AgFA Data Dive – Dairy Profitability by Herd Size, 2014-2016

June 2018, By Kevin Bernhardt

Introduction

Profitability of Wisconsin dairy farms for the years 2014, 2015, and 2016 was analyzed using the Agricultural Financial Advisor (AgFA) database from the Center for Dairy Profitability at the University of Wisconsin[1]. The objectives of the analysis included:

- Comparing profitability both across and within farms of different herd sizes.
- Evaluating the sources of profitability.
- Assessing not only the midpoint, but also the range of results.

The median will be used as a measure of central tendency versus average to avoid the effect of outliers. Percentiles around the median will measure the range of variability (Figure 1).

The AgFA database includes 251 dairy farms from 2014-16 resulting in 725 total observations. Farms were categorized into six groups based on the number of milking cows. Table 1 shows the categories, number of farms in each category, and number of observations in each category (each observation is a year).

Figure 1:
Statistical Measures

90th percentile

75th percentile

Median, 50th percentile

25th percentile

10th percentile

The median level of profitability increased as herd size increased. However, no matter the herd size, there was a range of profitability below and above the median level. Thus, regardless of herd size, and the economics at play in different sized farms, there is room for management to effect profitability.

Table 1: Description of Data

Herd Size (number of milking cows)	Number of Farms	Number of Observations
1-49	34	97
50-99	83	241
100-199	58	172
200-499	43	125
500-999	21	58
1,000 +	12	32

There is no such thing as a "normal" year in farming, but there are extremes. Figure 2 shows Class III prices for the 10 years including and preceding 2016. The ten-year average price was $16.80 (orange line). The three-year average for 2014-16 was $17.67, $.87 higher than the ten-year average. The gray-shaded area shows the years for this analysis.
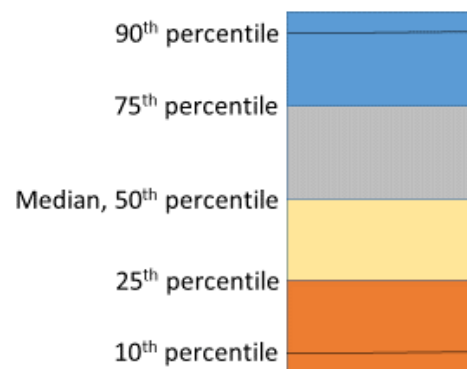
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[1] Additional information provided by the Center for Farm Financial Management database called FINBIN from the University of Minnesota.

Corroboration

Table 2 shows comparisons of selected measures from the Center for Dairy Profitability's AgFA database versus the FINBIN database from the Minnesota Center for Farm Financial Management. The FINBIN database included 1,333 Minnesota and Wisconsin farms for the same years, 2014-2016.

Assessing Profitability

Profitability can be measured by absolute dollars, percentage return on assets, return per cow, etc. The primary focus for this report will be a set of ratio measures that provide a means to map the sources of profitability and give insights where profitability is enhanced or where there are drags on profitability.

The map, known as the DuPont system for financial analysis (Figure 3), begins with the Return on Assets (ROA) profitability measure. Return on Assets results from two primary levers of profitability:

1. Utilization of assets to create gross revenues – measured by the Asset Turnover ratio (ATO).
2. Efficient use of expenses – measured by the Operating Profit Margin ratio (OPM).

The map can then be traced further back to see what is influencing ATO and OPM. A full analysis is beyond the scope of this report, but broad measures such as production, price, and cost of production are evaluated.

Figure 2: Class III Prices

Table 2:
Comparison of AgFA versus FINBIN Data

	Cost of Production			Milk per Cow			Milk Price		
	AgFA	FINBIN	Percent Difference	AgFA	FINBIN	Percent Difference	AgFA	FINBIN	Percent Difference
All Data	17.58	18.36	4.4%	22,627	21,713	-4.0%	17.97	17.73	-1.3%
1-49	18.30	21.46	17.3%	19,445	16,556	-14.9%	18.02	18.10	0.4%
50-99	17.62	18.58	5.4%	21,650	20,363	-5.9%	17.44	17.73	1.7%
100-199	17.56	18.12	3.2%	22,305	22,526	1.0%	17.86	17.63	-1.3%
200-499	17.40	18.09	4.0%	24,986	24,446	-2.2%	18.17	17.69	-2.6%
500-999 (AgFA)	16.67			26,916			18.52		
Over 500 (FINBIN)		17.94			27,058			17.9	

