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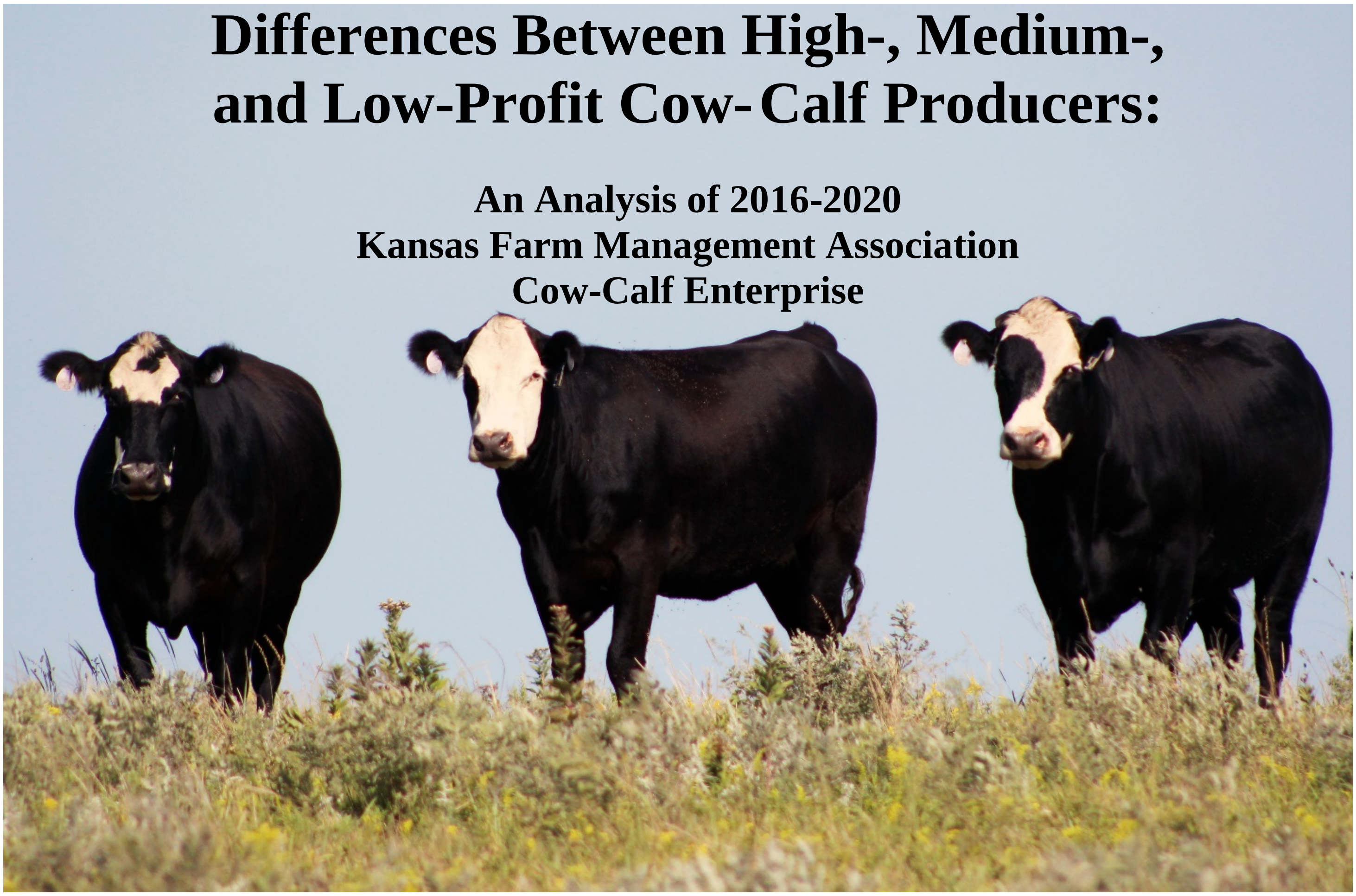
An Analysis of 2016-2020 Kansas Farm Management Association Cow-Calf Enterprise



Source: Beef Cattle Institute

Kansas State University
Department of Agricultural Economics
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Dustin L. Pendell (dpendell@ksu.edu)
Kevin L. Herbel (kherbel@ksu.edu)

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Ask anyone involved in the cow-calf industry and they will tell you the economic returns to cow-calf producers fluctuate considerably from year-to-year. 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 2020. Over the 46-year period, there were 132 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 $71.02 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 $183.33, $61.11, and -$30.73, for the top-, middle-, and bottom-periods, respectively. In other words, there is over a $214 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. 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.

[1]This paper is an update to Pendell and Herbel (2021) - "Differences Between High-, Medium-, and Low-Profit Producers: An Analysis of 2015-2019 Kansas Farm Management Association Cow-Calf Enterprise." Available at: Differences Between High-, Medium-, and Low-Profit Cow-Calf Producers - 2015-2019 | AgManager.info.

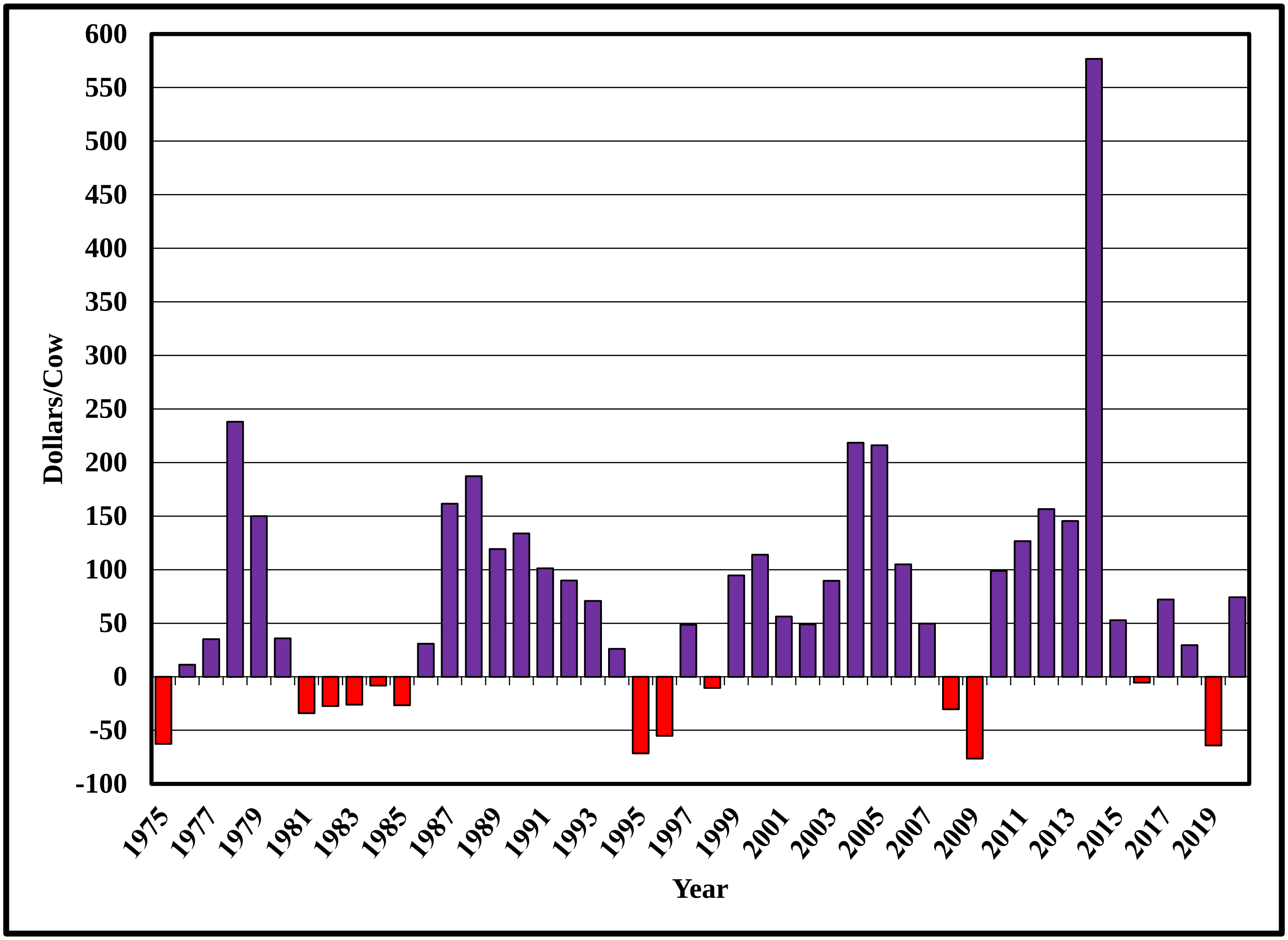

Figure 1. Returns over Variable Cost for Cow-Calf Enterprise, 1975-2020

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 46-year time frame, the average returns over total costs are -$114.41 per cow with a low of -$404.36 and a high of $226.35 (returns over total costs were only positive in 6 of the 46 years). Given that average returns over total costs are only positive 13% 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 46-year returns over total costs into thirds, similar to returns over variable costs. This resulted in averages per cow of $13.96, -$108.62, and -$248.95 for the top-, middle-, and bottom-third of years, respectively. In other words, there is a large difference of $263 in the average returns over total costs per cow between the "good" years and the "bad" years.

