

Dairy Replacement Heifer Economics

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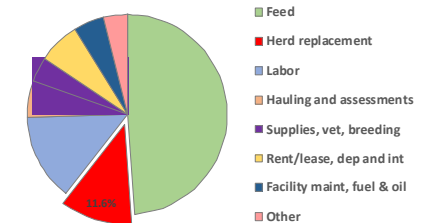
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Replacements are a major cost of milk production

Herd replacement is third largest of cost of milk production (feed and labor are top two costs)

Genske Mulder & Co, LLP -- Panhandle, 2016-18 Avg

Expense	\$/cow	% of total
Feed	\$1,892	48.8%
Herd replacement	451	11.6%
Labor	548	14.1%
Hauling and assessments	225	5.8%
Supplies, vet, breeding	159	4.1%
Rent/lease, dep and int	261	6.7%
Facility maint, fuel & oil	189	4.9%
Other	150	3.9%
Total	\$3,876	100.0%



Personal communication with partner of Genske, Mulder and Co., LLP

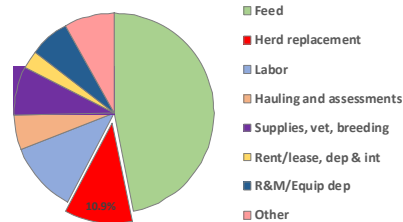
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Replacements are a major cost of milk production

Herd replacement is third largest of cost of milk production (feed and labor are top two costs)

Frazer, LLP -- Panhandle, 2016-18 Avg

Expense	\$/cow	% of total
Feed	\$1,632	46.8%
Herd replacement	380	10.9%
Labor	397	11.4%
Hauling and assessments	196	5.6%
Supplies, vet, breeding	274	7.9%
Rent/lease, dep & int	101	2.9%
R&M/Equip dep	225	6.5%
Other	281	8.1%
Total	\$3,487	100.0%



Frazer, LLP -- <https://frazerllp.com/>

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Factors impacting heifer replacement decisions

- Number of heifers needed annually
 - Herd replacement rate (static herd size)
 - Herd expansion plans (growth)
 - Heifer raising program (mortality, growth rates, etc.)
- Number of heifers produced annually
 - Reproduction program (pregnancies, type of semen, etc.)
- Costs of raising a heifer
 - Available alternatives (e.g., custom growers, purchase springers, etc.)
- Heifer market prices
 - Current vs long-run, at various stages of growth (calf → springer)
- Which heifers to sell, and which heifers to keep

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Number of heifers needed annually

1. Number of heifers needed annually

Factors determining the number of heifers needed annually*

Metric		Example herd
A. Herd turnover, %		37.0%
B. Culled by 14 months, %		10.0%
C. Culled after 14 months, %		5.0%
D. Heifers that conceive, %	(1 - B - C)	85.0%
E. Pregnant heifers that calve, %		95.0%
F. Heifers entering program that calve, %	D x E	80.8%
G. DOA risk of heifers		5.7%
H. Heifer births needed per cow in herd	(A/F) / (1-G)	48.6%
I. Heifers calving as pct of heifer births	A / H	76.1%

* Based on static herd size.

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Number of heifers needed annually

1. Number of heifers needed annually

Factors determining the number of heifers needed annually*

Metric		Example herd	47-hrd avg**
A. Herd turnover, %		37.0%	38.8%
B. Culled by 14 months, %		10.0%	9.9%
C. Culled after 14 months, %		5.0%	5.7%
D. Heifers that conceive, %	(1 - B - C)	85.0%	84.4%
E. Pregnant heifers that calve, %		95.0%	93.9%
F. Heifers entering program that calve, %	D x E	80.8%	79.2%
G. DOA risk of heifers		5.7%	5.7%
H. Heifer births needed per cow in herd	(A/F) / (1-G)	48.6%	52.3%
I. Heifers calving as pct of heifer births	A / H	76.1%	74.7%

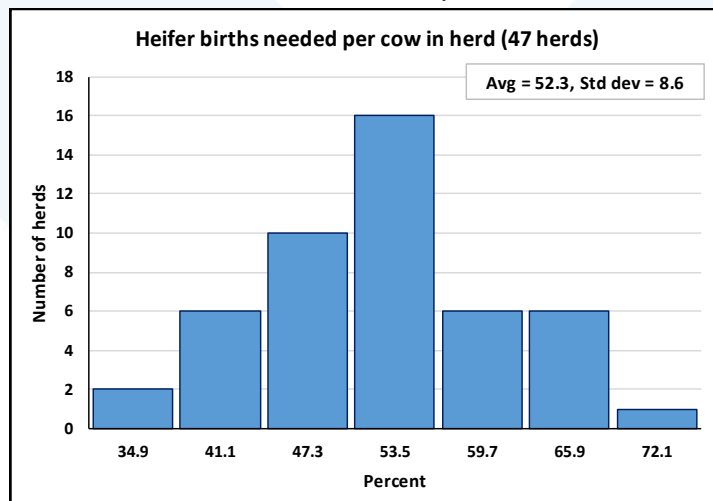
* Based on static herd size.

