (correlation = 0.48)

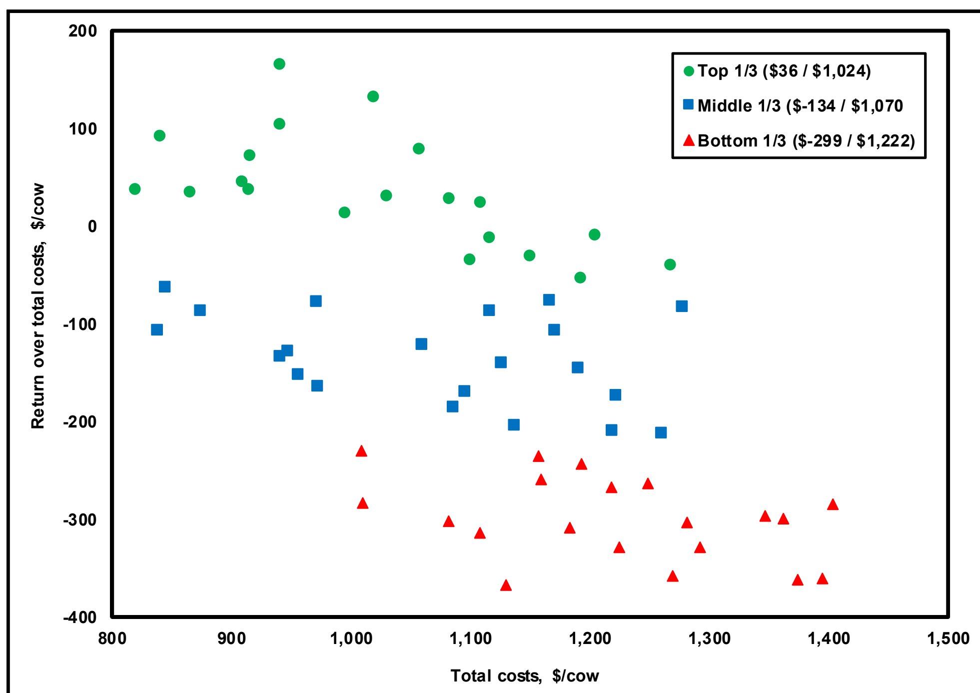

Figure A4. Profit vs. Total Costs (correlation = -0.64)