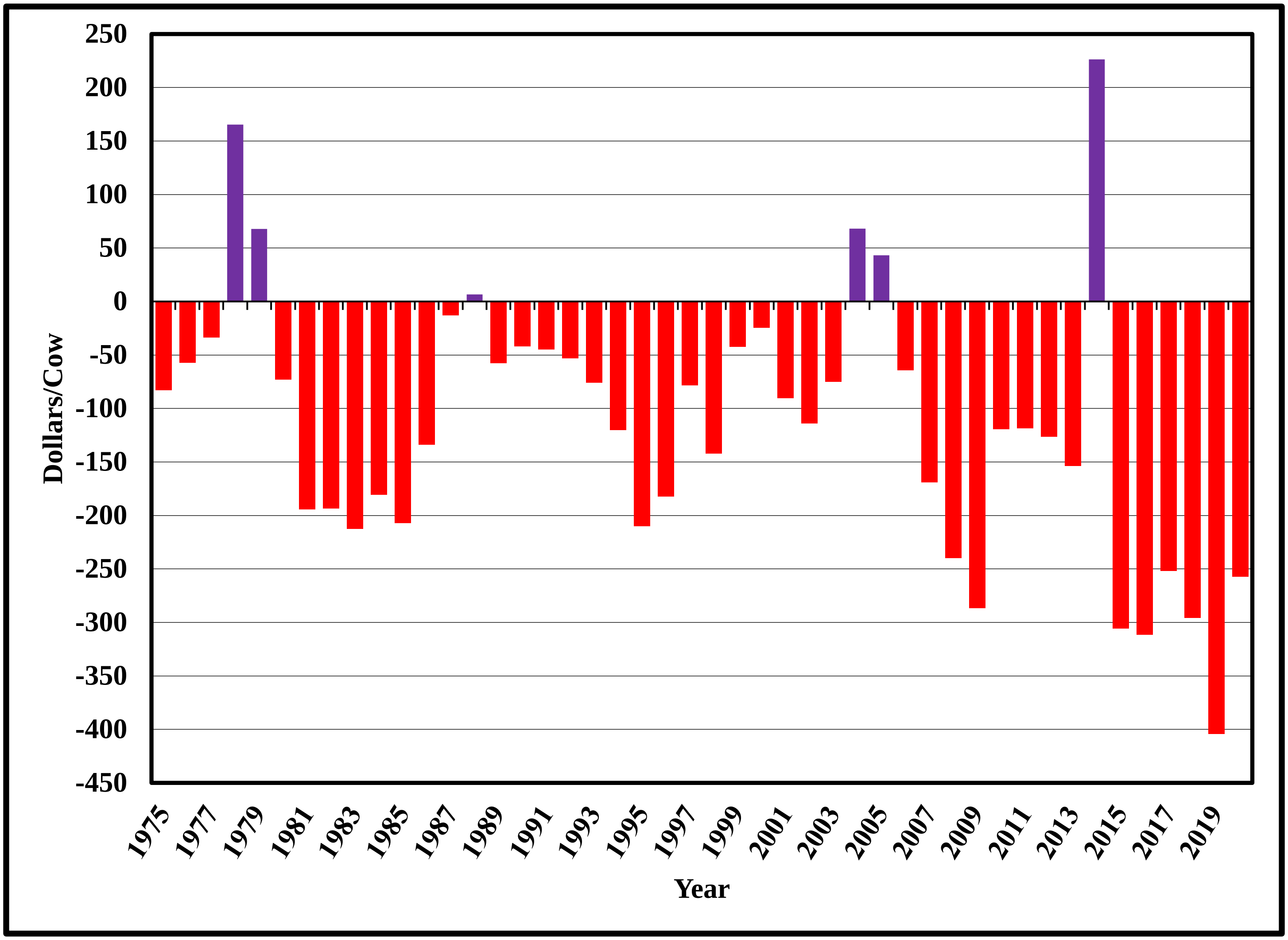

Figure 2. Returns over Total Cost for Cow-Calf Enterprise, 1975-2020

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 2016-2020 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 2016-2020), 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 81 operations with multi-year average returns to analyze (15 had five years of data, 25 had four years of data, and 42 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, several variables from the KFMA whole-farm database were included. These are operator age, number of operators per farm and a variable to represent the percentage of labor used for the cow-calf

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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 15 operations that had data each year from 2016-2020.

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

enterprise. Operator age represents the average age of the individuals managing the operations during the multiple-year period considered. Number of operators indicates the number of individuals in these management positions on the farms. If this number is less than one, management of the operation is less than full time while a number greater than one indicates there are multiple individuals providing management of the farm. The labor percentage variable is for all livestock, not just beef cows. The percent of labor variable provides an indication as to the relative importance of livestock enterprises to the total farm. A high percentage indicates a farm specializes in livestock, whereas, a low percentage indicates the operation relies relatively more on crop enterprises.

Multi-year averages were calculated for all variables for each of the 81 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 81 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. For this 2016-2020 period, farms in the high-profit group had an operator age of 52 years and number of operators of 1.07 compared to an operator age of 58 years and number of operators of 0.88 in the low-profit group.

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 0.90 across all operations and, while similar for each of the three profit categories, the high-profit farms were about 3% higher. High-profit farms had a 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 more than 120% larger than the size of the low 1/3 category (178 versus 81 cows). There was a 0.80 (9%) pasture acres per cow difference between the high and low profit farms, with the high profit-farms average of 9.64 acres per cow compared to 8.84 acres per cow on the lower profit farms. Even though the high-profit farms sold slightly heavier calves, they received a slightly higher price for calves as compared to the low- and mid-profit operations. High-profit operations generated over $176 (26%) more revenue per cow than the low-profit operations.

The differences in costs between operations and the differences in revenue between operations were similar. High-profit operations had a $284 per cow cost advantage over low-profit farms (23% advantage) and a $171 (15%) cost advantage over the mid-profit farms. High-profit operations had a cost advantage in every cost category compared to low-profit operations and every cost compared category mid-profit operations, except for pasture.

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-profit operations was 18.09, 18.23 for the middle-profit farms, and 18.24 for the low-profit operations, where 2016=16, 2017=17 and so on. These averages were not statistically different from each other at the 5% level, suggesting that profit differences likely were not driven by specific years in which producers had data for (remember not all farms have data in all years).

[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.

Combining the gross income and cost advantages for the high-profit farms results in a net return advantage of $459.90 and $272.79 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 $352.21 per cow over this 5-year time period, the top third of the producers fared much better than the average (average loss of $107.99).

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.

Table 1. Beef Cow-Calf Enterprise Returns over Total Costs, 2016-2020 (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	81	27	27	27		
Age of Operator	55.8	52.2	57.1	58.2	-6.0	-10%
Number of Operators	0.99	1.07	1.04	0.88	0.19	22%
Labor allocated to livestock, %	29.7	34.2	29.6	25.2	9	35%
Pasture Acres per Cow	9.11	9.64	8.86	8.84	0.80	9%
Number of Cows in Herd	133	178	140	81	97	120%
Number of Calves Sold	120	163	126	72	91	127%
Calves Sold per Cow in Herd	0.903	0.915	0.895	0.887	0.03	3%
Weight of Calves Sold, lbs.	617	623	622	604	19	3%
Calf Sales Price / Cwt	$147.45	$149.23	$146.14	$146.98	$2.25	2%
Gross Income	**$765.46**	**$858.03**	**$756.40**	**$681.94**	**$176.09**	**26%**
Feed	$343.63	$261.49	$363.12	$406.28	-$144.79	-36%
Pasture	$176.62	$182.70	$179.83	$167.33	$15.37	9%
Interest (incl opportunity cost)	$162.59	$158.54	$164.34	$164.91	-$6.37	-4%
Vet Medicine / Drugs	$37.82	$37.44	$36.95	$39.08	-$1.64	-4%
Livestock Marketing / Breeding	$22.39	$20.02	$21.30	$25.85	-$5.83	-23%
Depreciation (economic)	$52.39	$40.30	$55.89	$60.96	-$20.66	-34%
Machinery	$82.35	$66.26	$82.29	$98.50	-$32.25	-33%
Labor (incl operator labor)	$186.07	$158.90	$176.90	$222.43	-$63.53	-29%
Other	$53.81	$40.38	$56.56	$64.49	-$24.11	-37%
Total Cost	**$1,117.67**	**$966.01**	**$1,137.18**	**$1,249.82**	**-$283.81**	**-23%**
Net Return to Management	**-$352.21**	**-$107.99**	**-$380.77**	**-$567.88**	**$459.90**	