** Convenience sample of 47 herds on Elanco's DDAS for the year 2018.

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Heifers needed varies considerably across dairies

1. Number of heifers needed annually

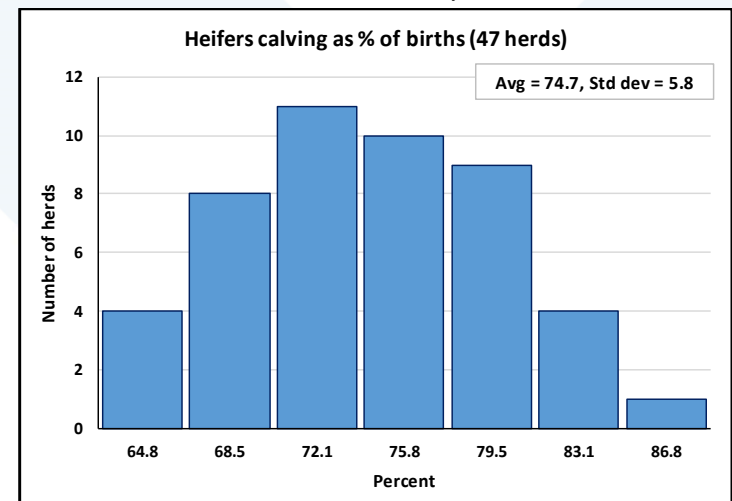


Based on data from a convenience sample of 47 herds on Elanco's DDAS for the year 2018.

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Heifers needed varies considerably across dairies

1. Number of heifers needed annually



Based on data from a convenience sample of 47 herds on Elanco's DDAS for the year 2018.

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Number of heifers needed – Example calculations

1. Number of heifers needed annually

Examples of the number of heifers needed annually

	Scenario			
	A	B	C	D
Herd size (milking and dry), hd	1,000	1,000	1,000	1,000
Milking, hd	890	890	890	890
Fresh events per cow in herd	1.15	1.15	1.15	1.15
Fresh events per year	1,150	1,150	1,150	1,150
Herd turnover, %	37.0%	37.0%	37.0%	42.0%
Herd growth, %	0.0%	5.0%	0.0%	0.0%
Cows removed = Heifers need to calve, hd	370	420	370	420
Heifers that conceive, %	85.0%	85.0%	80.0%	85.0%
Pregnant heifers that calve, %	95.0%	95.0%	90.0%	95.0%
Heifers entering program that calve, %	80.8%	80.8%	72.0%	80.8%
Heifers needed to enter program, hd	458	520	514	520
DOA risk of heifers, %	5.7%	5.7%	6.0%	5.0%
Number of heifer births needed, hd	486	552	547	547
Heifers that freshen as pct of heifer births, %	76.1%	76.1%	67.7%	76.7%

A lot of different factors determine how many heifer calf births are ultimately needed on an annual basis.

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Factors impacting heifer replacement decisions

1. Number of heifers needed annually

- Herd replacement rate (static herd size)
- Herd expansion plans (growth)
- Heifer raising program (mortality, growth rates, etc.)

2. Number of heifers produced annually

- Reproduction program (pregnancies, type of semen, etc.)

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Number of heifers produced – Example calculations

2. Number of heifers produced annually

Examples of the number of heifers needed annually

	Scenario				
	A	B	C	D	
Herd size (milking and dry), hd	1,000	1,000	1,000	1,000	
Fresh events per year	1,150	1,150	1,150	1,150	
Cows removed = Heifers need to calve, hd	370	420	370	420	
Heifers entering program that calve, %	80.8%	80.8%	72.0%	80.8%	
Heifers needed to enter program, hd	458	520	514	520	
DOA risk of heifers, %	5.7%	5.7%	6.0%	5.0%	
Number of heifer births needed, hd	486	552	547	547	
Conception rate by semen type	% female	Percent	Percent	Percent	Percent
Conventional, %	48.0%	100%	65%	35%	0%
Sexed, %	88.0%	0%	20%	35%	55%
Beef, %	0.0%	0%	15%	30%	45%
Heifers from conventional semen	552	359	193	0	
Heifers from sexed semen	0	202	354	557	
Total number of heifers	552	561	547	557	

There are many ways to achieve the required number of heifer calf births (or exceed it).

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Factors impacting heifer replacement decisions

1. Number of heifers needed annually

- Herd replacement rate (static herd size)
- Herd expansion plans (growth)
- Heifer raising program (mortality, growth rates, etc.)