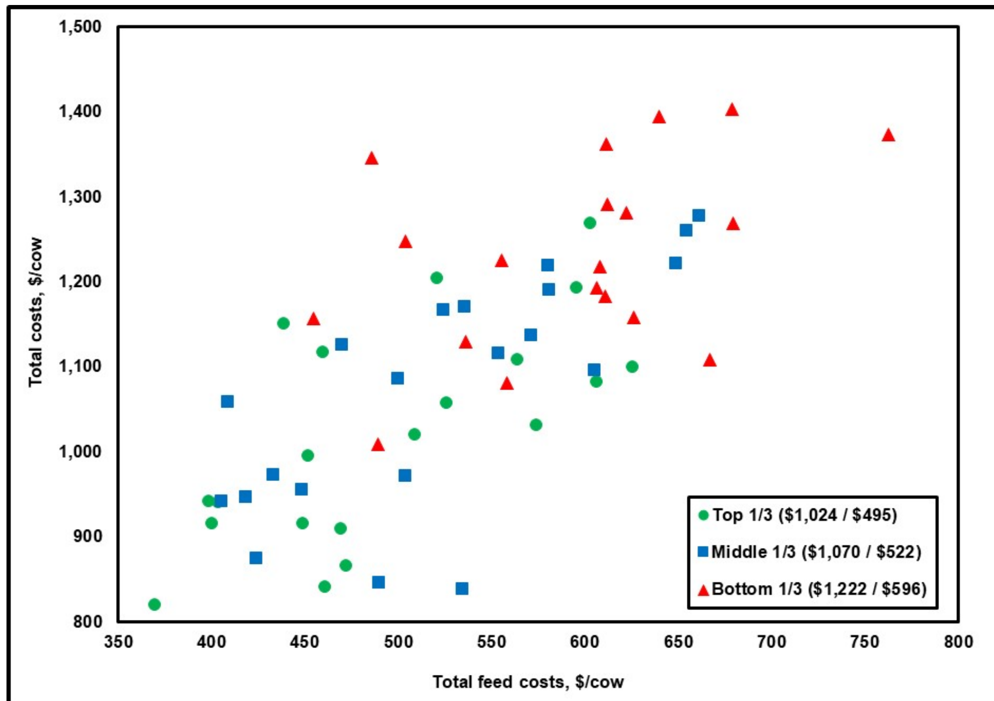

Figure A5. Total Costs vs. Total Feed Costs (correlation = 0.72)

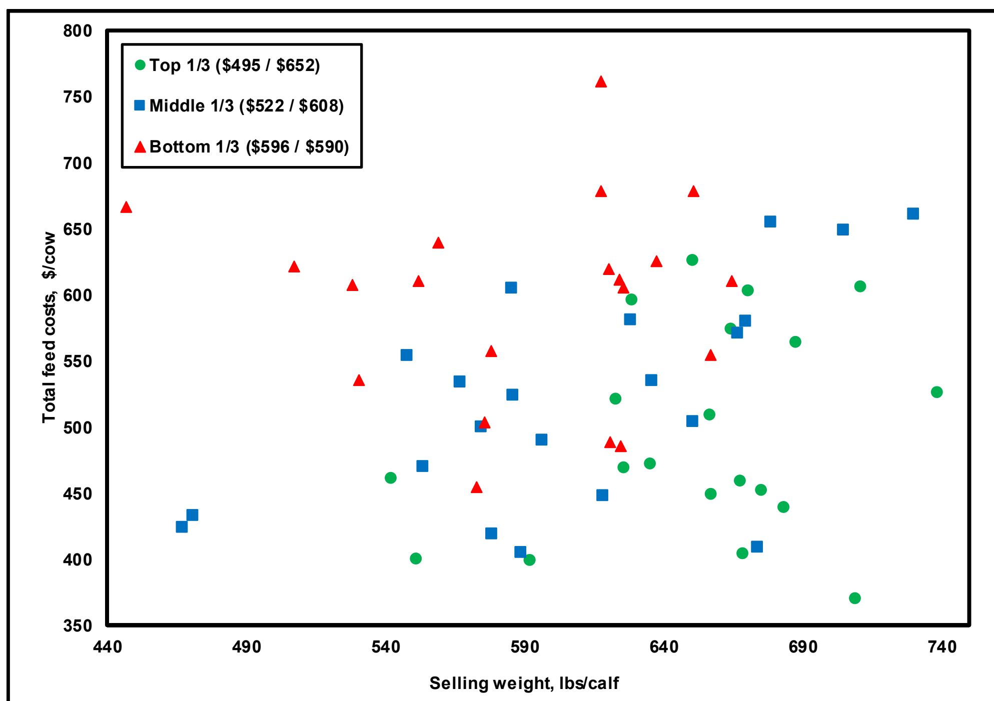

Figure A6. Total Feed Costs vs. Calf Selling Weight (correlation = 0.09)