*Sorted by Net Returns over Total Costs per Cow

Table 2 (on the following page) 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 $411.46 per cow (compared to $459.90 using total costs). Similar to table 1, high-profit operations have the largest number of cows in the herd when compared to mid- and low-profit operations. The operation size for the different groups is different between the two analyses (i.e., tables 1 and 2) because 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=0.99) 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 27 high-profit operations in table 1, 24 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 when looking at total costs still holds. 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, 2016-2020 (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	81	27	27	27		
Age of Operator	55.1	52.8	56.2	56.4	-3.6	-6%
Number of Operators	0.99	1.09	0.92	0.96	0.13	13%
Labor allocated to livestock, %	29.2	34.0	30.5	23.0	11	48%
Pasture Acres per Cow	9.07	9.69	9.02	8.49	1.2	14%
Number of Cows in Herd	133	174	125	100	74	73%
Number of Calves Sold	120	159	114	88	71	80%
Calves Sold per Cow in Herd	0.903	0.913	0.908	0.878	0.04	4%
Weight of Calves Sold, lbs.	617	624	628	597	27	5%
Calf Sales Price / Cwt	$147.45	$148.85	$146.56	$146.94	$1.91	1%
Gross Income	**$765.46**	**$844.58**	**$785.36**	**$666.43**	**$178.15**	**27%**
Feed	$343.63	$248.06	$377.38	$405.44	-$157.38	-39%
Pasture	$176.62	$186.57	$176.94	$166.35	$20.22	12%
Interest	$32.50	$21.34	$36.22	$39.94	-$18.59	-47%
Vet Medicine / Drugs	$37.82	$32.72	$41.99	$38.75	-$6.03	-16%
Livestock Marketing / Breeding	$22.39	$15.81	$22.39	$28.97	-$13.16	-45%
Machinery	$82.35	$66.98	$83.86	$96.21	-$29.23	-30%
Labor	$17.50	$16.25	$10.60	$25.65	-$9.40	-37%
Other	$53.81	$41.53	$58.64	$61.26	-$19.73	-32%
Total Variable Cost	**$766.62**	**$629.26**	**$808.01**	**$862.58**	**-$233.31**	**-27%**
Return over Variable Costs	**-$1.16**	**$215.31**	**-$22.65**	**-$196.15**	**$411.46**	

*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, it can be seen that the cost difference represents a larger portion of difference in net return than the difference in income. In fact, 61.7% of the average difference in net return to management between high- and low-profit farms is due to cost differences. The other 38.3% is due to differences in gross income per cow, which is primarily because the high-profit farms sold a larger number of calves and sold slightly heavier calves at a slightly higher price. 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 81 operations. The focus is on returns over total costs (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 0.67, 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. There is a negative relationship between price and gross income (r=-0.24) possibly suggesting that price is not as important as weight when determining gross margin. On the other hand, there is a relatively strong positive relationship between gross income and average selling weight of calves (r=0.59). That is, producers selling more pounds tend to generate more income, but those getting higher prices 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. It is likely that a high percentage of these operations are selling calves and cull cows through a local or regional auction market making it difficult to differentiate themselves related to price received. 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.

[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.

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= -0.74). This is consistent with what was shown in table 1 – almost two-thirds of the differences in returns are due to costs. 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 relatively strong positive correlation as would be expected (r=0.77). While total feed costs represent 46.5% 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=0.28; figure A6). Figure A7 shows there is a negative relationship between total feed costs and the size of the cow herd (r=-0.33). This suggests the larger operations have lower total feed costs per cow; however, this analysis would not strongly 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 less on purchased feed.[8] Figure A8 shows the very strong relationship between total feed costs and non-pasture feed costs (r=0.83). Producers that are able to control their non-pasture feed costs also have lower total costs, which is expected given 30.7% 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=-0.47). 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=0.12 and r=0.09, 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 (a little smaller than feed costs) indicating that management of these categories is important to profitability. 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.

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 is only one herd in this analysis with over 300 cows so we cannot say much about the costs for 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 300+ 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= -0.15). The negative relationship indicates that those producers that specialize in livestock (i.e., have a higher

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

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. While this relationship is not particularly strong, it does hint at the advantage to specialization.

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:

$$\begin{aligned} Profit_i = A_0 + A_1 * Cows_i + A_2 * Cows_i^2 + A_3 * Weight_i + A_4 * Price_i + A_5 * Wean\%_i \\ + A_6 * Acre + A_7 * Age + A_8 * Feed\%_i + A_9 * Pasture\%_i + A_{10} * \ Labor\%_i \\ + A_{11} * Dep, Mach, Int\%_i + A_{12} * Year_i, \end{aligned} \tag{1}$$

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.), *Wean%* reflects weaning percentage (calves sold per cow in herd), *Acre* is the number of acres of pasture per cow, *Age* is the age of the producer (years), *Feed%* is the percentage of total costs represented as non-pasture feed costs (%), *Pasture%* is the percentage of total costs represented as pasture costs (%), *Labor%* is the percentage of total farm labor allocated to livestock (%), *Dep,Mach,Int%* is the percentage of total costs represented as depreciation, machinery, and cash interest costs (%), *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_{12} are parameters to be estimated. All variables are multi-year averages based on the number of years of data each operation had over the 2016-2020 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%*, *Labor%*, and *Dep,Mach,Int%* should be negative because operations that have non-pasture feed, labor, and depreciation, machinery, and cash interest costs as a high percent of total costs are expected to have lower profits. Based on figure A9, *Pasture%* is expected to be positive. As producers keep their cattle on pasture longer, they are reducing the non-pasture feed costs. 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:

$$\begin{aligned} Cost_i = B_0 + B_1 * Cows_i + B_2 * Cows_i^2 + B_3 * Weight_i + B_4 * Wean\%_i + B_5 * Acre \\ + B_6 * Age + B_7 * Feed\%_i + \ B_8 * Pasture\%_i + \ B_9 * Labor\%_i \\ + B_{10} * Dep, Mach, Int\% \ \ B_{11} * Year_i, \end{aligned} \tag{2}$$

[10] *Year* is calculated as follows: 2016=16, 2017=17,…, and 2020=20. Next, an average of the years an operation conducts an enterprise analysis is calculated. *Year* is bounded by 17.0 (3-year average including years 2016, 2017, and 2018) and 19.0 (3-year average including years 2018, 2019, and 2020). If a producer had data for all five years, the *Years* variable would take on a value of 18.0 (average of 2016, 2017, 2018, 2019, and 2020). The average value of *Years* across all 81 operations was 18.2.

where *Cost* is the multi-year average total cost per cow, the other variables are as previously defined, and B_0 to B_{11} 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 coefficient on *Acre*, *Age*, *Feed%*, *Pasture%*, and *Dep,Mach,Int%* were statistically significant with a 90% confidence interval. As expected, the negative coefficient on *Acre*, indicates that for every additional pasture acre per cow, profit decreases by $17.64 per cow. Likewise, each 1% increase in *Feed%* and *Dep,Mach,Int%* relative to total costs results in a decrease in profit by $7.05 and$10.90 per cow, respectively. *Age also* has a negative coefficient (-3.69) suggesting that for each additional year in operator age, the net return declines by $3.69 per cow. The *Pasture%* coefficient is +10.15. This implies that a 1% increase in pasture costs relative to total costs will lead to an increase in profit by $10.15 per cow. This is consistent with figure A9; producers could be making a trade-off between non-pasture feed and pasture, potentially leading to increased profit. Although not statistically significant with a 90% confidence interval, *Labor%* is marginally significant with a negative coefficient (-2.36). The coefficients on *Cows*, $Cows^2$, *Weight*, *Price*, *Wean%*, and *Year*, were not statistically significant. Thus, the general conclusions from table 1 and table 2 would not change. The R-square value for equation (1) was 0.508 implying that roughly 51% of the variation in the dependent variable (profit per cow) was explained by variability in the independent variables included in the model.