Identifying the “best” strategy is complex, but knowing costs of raising a heifer by stage of production is an important starting point.

2. Number of heifers produced annually

- Reproduction program (pregnancies, type of semen, etc.)

Strategies regarding number of heifers to produce

- As many as possible, sell “excess” calves
- As many as possible, sell “excess” heifers/springers
- As many as possible, bring into herd (e.g., grow or replace cows)
- Only as many as needed
- None – purchase replacements
- Combination of several of the above

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Factors impacting heifer replacement decisions

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2. Number of heifers produced annually
 - Reproduction program (pregnancies, type of semen, etc.)
3. Costs of raising a heifer
 - Available alternatives (e.g., home raised, custom growers, etc.)

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A few important economic concepts...

- Variable vs. fixed costs
(economies of size (scale) is related to fixed cost)
- Short run vs. long run
- Cash vs. economic costs (P&I pmt vs depreciation)
- Price = cost (implies profit = \$0)
(on average, in the long run, in competitive industries)
- Marginal revenue > marginal cost
(decision rule for profit maximization)
- Partial budget vs. whole-farm analysis
- Time value of money
- Comparative advantage, revealed preference, time & wealth

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Economic concepts with actual data

Examples of historical dairy returns

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Historical returns to dairy operations

Generate a Summary Report

WHOLE FARM
CROP
LIVESTOCK

Generate a Benchmark Report

WHOLE FARM
CROP
LIVESTOCK

Compare Your Farm

FINANCIAL RATIOS

LIVESTOCK Benchmark Report

Livestock Enterprise: Dairy
Livestock Unit: Cow

Location

State: All States
Group: Southwest Minnesota Farm Business Management Association, Min State College & University South, Min State College & University North, Min State College & University Red River Valley, Wisconsin Technical College System

Filters

Years: 2016
Profitability Groups: All Levels
Profitability Measure: Net Return
Enterprise Size (COW): All Levels
Special Sort Items to Include: None Selected
Special Sort Items to Exclude: None Selected

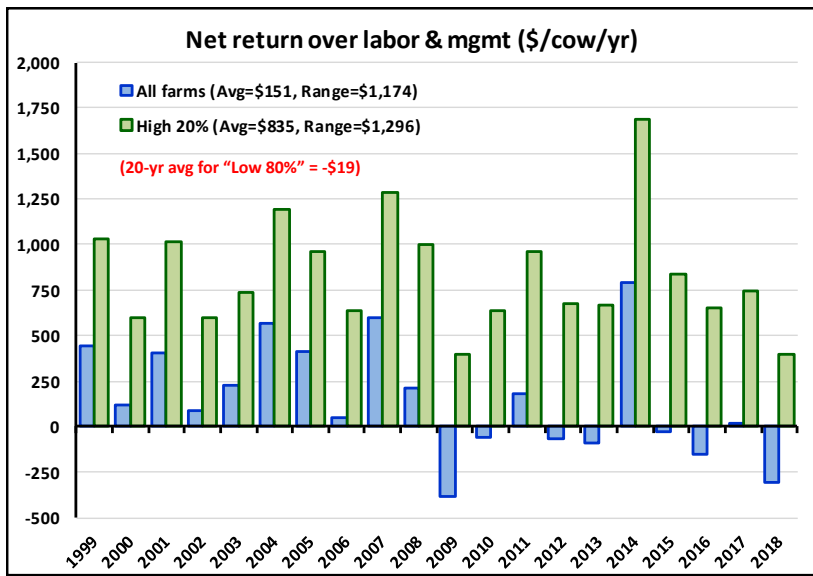
Generate Report

Benchmark reports for Dairy from 1999-2018 by profitability group.

High 20% vs All (by year)