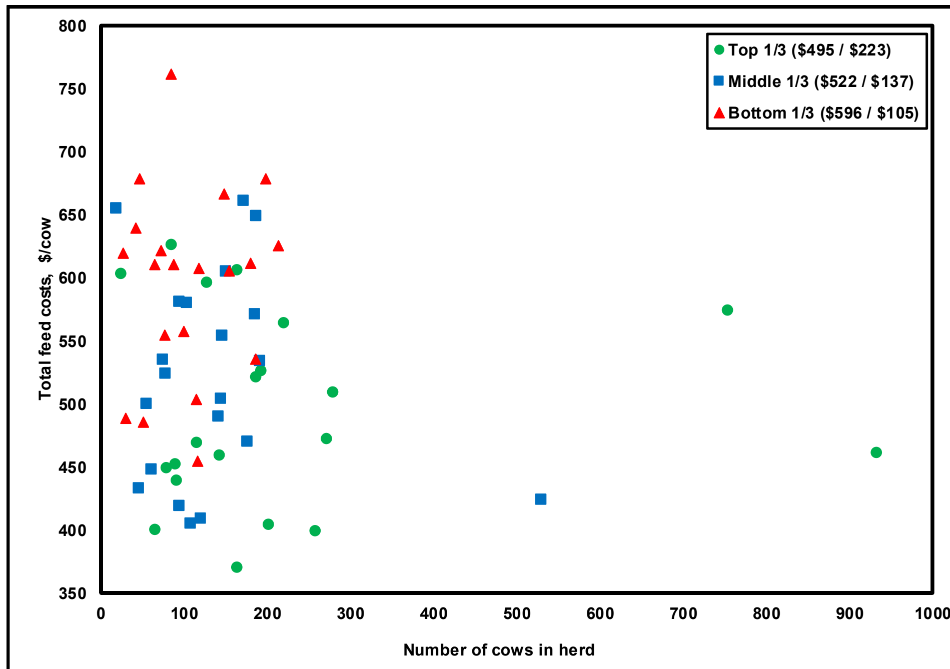

Figure A7. Total Feed Costs vs. Size of Cow Herd (correlation = -0.14)

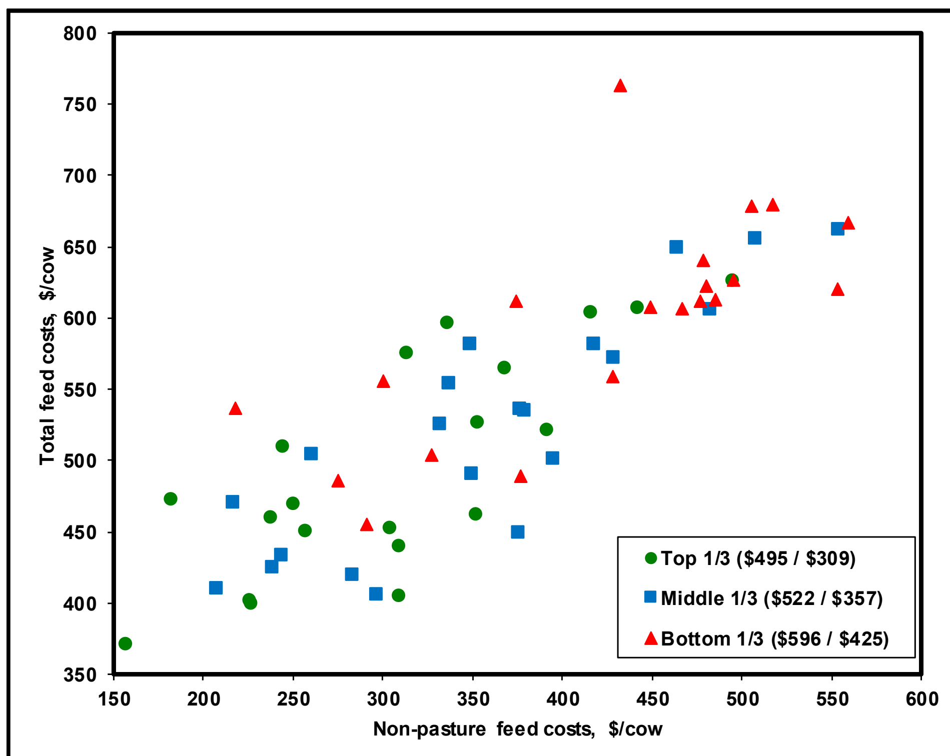

Figure A8. Total Feed Costs vs. Non-Pasture Feed Costs (correlation = 0.84)