Figure 3:
Partial DuPont Map of Profitability

Profitability Results for 2014-2016

Table 3 shows median results overall and for each herd size category. Median profitability as measured by Return on Assets (ROA) increases as herd size increases from a median of 0.5% for 1-49 herd sizes to 6.8% for the 1,000 plus herd sizes. The average increase in median ROA from one herd size category to the next is 1.3%. The sources of profitability, asset utilization (measured by the Asset Turnover ratio, ATO) and cost efficiency (measured by the Operating
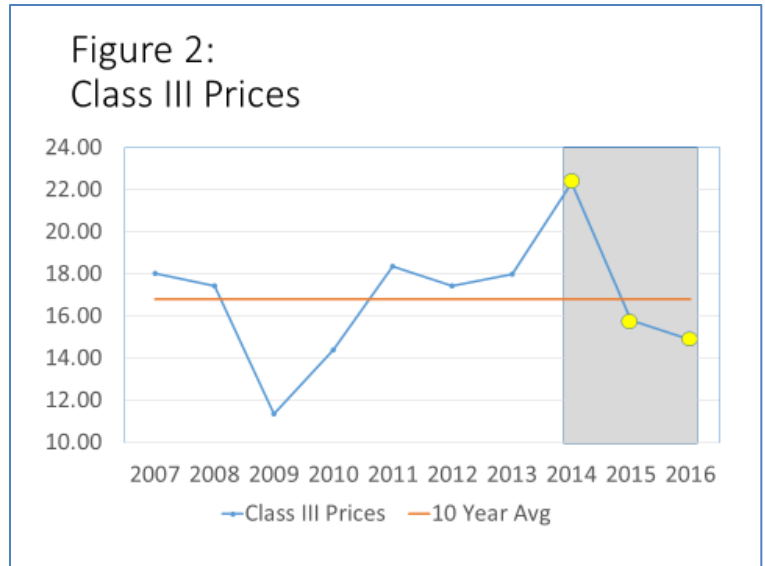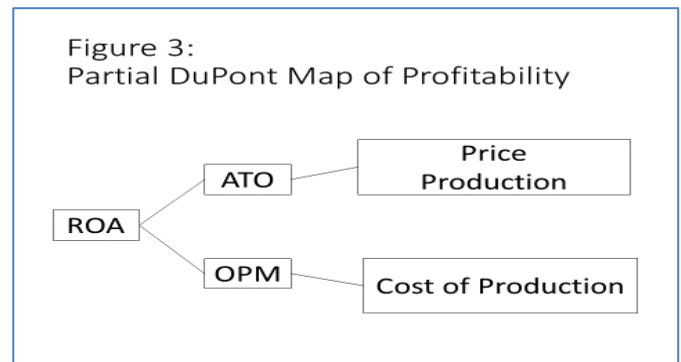
Profit Margin ratio, OPM), also increased as herd size increased. However, focus on the median alone does not tell the whole story.

First, Figure 4 shows a scatter plot of ROA for all farms and all years. The herd size categories are each a different colored dot. While there is a statistical median, there are certainly farms that fared much better or much worse than the median.

Second, Table 3 shows the percent ownership of assets by each herd size. Farms that own a relatively higher portion of assets would be expected to have a lower ROA because the denominator (total assets) is relatively higher than a farm that does not own a large share of assets and leases instead. As Table 3 shows ownership is much higher for the smaller herd sizes. Thus, the ROA difference is not as much when ownership is taken into account.

Third, and an important objective of this article, is that within each herd size there is variation in profitability as measured by ROA. Table 4 and Figure 5 show the variability in ROA in tabular and line diagram formats. Table 4 shows the median ROA for each herd size, but also shows percentile measures of variability around the median. The difference between the 90th and 10th percentile farm is 8.4% for 1-49 herd size farms and 15% for 1,000 plus herd sizes. Figure 5 is a visual of the values shown in Table 4. The gray line is the median with other colored lines representing percentiles around the median. The gray-shaded area is Return on Assets less than zero.