Table 3 also lists regression output from the cost model (equation (2)). *Weight*, *Acre*, *Age*, *Feed%*, and *Dep,Mach,Int%* were statistically significant with a 90% confidence interval. All of the statistically significant variables were positive, suggesting they contribute to an increase in costs per cow. Specifically, a 1 lb. increase in weight leads to an increase in costs by $0.89 per cow. For each additional acre per cow stocking rate, costs increase by $15.33 per head. An additional year in operator age, the cost increase by $2.67 per cow. A 1% increase in *Feed%* and *Dep,Mach,Int%* leads to an increase in costs by $6.29 and $8.37 per cow, respectively. The R-square value for equation (2) was 0.380 implying that roughly 38% 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	-0.217	1.000	-379.852	0.592
Cows	0.851	0.437	0.103	0.908
Cows^2	0.001	0.780	-0.002	0.433
Weight	0.176	0.692	0.891	0.002
Price	-1.102	0.666	n/a	n/a
Wean%	4.575	0.232	1.159	0.704
Acre	-17.643	0.042	15.325	0.033
Age	-3.691	0.047	2.671	0.081
Feed%	-7.045	0.087	6.294	0.066
Pasture%	10.154	0.086	-6.838	0.161
Labor%	-2.356	0.115	1.619	0.189
Dep,Mach,Int%	-10.895	0.021	8.368	0.031
Year	-10.572	0.782	18.440	0.555
R-square**	0.508		0.380	

*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 46 years there has been a difference of approximately $263 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 costs are more important in explaining differences in profit between producers than production (weight), price, and weaning percentage. In the data analyzed here, economies of size appear to exist such that larger operations tend to have lower costs. However, it is important to point out that being a large operator does not guarantee low costs and high profits, as several mid-sized to smaller operations were cost competitive. There is some indication that focused management efforts can lead to improved cost management as operations that specialized in the cowherd enterprise relative to crop enterprises (based on their labor allocation) tended to have lower costs. One factor that is always important regarding profit and cost differences between cow-calf producers is how well they manage their *feed costs*. It is important for a producer to know their total feed costs (purchased feed; raised feed; grazed crop residues, cover crops and temporary pasture; native and cool season pasture) and how they compare with others. This should include identifying where inefficiencies, including feed waste, might exist. With this information, decisions can be made to identify comparative disadvantages to be addressed and comparative advantages to be capitalized on. Management of non-feed costs (especially labor, machinery, and depreciation) is also important. One of the ways to manage these non-feed costs can be operation size, as larger operations tended to have lower costs per cow for labor and for machinery operating costs and depreciation. In the end, however, it is important for each manager to clearly understand the resources and constraints of their situation and to manage by making changes and adjustments appropriate for that situation.

The data reported here clearly show that there is tremendous variability across producers. This means there is room for producers to improve their relative situations and profitability. However, before one can improve, they need to know where they stand relative to other producers. Thus, keeping records that allow 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 81 Beef Cow-Calf Operations.

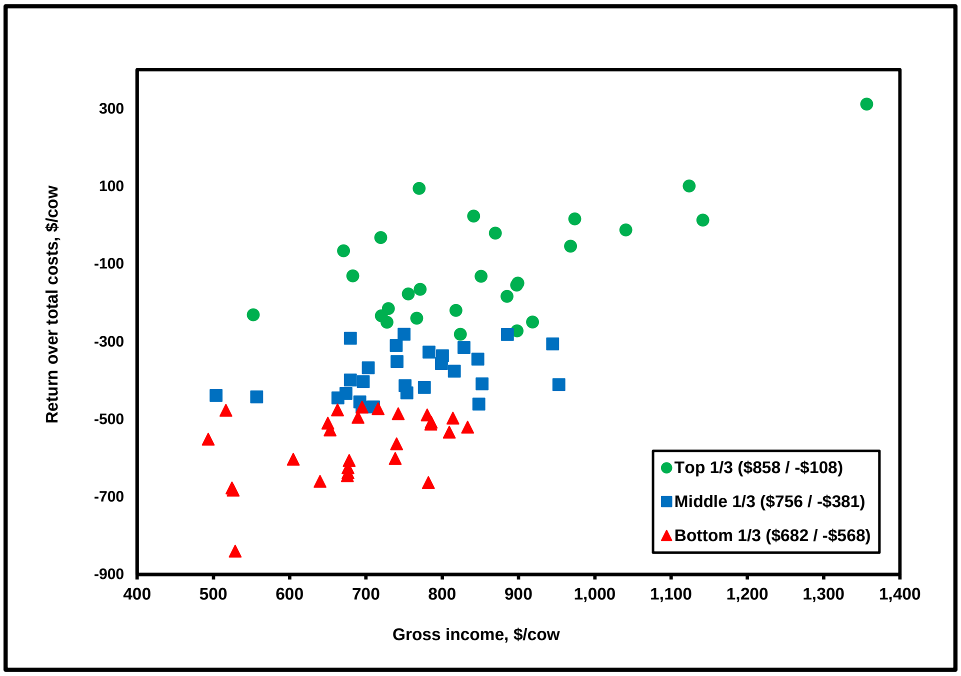

Figure A1. Profit vs. Gross Income (correlation = 0.67)

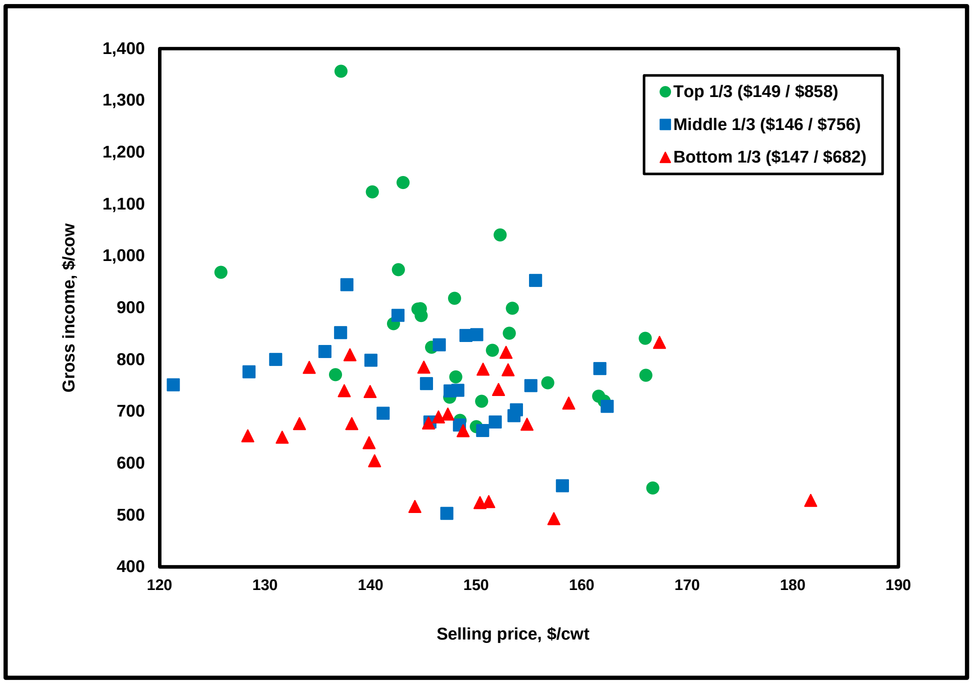

Figure A2. Gross Income vs. Selling Price (correlation = -0.24)

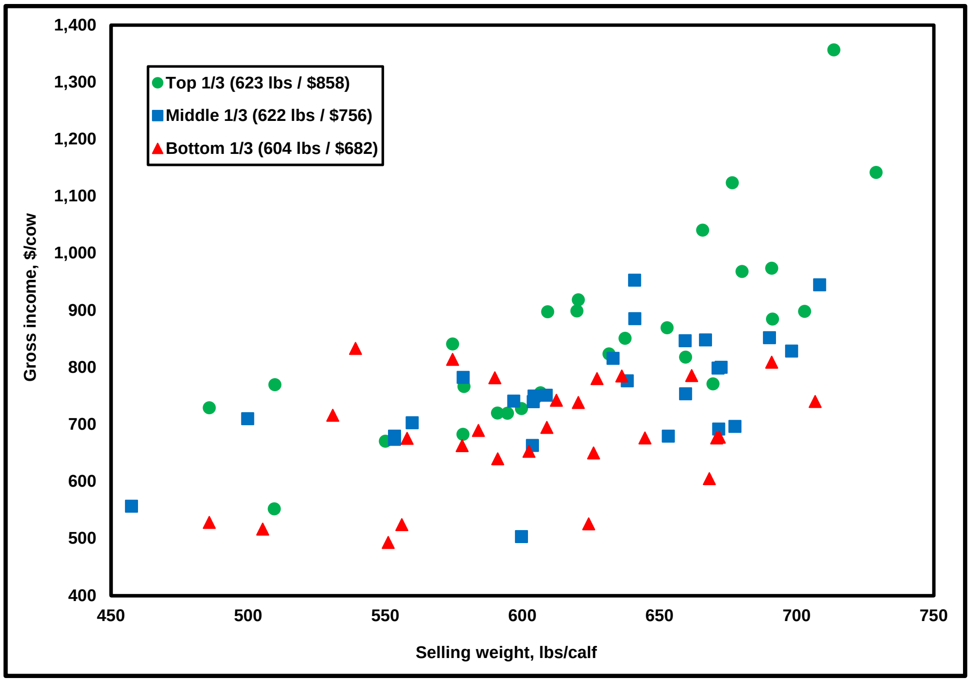

Figure A3. Gross Income vs. Calf Selling Weight (correlation = 0.59)