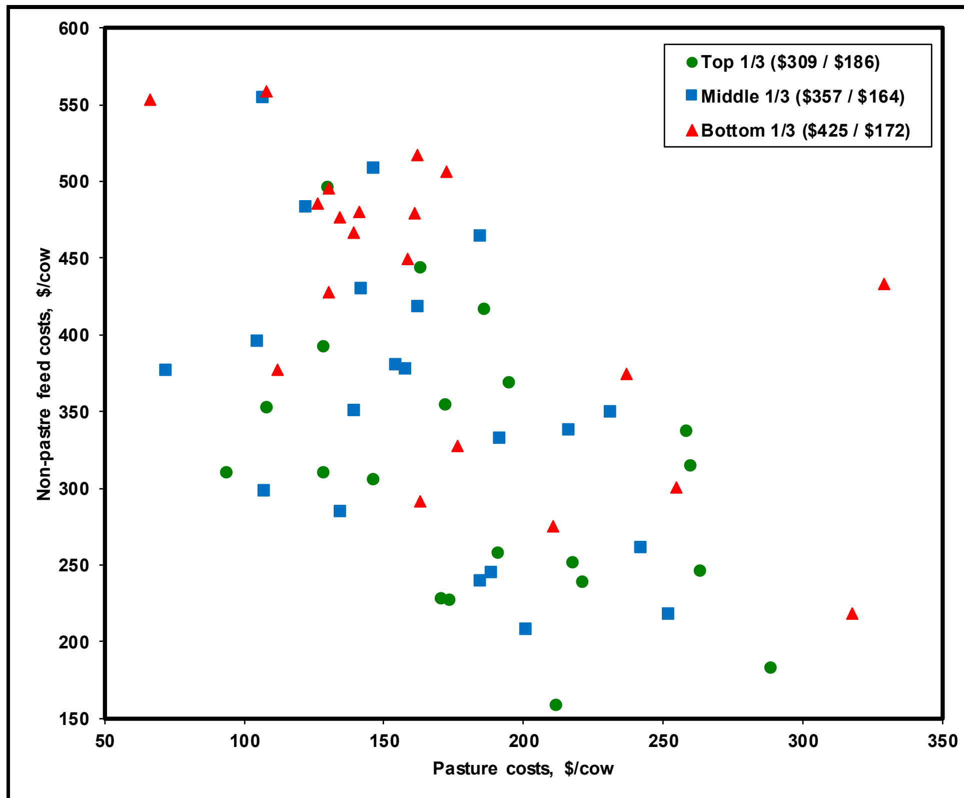

Figure A9. Non-Pasture Feed Costs vs. Pasture Costs (correlation = -0.52)

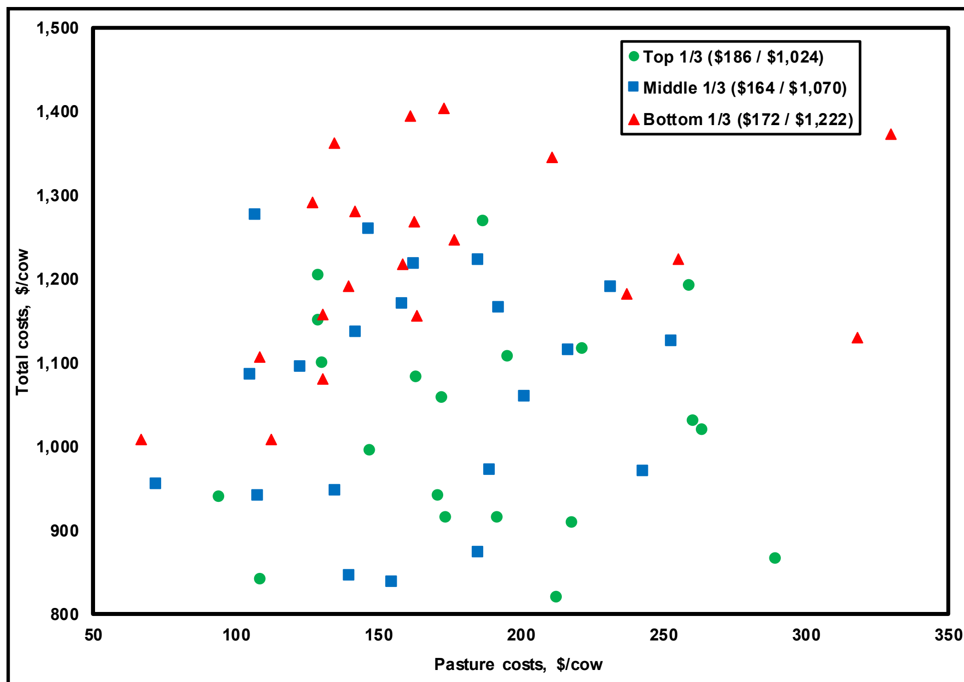

Figure A10. Total Costs vs. Pasture Costs (correlation = 0.09)