Table 3:
Median Profitability Results, 2014-2016

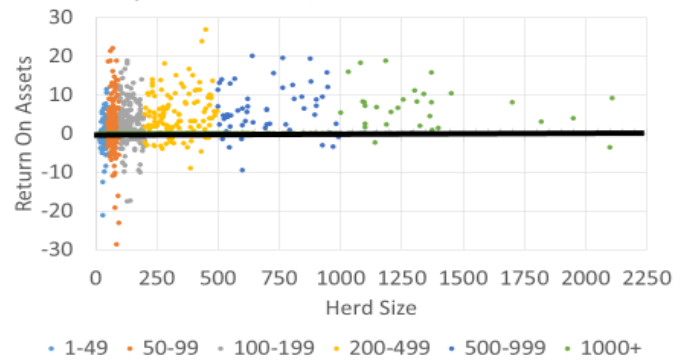| Herd Size	ROA	ATO	OPM	% Ownership of Assets
Overall	2.2%	27.3%	9.0%	
1-49	0.5%	15.7%	3.5%	84.4%
50-99	1.6%	19.7%	8.9%	74.5%
100-199	2.4%	27.8%	8.7%	54.4%
200-499	4.0%	43.2%	10.6%	40.9%
500-999	4.9%	49.3%	12.4%	38.0%
1,000 +	6.8%	48.7%	13.3%	37.8%

Figure 4:
ROA by Herd Size, 2014-2016

Table 4:
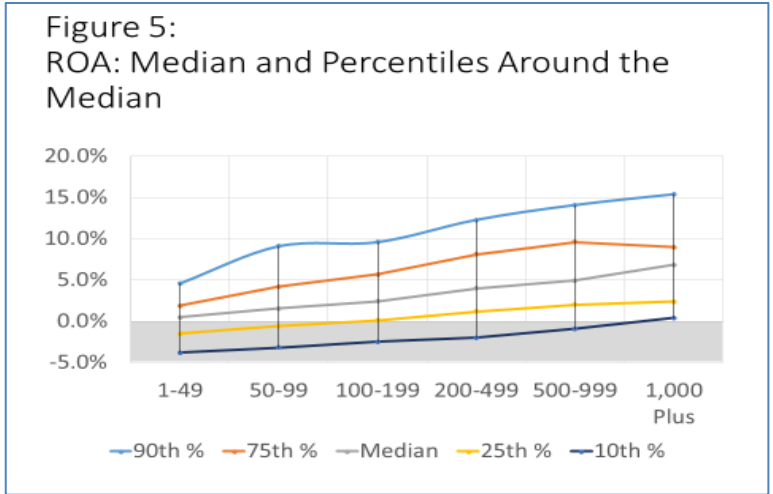## ROA, Median and Percentiles around the Median

Herd Size	90th	75th	Median	25th	10th	Difference 90th-10th
1-49	4.6%	1.9%	0.5%	-1.5%	-3.8%	8.4%
50-99	9.1%	4.2%	1.6%	-0.6%	-3.2%	12.3%
100-199	9.6%	5.7%	2.4%	0.1%	-2.5%	12.1%
200-499	12.3%	8.1%	4.0%	1.2%	-2.0%	14.3%
500-999	14.1%	9.6%	4.9%	2.0%	-0.9%	15.0%
1,000 +	15.4%	9.0%	6.8%	2.4%	0.4%	15.0%

One implications of these results is that opportunity exists regardless of herd size. For example, Table 4 shows that while the median for the 100-199 herd size farm is 2.4%, the top 90th percentile is getting 9.6% ROA. Just as the median increases with herd size, the variability around the median increases as well. Thus, a second implication is that there is greater opportunity and greater risk with larger herd sizes. Greater opportunity likely comes from economies of scale, ability to specialize, and capacity to utilize and afford certain technologies. However, "mistakes" cost more and there is not as much diversification to absorb hits, particularly cash flow hits.

Source of Profitability
Since there is a range of profitability, a next question is how one manages themselves to the top end of that range! The Asset Turnover (ATO) and Operating Profit Margin (OPM) ratios provide hints to where profitability is coming from or what may be a drag on profitability.

Figures 6 and 7 show graphs of ATO and OPM. The ATO ratio is gross revenues divided by total assets. It measures how well assets are worked to create gross revenues, the higher the better. For example, the 10th and 90th percentile for the 100-199 herd size is 16.3% and 59.4% respectively. For every dollar of assets,

Figure 5:
ROA: Median and Percentiles Around the Median

Figure 6:
ATO: Median and Percentiles

Figure 7:
OPM: Median and Percentiles

the 10th percentile farm is generating $.163 in gross revenues. For a farm with $1 million in total assets, that is $163,000 in gross revenues. ATO for the 90th percentile farm is 59.4 percent. Thus, the same $1 million in total assets creates $594,000 in gross revenues, a $431,000 increase for the same level of assets. Figure 6 shows that all herd sizes have a fairly wide range, 20% or more, with the middle herd sizes having the widest range.