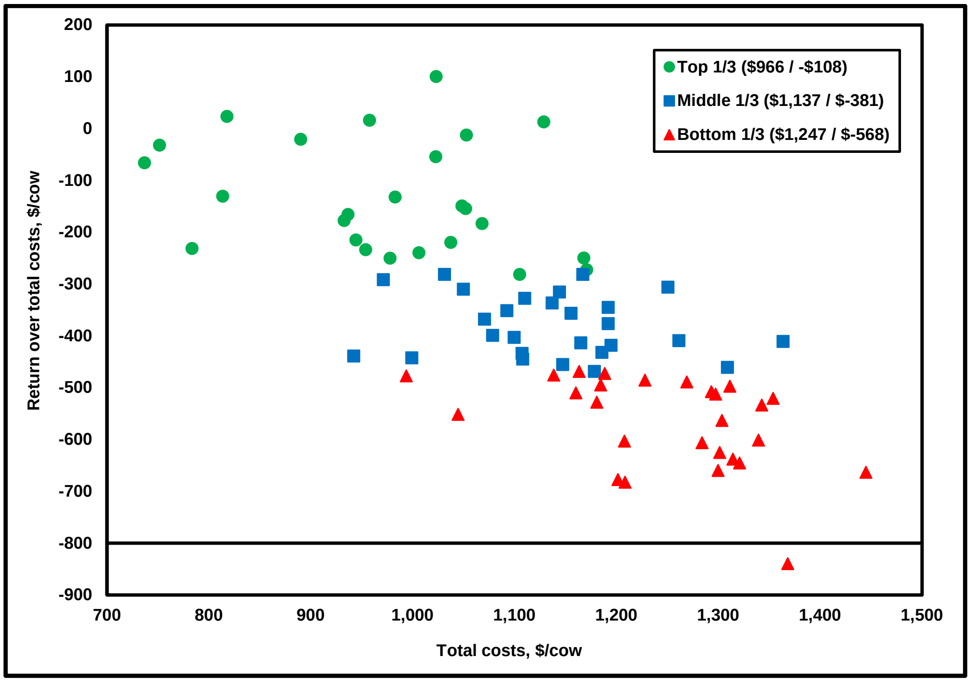

Figure A4. Profit vs. Total Costs (correlation = -0.74)

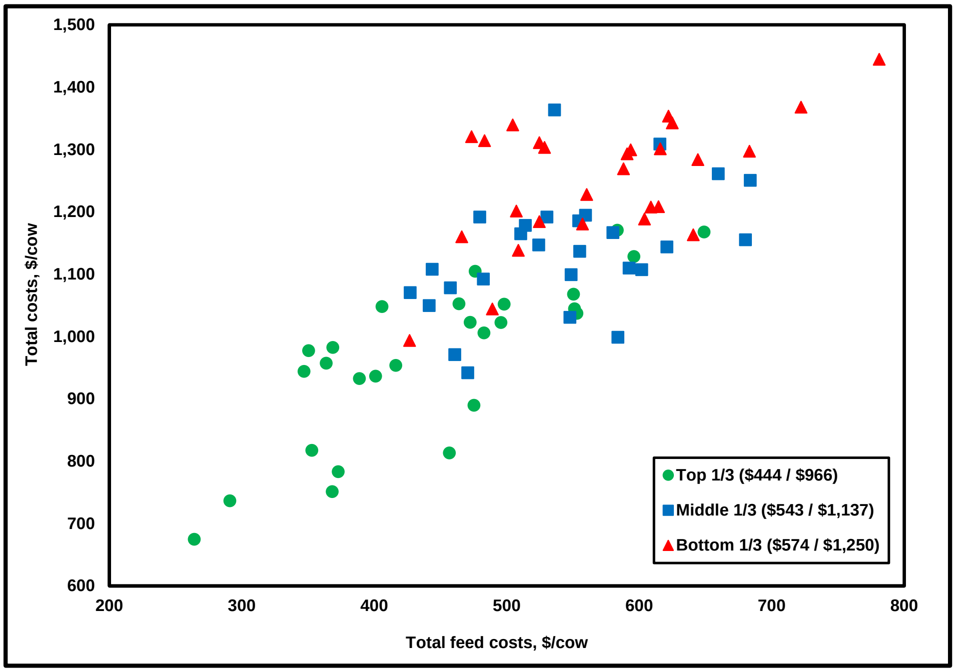

Figure A5. Total Costs vs. Total Feed Costs (correlation = 0.77)

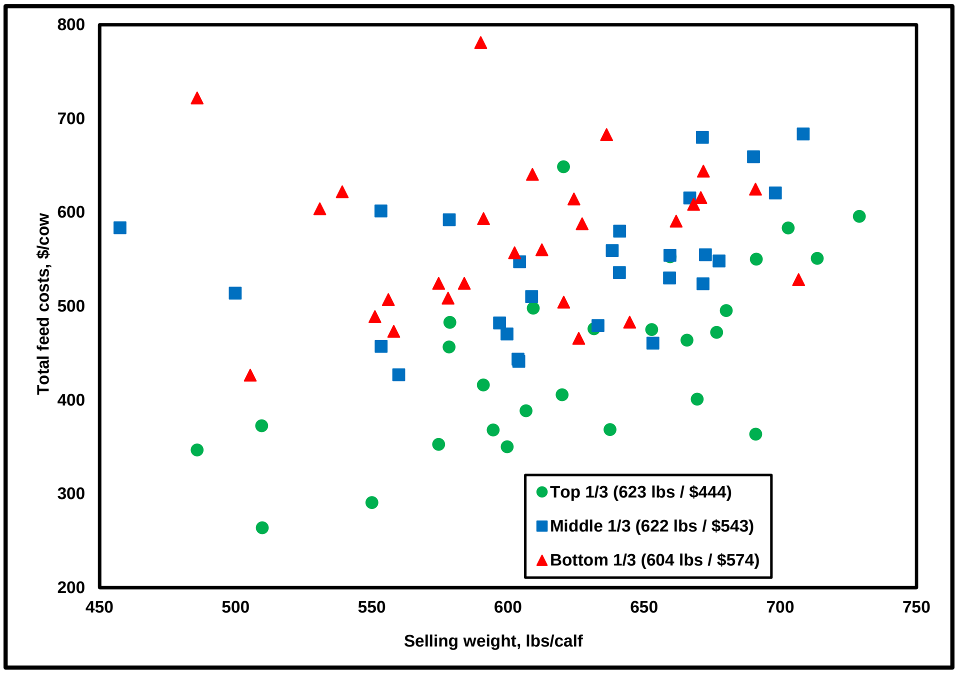

Figure A6. Total Feed Costs vs. Calf Selling Weight (correlation = 0.28)