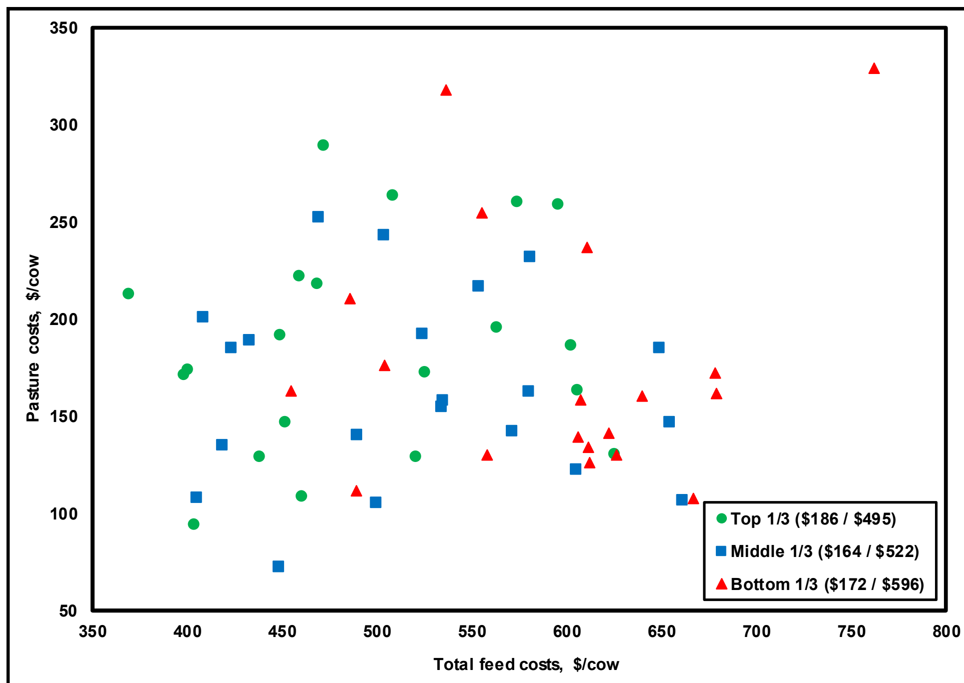

Figure A11. Pasture Costs vs. Total Feed Costs (correlation 0.03)