The Asset Turnover Ratio can be improved with management that results in more gross revenues generated by the same level of assets or the same gross revenues generated from less assets. Potential management practices include:

Increasing the numerator (revenues) relative to the denominator (total assets):
- Increase productivity (mortality rates, conception, feed conversion, fertility and nutrition programs, health protocols, cow comfort, days in milk)
- Timeliness of operations
- Marketing and price premiums and discounts
- Assets whose poor condition is impacting productivity (poor ventilation, bedding, slippery floors, poor maintenance on machinery causing breakdowns)

Decreasing the denominator (total assets) relative to the numerator:
- Reduce unused or underutilize assets
- Leasing versus owning, custom hire, or asset sharing
- Land, buildings, equipment not fully used
- Enterprises that have assets associated with them, but are not creating "big enough" revenues (enterprise budgeting/accounting might be useful in this case)
- Reduce excess machinery capacity
- Eliminate obsolete or inefficient assets

The Operating Profit Margin (OPM) ratio (Figure 7) is profits divided by gross revenues. It is an efficiency measure that shows how much of each dollar of gross revenues being generated are kept after expenses are paid. For example, the 10th and 90th percentile level for the 100-199 herd size is -13.5% and 24.1% respectively. If gross revenues are $275 thousand then profits are -$37,125 and $66,275 respectively for the 10th and 90th percentile farm.

Again, a range exists for OPM at all herd sizes meaning management makes a difference. In this case, it is noteworthy that the range is greatest at the 1-49 herd size and decreases with each succeeding herd size. Thus, opportunity for efficiency management practices are important for all herd sizes, but particularly important for the smaller herd sizes. Any management that creates more profits with the same level of gross revenues or the same profits from less gross revenues will improve OPM and ultimately profitability. Potential practices include:
- Increasing yields per acre, per cow, etc. more than a corresponding increase in costs (feed waste, plant populations, plant maturity, pest control, animal health control, feed conversion)
- Reduce input costs: total, per acre, per cow, etc. (seed, fertilizer, feed, repairs, supplies, etc.)
- Labor (more production per laborer, maintain production with less labor, etc.)
- Training, incentive plans, communications, better procedures
- Negotiate more favorable rental arrangements
- Reducing costs through outsourcing possibilities, partnerships, alliances
- Increasing productivity via better quality facilities
- Preventative maintenance programs
- Adopting cost reducing technologies

Three primary factors that affect ATO and OPM are prices, production, and costs of production (Figures 8, 9, and 10). Prices received are a sum of the Class III base price, which is the same for everyone, and the additional basis paid by the milk plant for quality, quantity, components,

Producer Price Differential (PPD), and other premiums or discounts. If there is a price difference between farms, it is in one of the parts that make up the basis.

The median price (gray line in Figure 8) is fairly consistent (flat) across all herd sizes. More significant is the range of prices within each herd size. The upper end of the price range (75th and 90th percentiles) reflects the high price year, 2014 (see Figure 2), and organic dairies. However, it is noteworthy that for all herd sizes the average range of prices on just the lower end of the price range (10th percentile to median), is $2.07. To put that into perspective, for 100 cows producing 24,000 lbs., the spread of $2.07 is $49,680. Farm managers cannot change the Class III price, but at least some of the $2.07 difference of premiums/discounts is within the manager's control to change such as milk quality and marketing.

The median level of milk production per cow (Figure 9) increases by an average of 1,449 pounds per cow as herd size increases from one category to the next. However, each herd size had significant variation within. Across all herd sizes, the average difference between the 90th and 10th percentiles was 9,656 lbs. At a milk price of $17.00/cwt. this is $1,641 per cow. Table 5 shows a specific example based on 150 cows and the price and production values for the 100-199 herd size farms. Total revenues ranged from $459,297 at low production and low price to $691,048 for high production and high price. This accounts for a major part of the variation in the Asset Turnover ratio (ATO) seen in Figure 6 and ultimately on Return on Assets (Figure 5).
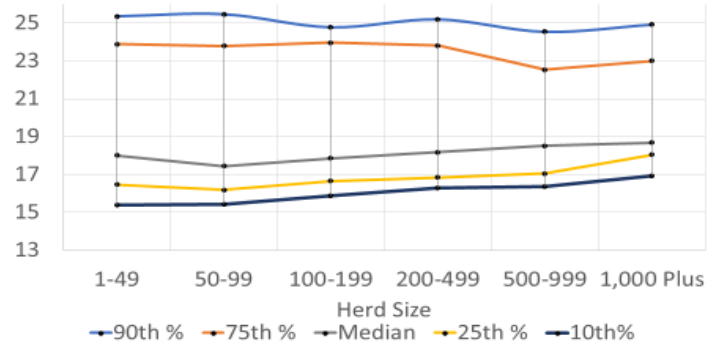