<https://finbin.umn.edu/LvBenchOpts/LvBenchIndex>

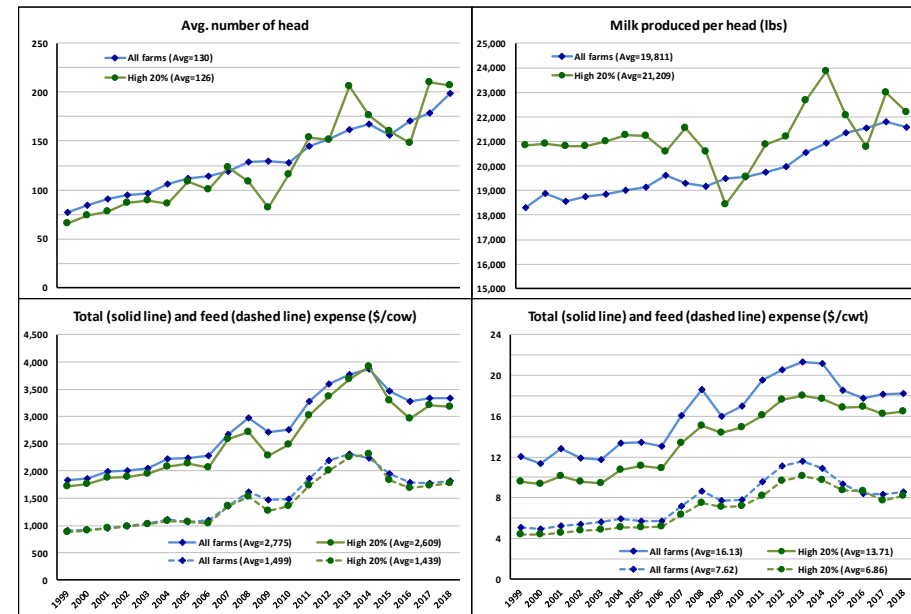
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Source: FINBIN Livestock Benchmark Report for Dairy (Cow); MN and WI Groups, Years 1999-2018, Various Profitability Groups. <https://finbin.umn.edu/LvBenchOpts/LvBenchIndex> accessed 8/23/19.

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Dairies in Top 20% similar size, considerably more productive and have lower costs per cow and per/cwt



Source: FINBIN Livestock Benchmark Report for Dairy (Cow); MN and WI Groups, Years 2007-2016, Various Profitability Groups. <https://finbin.umn.edu/LvBenchOpts/LvBenchIndex> accessed 8/23/19.

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Historical returns to dairy operations

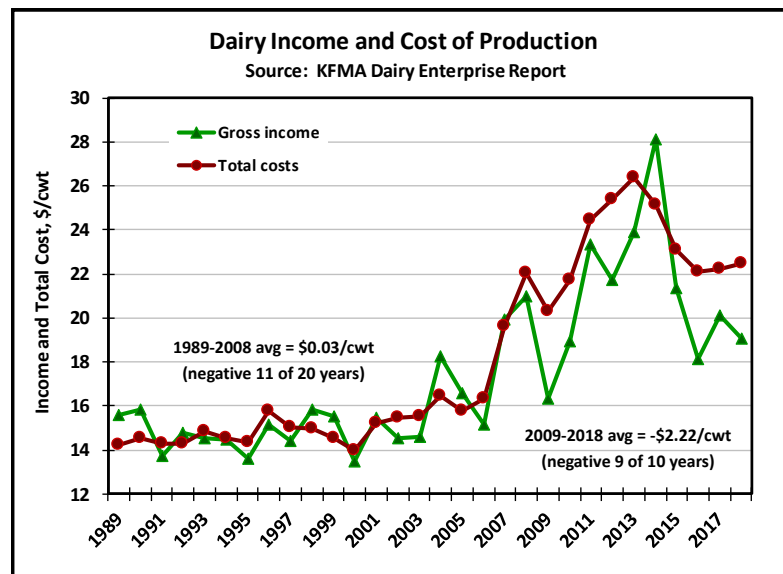
2018 Enterprise Summary Dairy Cows State

2018 Data - Kansas		2017		2016	
Enterprise Summary		Enterprise Summary		Enterprise Summary	
DAIRY COWS		DAIRY COWS		DAIRY COWS	
	2018	2017	2018	2017	2016
Number of Farms	10	10	11	11	11
Number of Cows	22,047	22,047	22,047	22,047	22,047
Number of Milk Cows	22,047	22,047	22,047	22,047	22,047
Milk Production (cwt)	4,833,833	4,833,833	4,833,833	4,833,833	4,833,833
State Income / Cow	5,130.21	5,130.21	5,130.21	5,130.21	5,130.21
Feed Cost / Cow	2,287.27	2,287.27	2,287.27	2,287.27	2,287.27
Non-Feed Cost / Cow	1,215.45	1,215.45	1,215.45	1,215.45	1,215.45
State Income / CWT Milk	2.42	2.42	2.42	2.42	2.42
Feed Cost / CWT Milk	1.12	1.12	1.12	1.12	1.12
Non-Feed Cost / CWT Milk	0.57	0.57	0.57	0.57	0.57