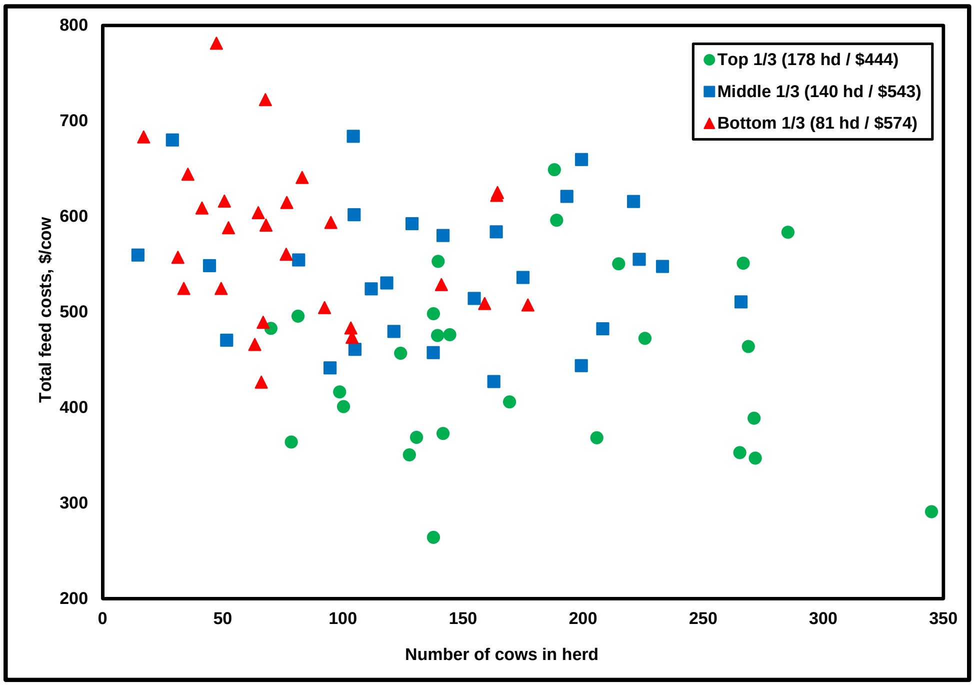

Figure A7. Total Feed Costs vs. Size of Cow Herd (correlation = -0.33)

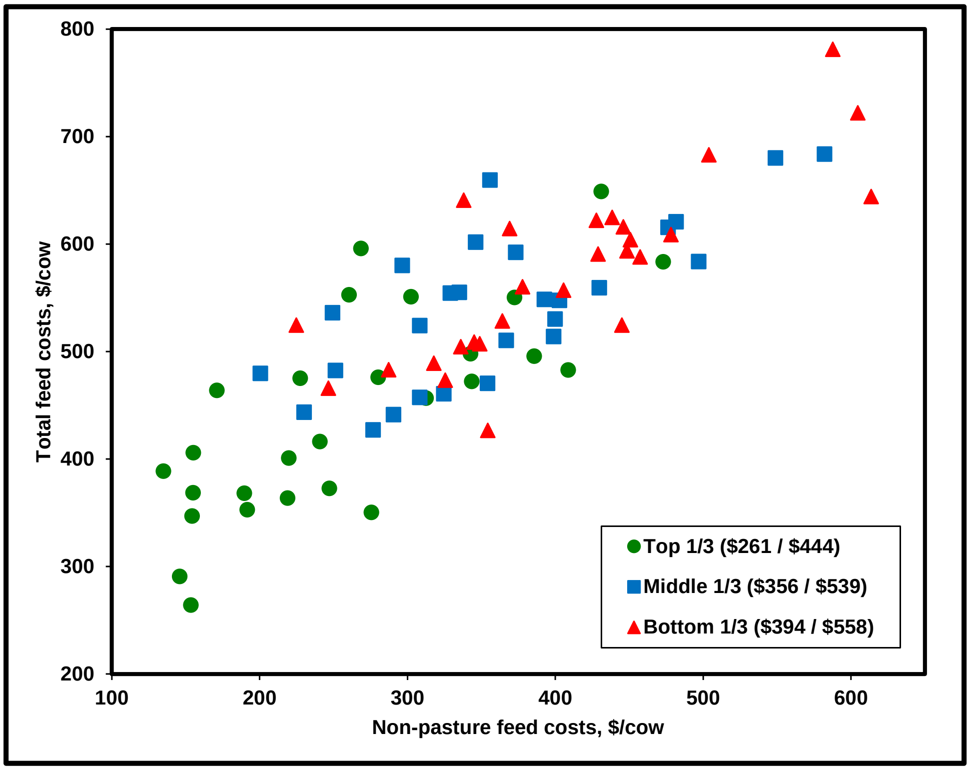

Figure A8. Total Feed Costs vs. Non-Pasture Feed Costs (correlation = 0.83)

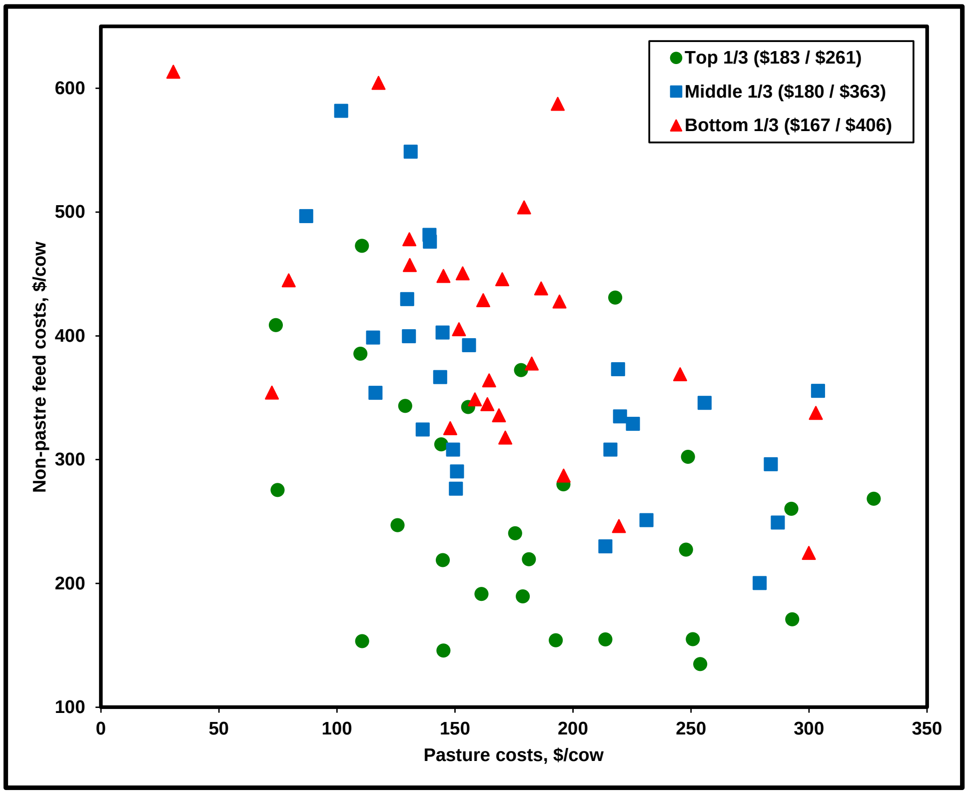

Figure A9. Non-Pasture Feed Costs vs. Pasture Costs (correlation = -0.47)

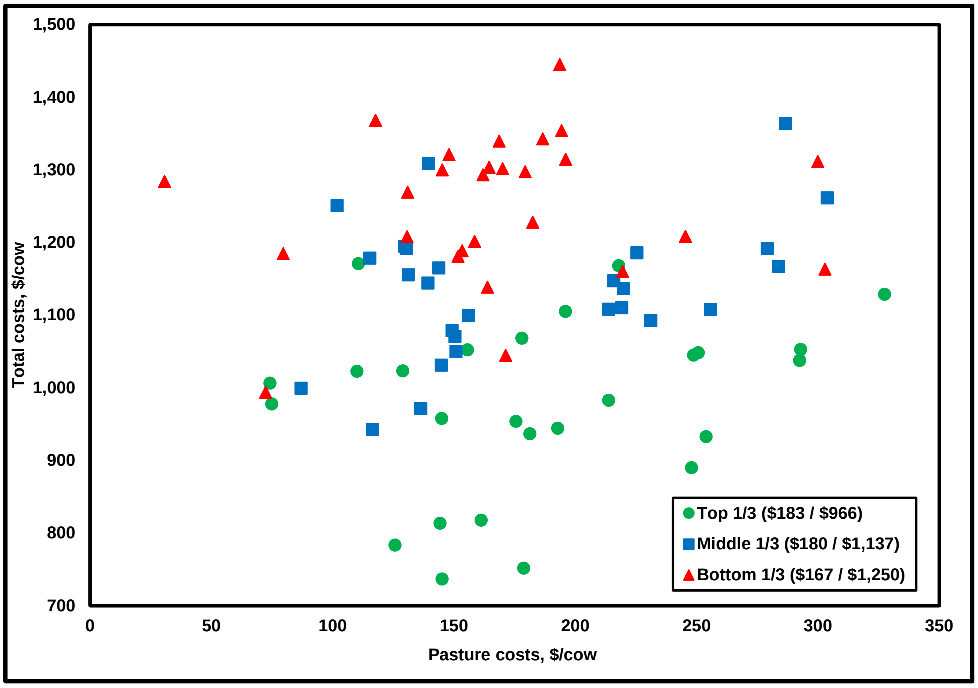

Figure A10. Total Costs vs. Pasture Costs (correlation = 0.12)