Figure 8:
Price: Median and Percentiles

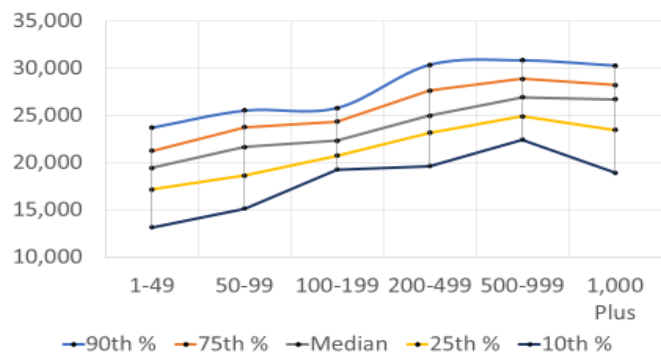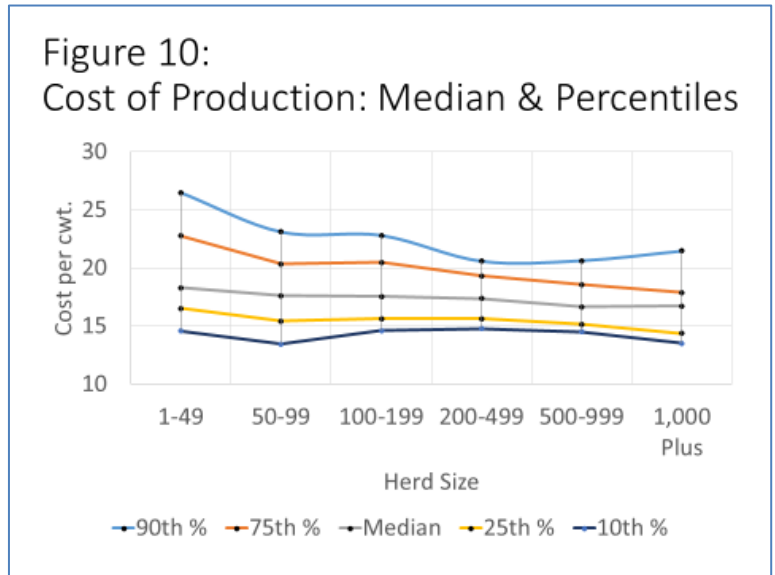Figure 9:
Milk per Cow: Median and Percentiles

Table 5:
Total Revenue for 150 Cows Based on Combinations of Price and Production for the 100-199 Herd Size

	10th Percentile Price ($15.88/cwt)	25th Percentile Price ($16.65/cwt)	Median Price ($17.86/cwt)
10th Percentile Production, 19,282 lbs	$459,297	$481,568	$516,565
25th Percentile Production, 20,745 lbs	$494,146	$518,106	$555,759
Median Production, 22,305 lbs.	$531,305	$557,067	$597,551
75th Percentile Production, 24,338 lbs	$579,731	$607,842	$652,015
90th Percentile Production, 25,795 lbs.	$614,437	$644,230	$691,048

Total Costs of Production[2] (Figure 10) generally decreased as herd size increased likely reflecting economies of scale, specialization and perhaps technology differences. However, the same story holds that there was variation and room for management within each herd size. The average difference in costs of production from the 90th to 10th percentile among all herd sizes is 8.27/cwt., a significant space for management to have an effect.

Figure 10: Cost of Production: Median & Percentiles

Efficiency as measured by the Operating Profit Margin ratio (OPM) is primarily affected by the difference between price per cwt. and costs of production per cwt. As has been seen, variation exists within each herd size on both price and costs of production. Figures 11 and 12 show two profit scenarios - low profit (high COP at 75th percentile and low price at 25th percentile) and high profit (low COP at 25th percentile and high price at median)[3]. In each case, price is the green line and costs of production the red line. If the green line is above the red line then the difference between the two is profits. If the red line is above the green line then the difference is losses.