Annual Dairy Enterprise Reports covering years 1989-2018

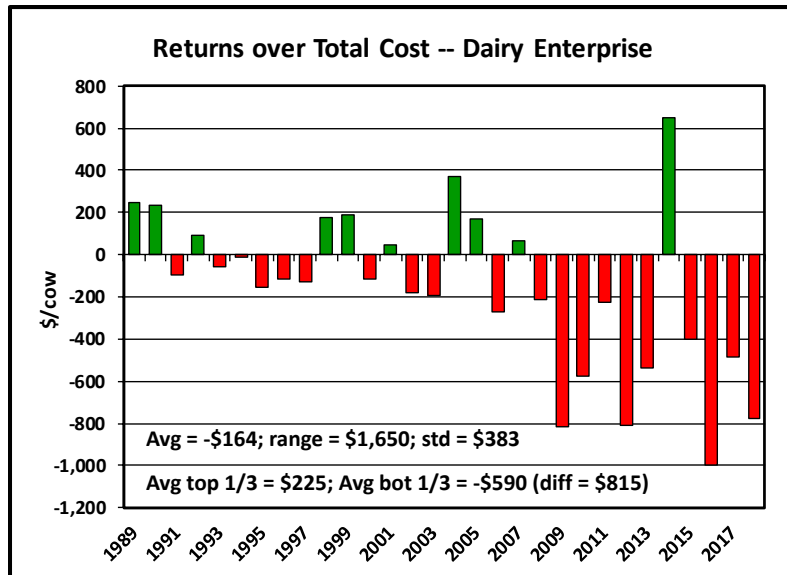
Reports from 1995-2018 available at <https://agmanager.info/kfma>

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Kansas Farm Management Association (KFMA) Enterprise Summaries for years 1995-2018 available at <https://agmanager.info/kfma>. Accessed 6-18-2019.

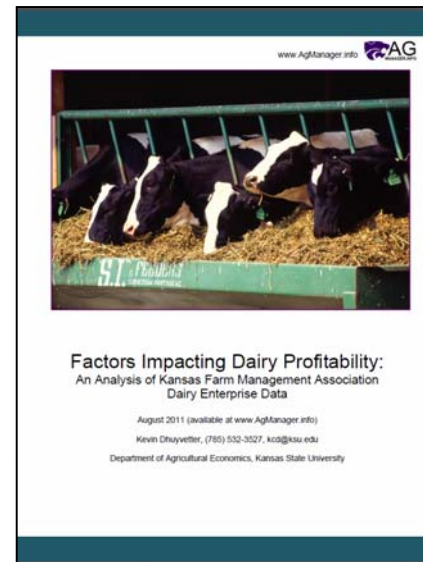
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Source: Kansas Farm Management Association (KFMA) Enterprise Report (various years) available at <http://agmanager.info/kfma>. Accessed 6-18-2017.

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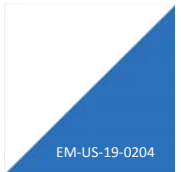
Historical returns to dairy operations



Available at <http://www.agmanager.info/node/7139>. Accessed 28 Dec 2016

Analysis of 2005-2010 Kansas Farm Management Association Enterprise Reports

Comparison by profit category based on individual farms multi-year average (high, mid, and low thirds)



Dairy enterprise measures among high, medium, and low profit groups (\$/cow)*

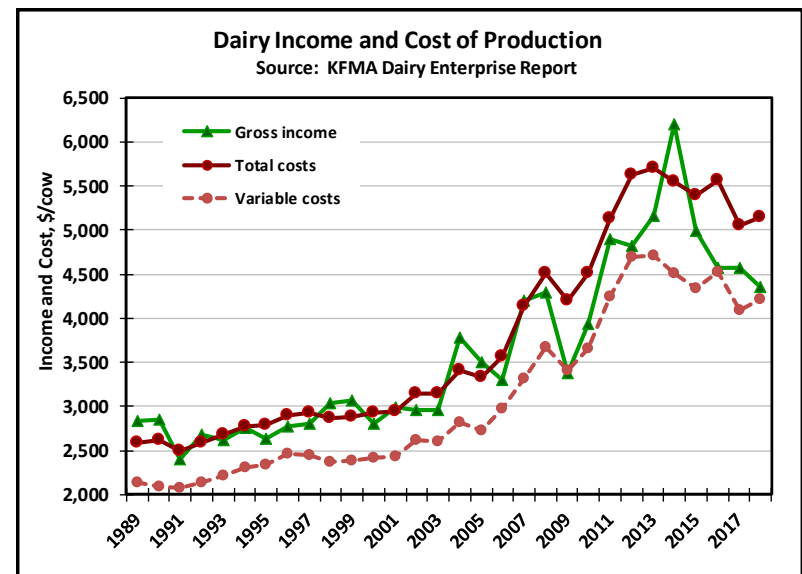
Item	All Farms	Profit Category			Diff. between High 1/3 & Low 1/3	
		High 1/3	Mid 1/3	Low 1/3	Absolute	%
Number of Farms	38	13	12	13		
Number of Cows in Herd	114	133	120	90	44	49%
Cull rate, %	26.0	24.27	30.78	23.44	0.83	4%
Pounds of milk/cow	20,326	22,788	19,655	18,482	4,307	23%
Milk price, \$/cwt	\$16.29	\$16.36	\$16.39	\$16.15	\$0.21	1%
Milk sales, \$/cow	3,292	3,720	3,206	2,944	776	26%
Other income, \$/cow	321	400	285	277	123	44%
Gross Income	\$3,613	\$4,119	\$3,491	\$3,220	\$899	28%
Feed	\$1,888	\$1,956	\$1,839	\$1,864	\$92	5%
Labor	652	555	636	765	-210	-27%
Vet	110	129	93	108	20	19%
Dairy supplies	292	320	265	288	32	11%
Other	1,022	988	958	1,116	-128	-11%
Total Cost	\$3,964	\$3,948	\$3,790	\$4,142	-\$194	-5%
Net Return to Management	-\$351	\$172	-\$300	-\$922	\$1,094	