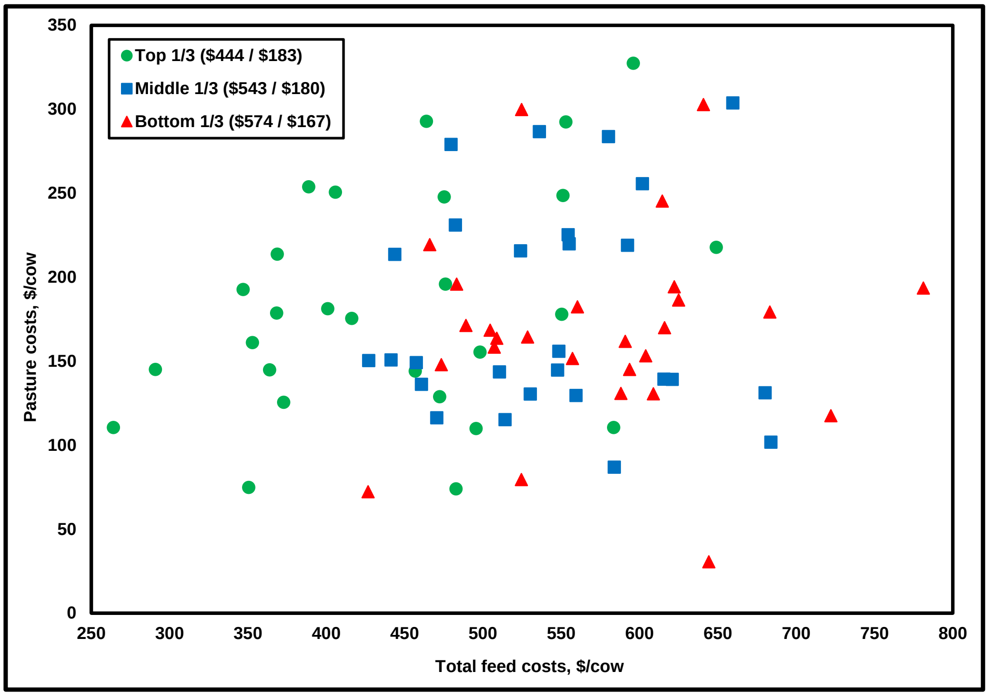

Figure A11. Pasture Costs vs. Total Feed Costs (correlation 0.09)

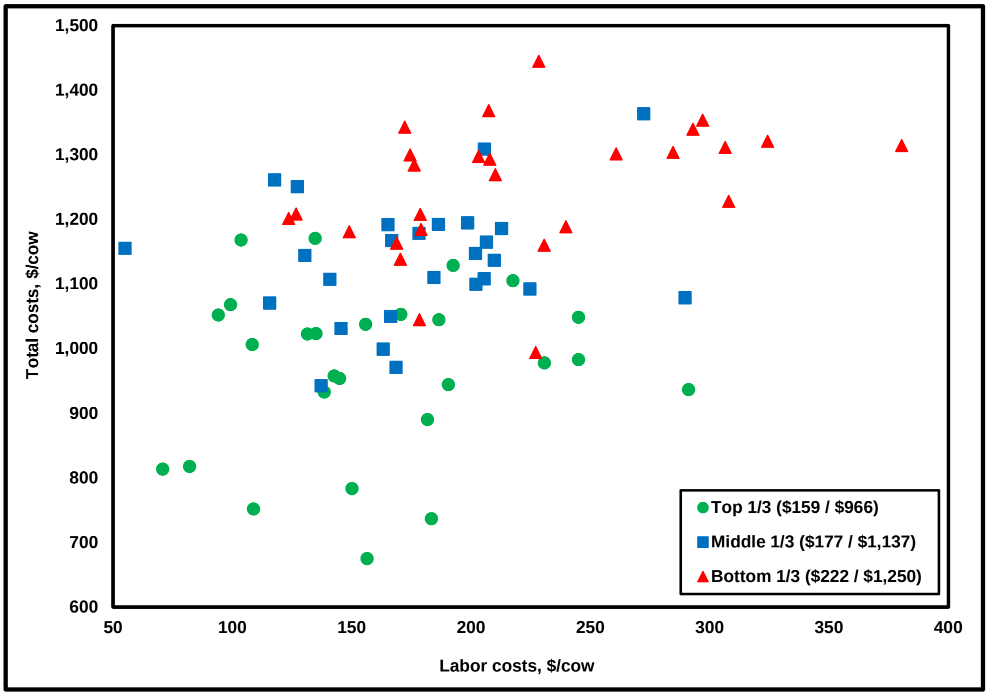

Figure A12. Total Costs vs. Labor Costs (correlation = 0.43)

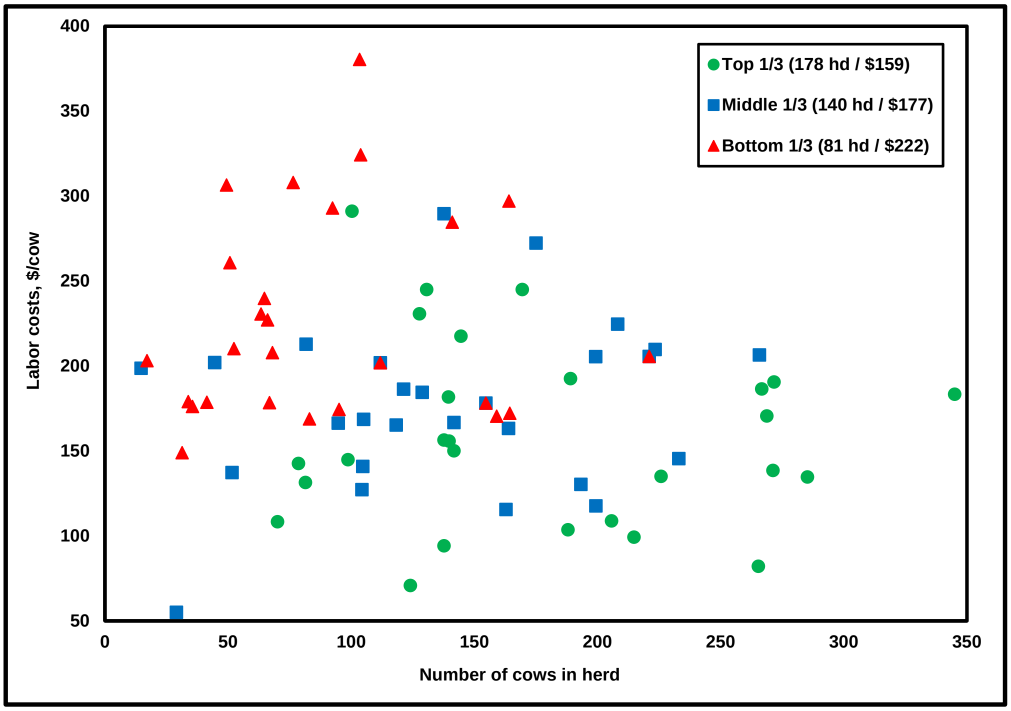

Figure A13. Labor Costs vs. Size of Cow Herd (correlation = -0.19)

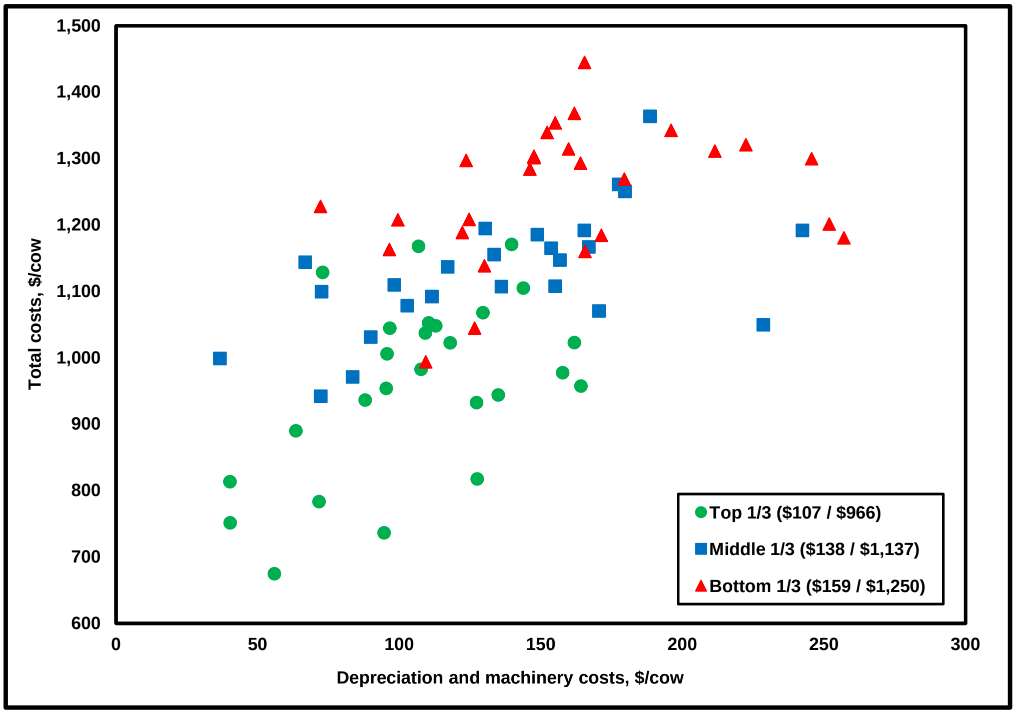

Figure A14. Total Costs vs. Depreciation and Machinery Costs (correlation = 0.60)