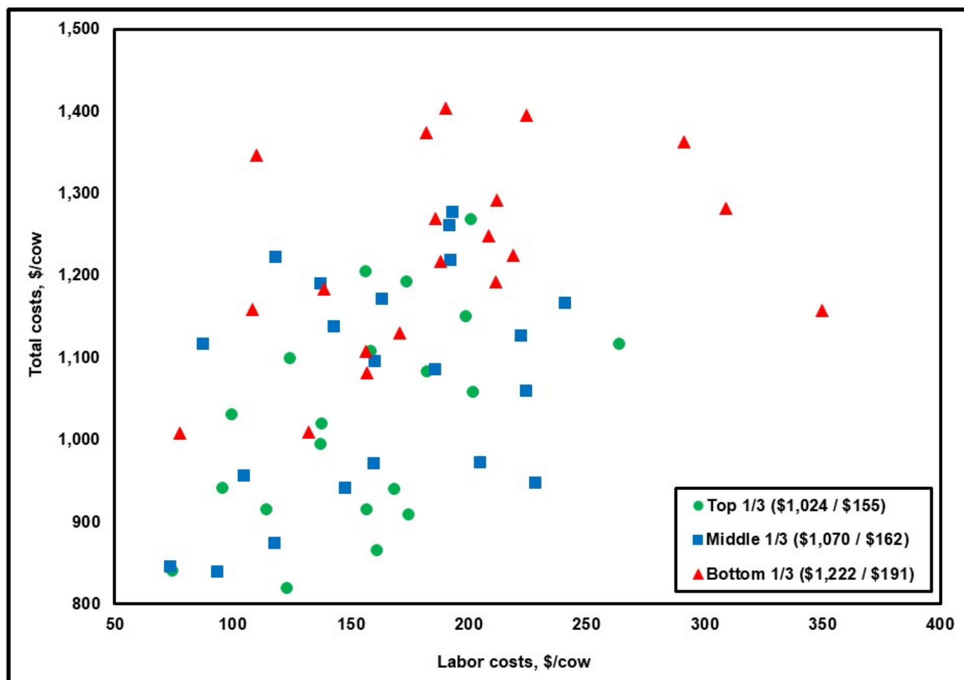

Figure A12. Total Costs vs. Labor Costs (correlation = 0.49)

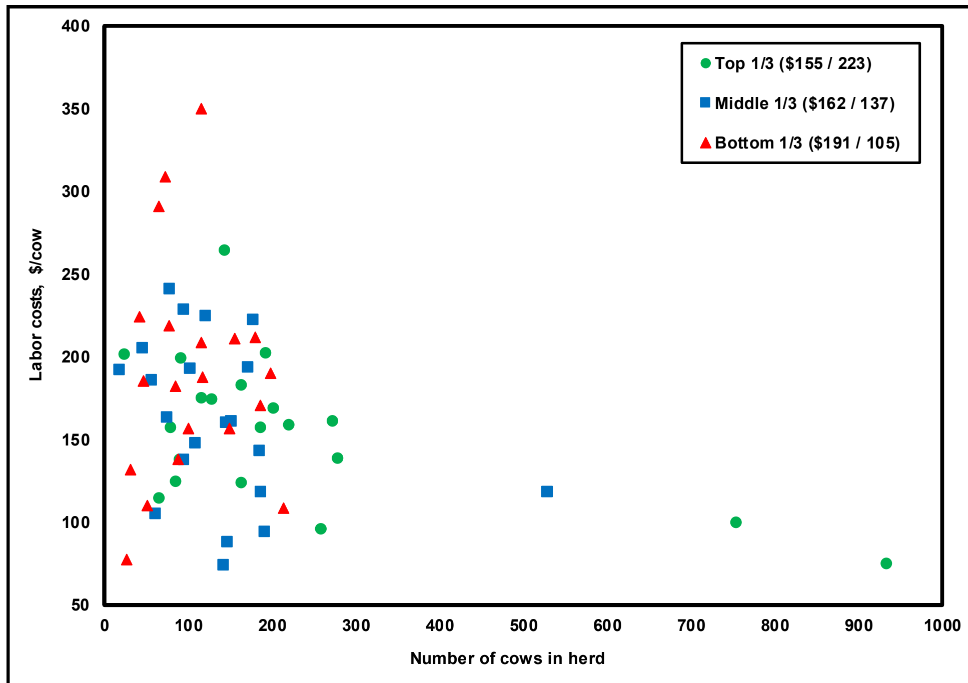

Figure A13. Labor Costs vs. Size of Cow Herd (correlation = -0.35)