* Sorted by Net Return to Management (Returns over Total Costs) per Cow (min of 4 years of 2005-2010)

Compared to \$815 between high/low years (82% income and 18% cost)

Dhuyvetter, K. 2011. Factors Impacting Dairy Profitability: An Analysis of Kansas Farm Management Association Dairy Enterprise Data." Kansas State Department of Agricultural Economics Report. August 2011

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Kansas Farm Management Association (KFMA) Enterprise Summaries for years 1995-2018 available at <http://agmanager.info/kfma>. Accessed 6-18-2019.

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Historical returns summary

- When examining information, it is important to understand how costs are defined
- If fixed costs are excluded from analysis, results will show less advantage to size of operation
- Non-cash costs (e.g., management, depreciation, etc.) are typically “fixed”
- Opportunity costs (e.g., market value of feed, labor, etc.) are important to consider when analyzing enterprises
- Excluding non-cash costs in the short run for decision making is okay, but remember this is not sustainable in the long run

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Estimating the cost per heifer raised

Assumptions used in the model:

- Newborn heifer value, \$/hd 100
- Birth weight, lb/hd 88
- Breeding weight, lb/hd 884
(57% of mature weight & 51” WH)
- Labor, \$/hr 15.00
- Interest, % 6.0
- AI cost, \$/service 18.00
- Large dairy using hutches, 100% milk replacer, indoor housing, and TMR feeding
- Percent of heifers ultimately calving 86.2%
(due to mortality of 7.3% and 6.5% repro culls)

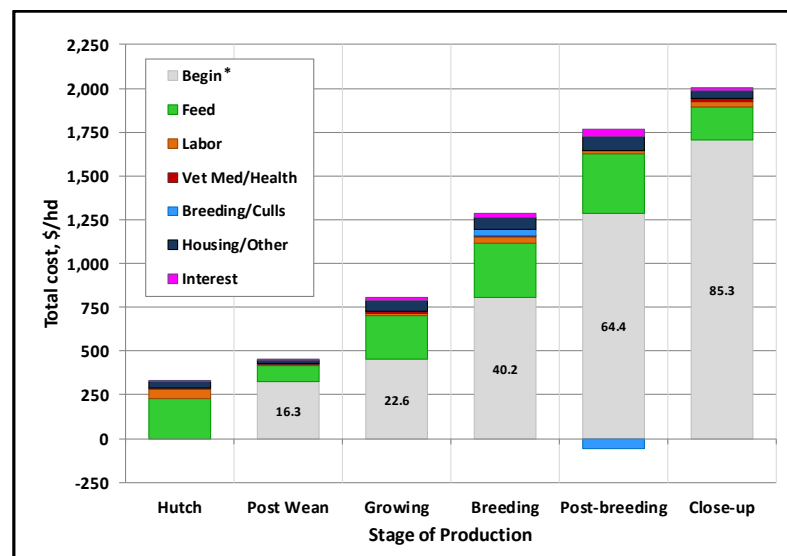
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Cost of raising a heifer -- Baseline