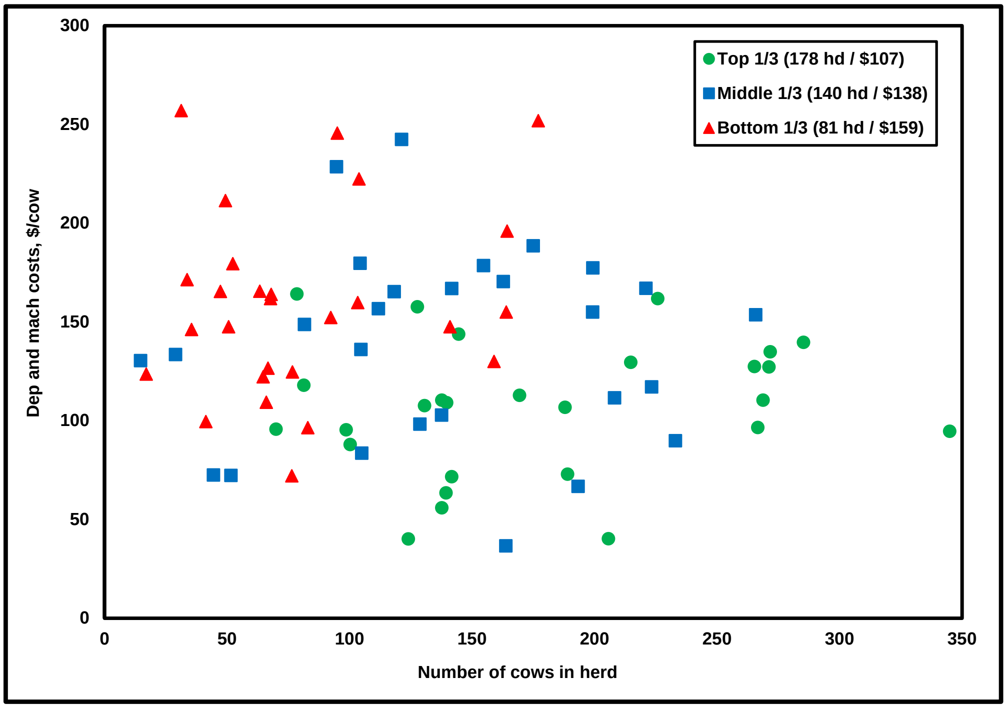

Figure A15. Depreciation and Machinery Costs vs. Size of Cow Herd (correlation = -0.15)

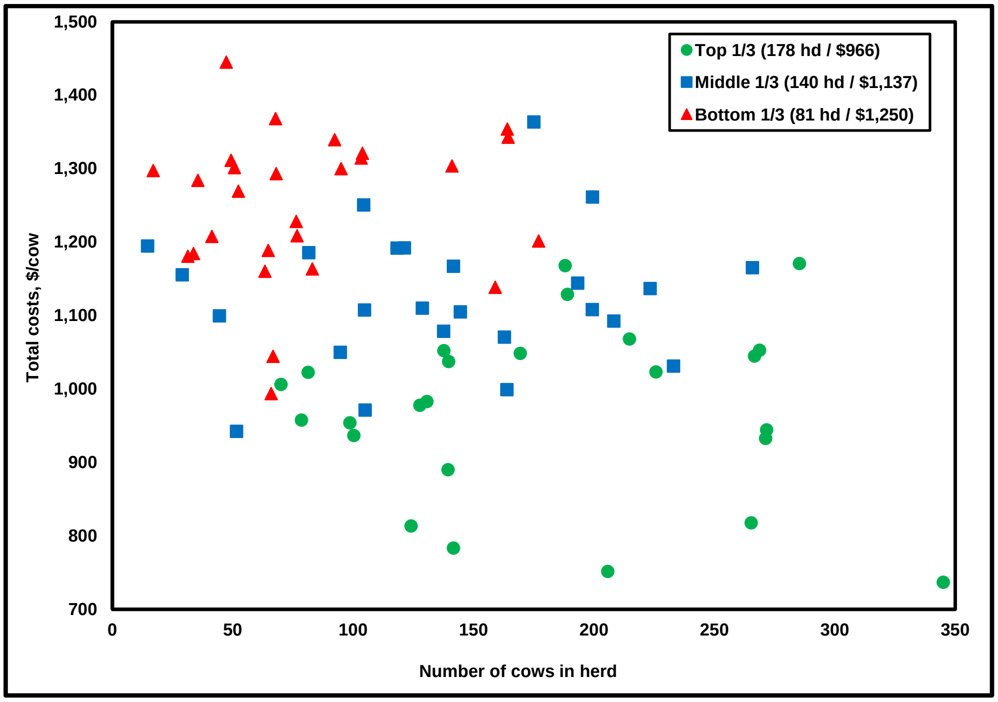

Figure A16. Total Costs vs. Size of Cow Herd (correlation = -0.35)

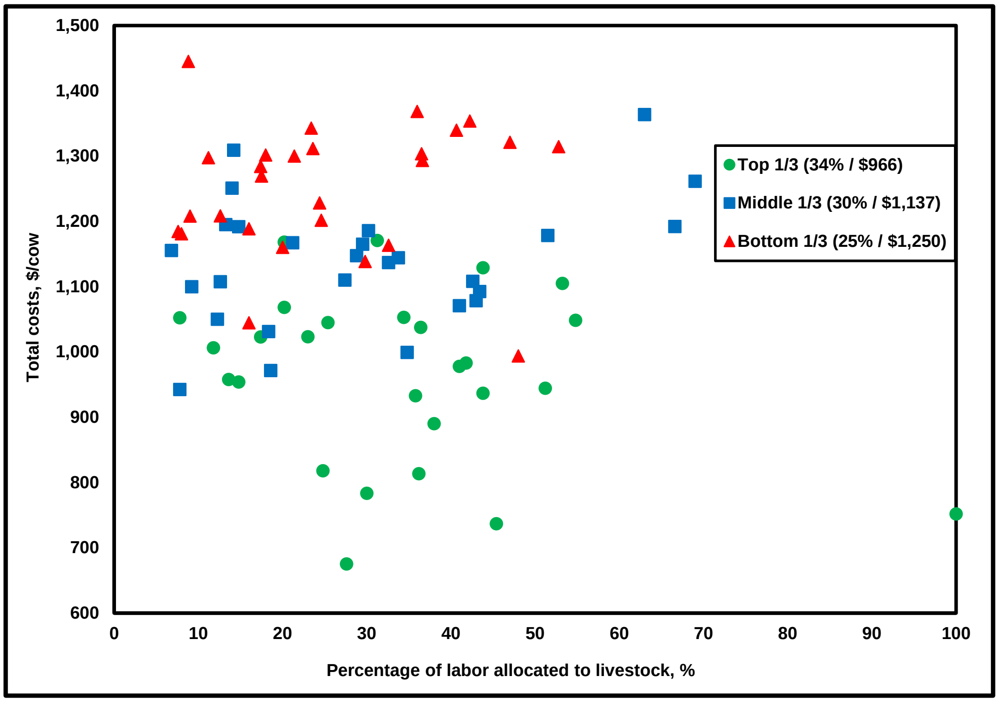

Figure A17. Total Costs vs. Labor Allocated to Livestock (correlation = -0.15)

K-State Agricultural Economics | 342 Waters Hall, Manhattan, KS 66506-4011 | (785) 532-1504 | fax: (785) 532-6925