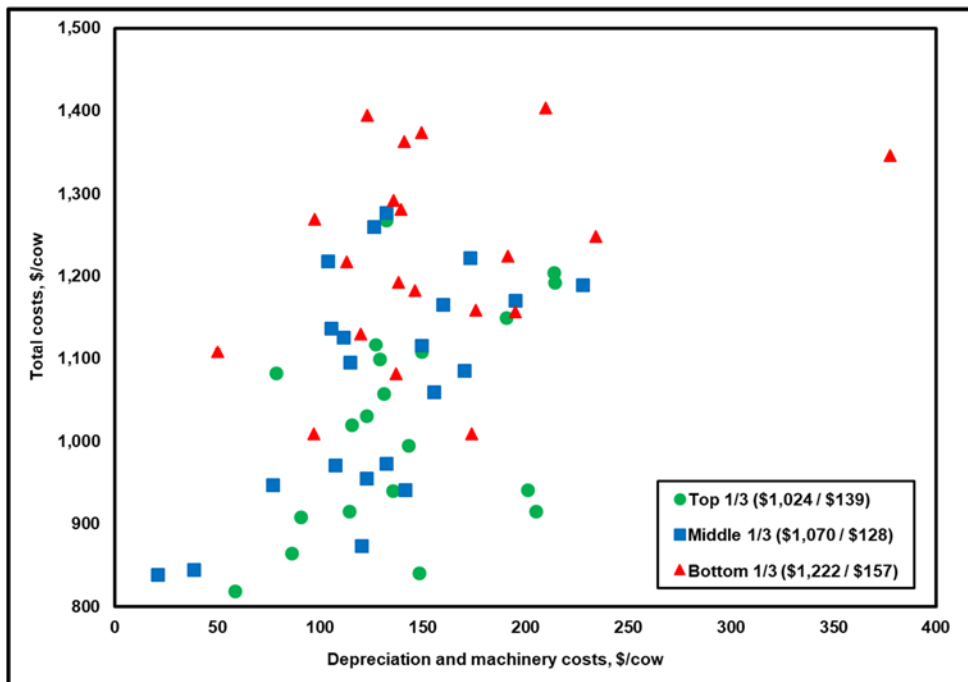

Figure A14. Total Costs vs. Depreciation and Machinery Costs (correlation = 0.45)

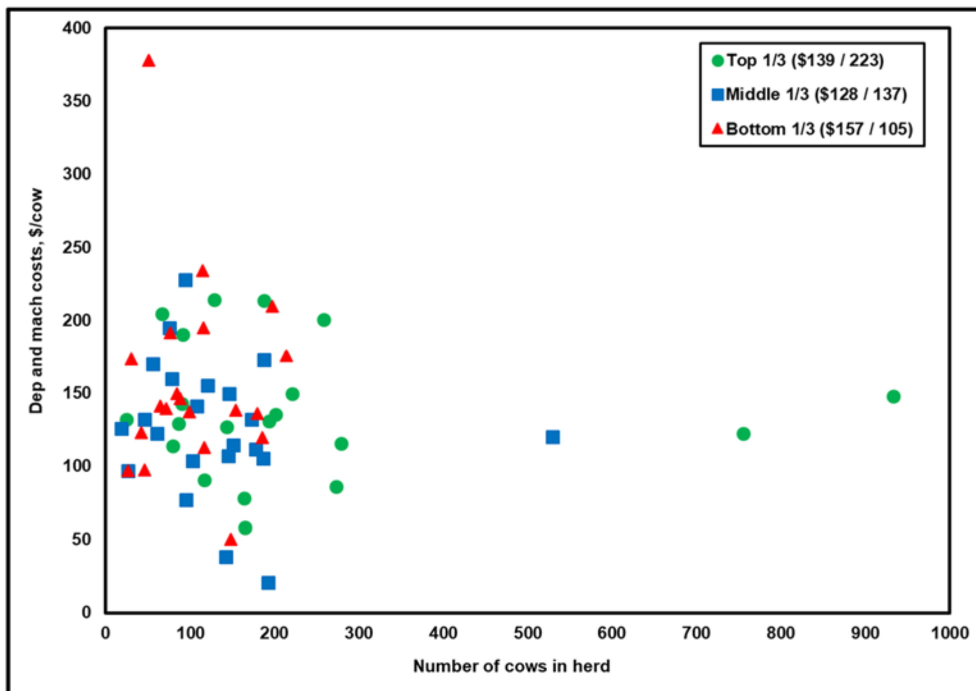

Figure A15. Depreciation and Machinery Costs vs. Size of Cow Herd (correlation = -0.10)