Stage of Production Age in months	Baseline						
	Hutch Birth to 2	Post Wean 2 to 4	Growing 4 to 10	Breeding 10.0-15.7	Post-breeding 15.7-21.4	Close-up 21.4-23.4	Total Birth - 23.4
Colostrum Milk*	182.11						
Starter*	20.19						
Grain*		74.49					
Hay*		5.67					
Feed (TMR)*			231.01	287.74	338.43	185.37	
Total Feed*	\$202.31	\$80.16	\$231.01	\$287.74	\$338.43	\$185.37	\$1,402
Labor*	47.92	10.49	12.29	33.43	14.43	31.12	\$160
Vet Med/ Health*	10.22	2.36	8.03	2.89	2.65	16.15	\$45
Breeding & Culls*	0.00	0.00	0.00	35.87	-57.90	0.00	-\$19
Housing and Other*	29.31	18.26	56.09	61.12	79.55	44.30	\$304
Interest*	1.39	3.47	16.68	26.28	39.42	17.12	\$109
Total Cost*	\$291	\$411	\$740	\$1,191	\$1,701	\$2,001	\$2,001
Cost/ Day*	\$4.85	\$1.86	\$1.77	\$2.57	\$2.43	\$4.83	\$2.81
Entering Weight (lbs)	85	192	325	702	1,037	1,341	85
Exit Weight (lbs)	192	325	702	1,037	1,341	1,443	1,443
Average daily gain (lbs)	1.78	2.17	2.06	1.92	1.77	1.68	
Cumulative ADG (lbs)	1.78	1.97	2.03	1.99	1.93	1.91	1.91
Cumulative from birth							
Total Cost*	\$291	\$411	\$740	\$1,191	\$1,701	\$2,001	\$2,001
Cost/ Day*	\$4.85	\$3.38	\$2.43	\$2.49	\$2.62	\$2.81	\$2.81
Cost Including Wet Calf*	\$396	\$519	\$852	\$1,307	\$1,829	\$2,131	\$2,131

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Baseline cost of raising a heifer



* Values in gray bars represents the percent of total costs incurred up to that stage of production (e.g., 64.4% of the total cost of raising a heifer is incurred through breeding stage).

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Sensitivity analysis of total cost of raising a heifer

		Feed Cost Adjustment				
		-25%	-10%	0%	10%	25%
Calf price, \$/head	\$50	1,754	1,941	2,066	2,191	2,378
	\$75	1,786	1,974	2,098	2,223	2,411
	\$100	1,819	2,006	2,131	2,256	2,443
	\$150	1,884	2,071	2,196	2,321	2,508
	\$200	1,949	2,136	2,261	2,386	2,573

At a calf price of \$100/head, total cost varies by \$624/head as feed costs vary by +/- 25%.

How are home-raised feedstuffs valued?

		Labor cost, \$/hr				
		\$9	\$12	\$15	\$18	\$21
Housing adjustment, %	25%	\$1,805	\$1,842	\$1,878	\$1,915	\$1,952
	50%	\$1,881	\$1,918	\$1,954	\$1,991	\$2,028
	75%	\$1,965	\$2,002	\$2,039	\$2,075	\$2,112
	100%	\$2,058	\$2,094	\$2,131	\$2,168	\$2,204
	125%	\$2,158	\$2,195	\$2,232	\$2,268	\$2,305

At a labor cost of \$15/hr, total cost varies by \$353/head as housing cost assumption varies.

If fixed and/or non-cash costs are excluded, is this appropriate?

		Housing Type		
		Drylot	Indoor housing	Pasture
Facility Type	Calf Ranch	\$1,865	\$2,095	\$1,843
	Large Dairy	\$1,901	\$2,131	\$1,880
	Small Dairy	\$2,169	\$2,399	\$2,148

Cost varies by \$556/head depending upon facility & housing type (and related assumptions).

How are fixed costs of facilities and equipment handled?

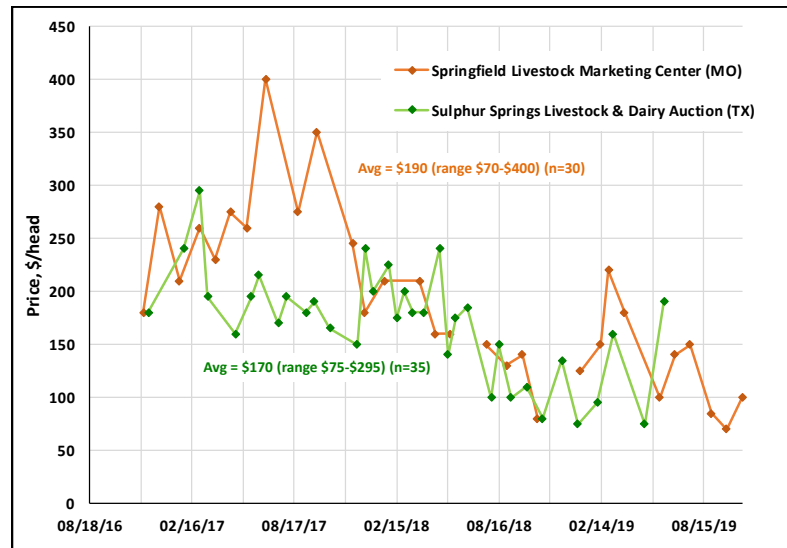
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- Heifer market prices
 - Current vs long-run, at various stages of growth (calf → springer)