Figure 11: Low Profit Scenario
High Costs: 75th Percentile Costs of Production
Low Price: 25th Percentile Price

Figure 12: High Profit Scenario
Low Costs: 25th Percentile Costs of Production,
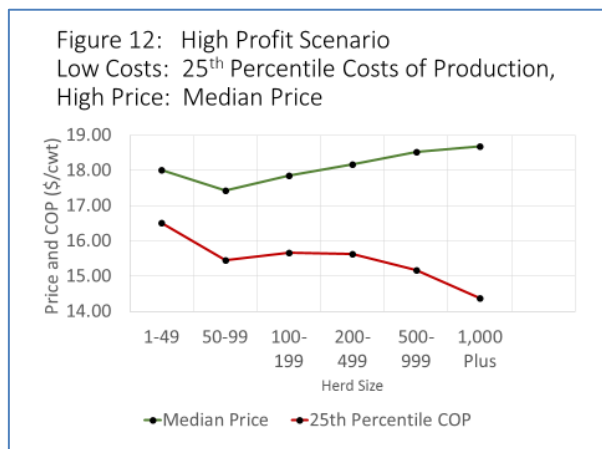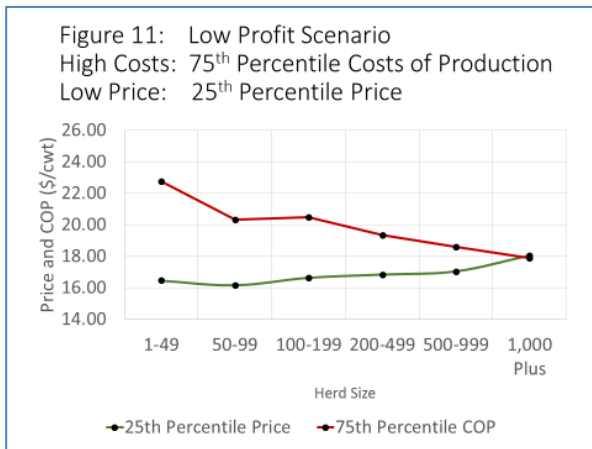High Price: Median Price

Table 6 shows the same information as Figures 11 and 12 for 150 cows based on the 100-199 herd size price and COP only. The values in the body of the table show the range of profitability based on revenues over total costs of production under different price and costs of production

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[2] Total Costs of Production (COP) include all cash expenses, accrual adjustments, depreciation, and unpaid labor & management.

[3] Median price was used for the high profit scenario because the higher 75th and 90th percentile prices likely reflect the high price year of 2014 versus a more average reflection of all three years.

scenarios. Management decisions that improve price or lower costs of production can make significant differences in profits and the ability to do so exists for all herd sizes.

Table 6: Profit Over Total Costs of Production (COP) Based on 150 Cows, 24,000 lbs./cow and the 100-199 Herd Size Price and COP Values for 2014-16

	Low Price (25th Percentile) ($16.65/cwt)	High Price (Median) ($17.86/cwt)
High Costs of Production (75th Percentile) $20.48/cwt	(137,880)	(94,320)
Median Costs of Production $17.56/cwt	(32,760)	10,800
Low Costs of Production (25th Percentile) $15.66/cwt	$35,640	79,200

Note: Total Costs of Production (COP) include all cash costs, depreciation, accrual adjusted expenses, and unpaid labor and management.

Conclusion

The debate on what herd size is best is an often-heard one. That debate includes sociological, environmental, and economic arguments that sometimes support each other and other times are at odds. That debate is useful in understanding economies of scales, specialization, technology adoption, and risk. However, the debate often left unsaid is that regardless of herd size, data show that opportunity exists to increase profitability and the opportunity is in management – increasing asset utilization, increasing efficiency of operations, and marketing. The variation in results tends to increase as herd size gets larger reflecting both the potential for greater opportunity and greater risk.

A human element (management) can get lost in the analysis of economic numbers. Universal management theory suggests that management is transferable. Perhaps in aggregate or at the executive level it is. However, for the farm business, the individual or relatively small farm management team, is involved in all aspects of production, cost containment, farm programs, risk management, and marketing. Thus, the ability, skills, and knowledge to manage a farm may not always be transferable to a different herd size operation any more than a manager can be just as effective managing a shoe store versus a tax preparation business. The production, management and economic challenges are different. Taking a profitable manager of a smaller herd size and placing them in a large-herd operation or visa versa may make both less successful because of their different abilities, skills, knowledge, and experiences. Perhaps the two are wired differently to be successful in different types of farm businesses. However, the 2014-2016 data show that both may have room to improve their management to effect greater profitability!