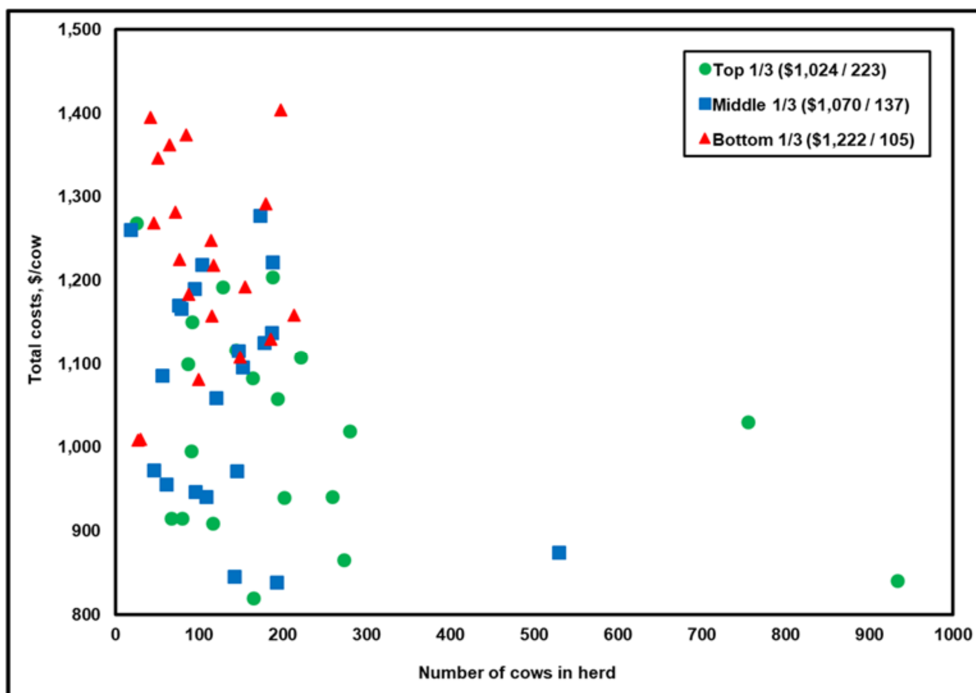

Figure A16. Total Costs vs. Size of Cow Herd (correlation = -0.35)

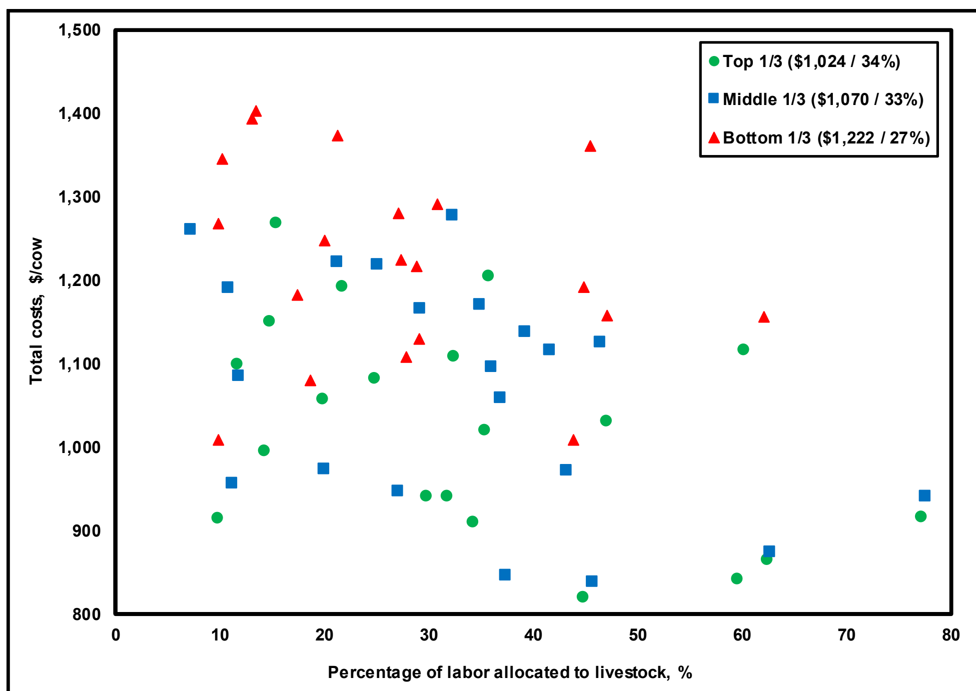

Figure A17. Total Costs vs. Labor Allocated to Livestock (correlation = -0.43)

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