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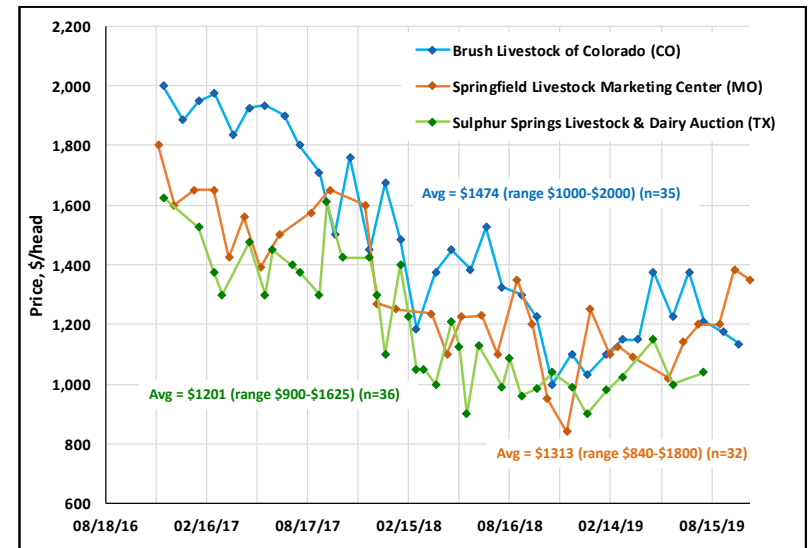
Price of heifer calves*



* Source: Compiled from Progressive Dairy Market Watch (<https://www.progressivedairy.com/magazine>) last accessed on 12/10/19

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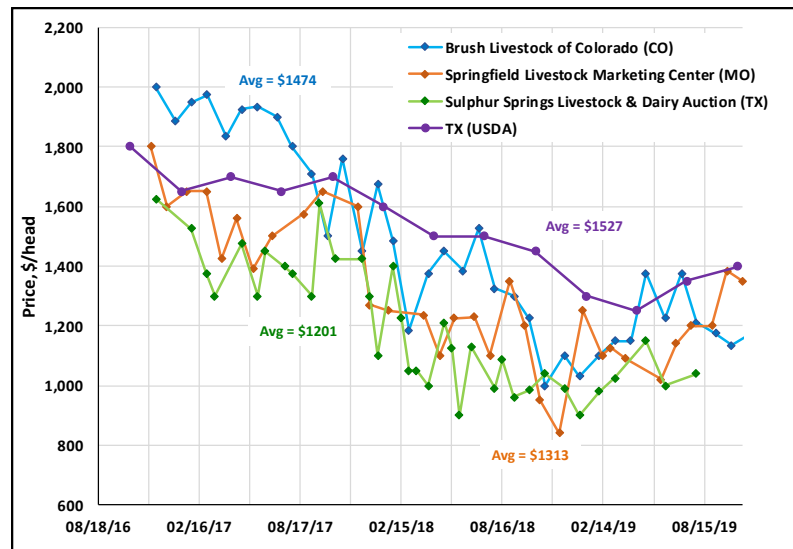
Price of top springers*



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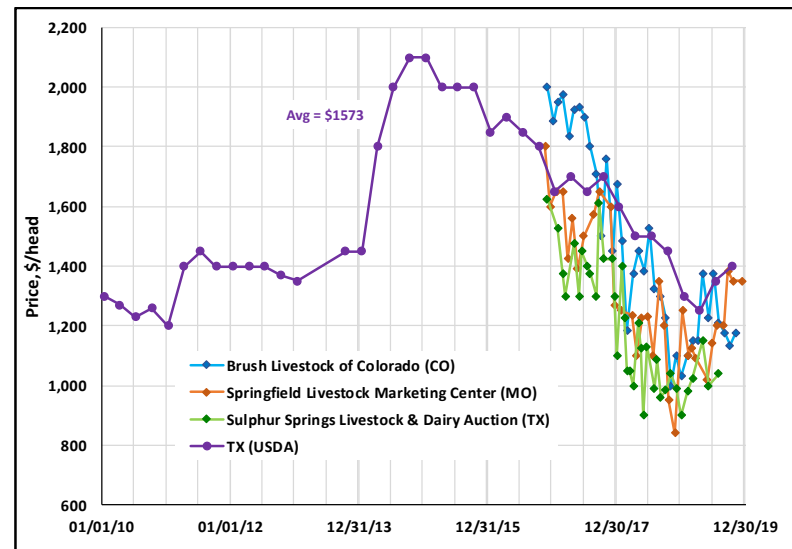
Price of top springers*



* Source: Compiled from Progressive Dairy Market Watch (<https://www.progressivedairy.com/magazine>) and USDA Quick Stats (<https://quickstats.nass.usda.gov/>) last accessed on 2/17/20

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Price of top springers*



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Based on heifer raising costs of ~\$1800-2100/hd and historical average springer values, raising heifers to springers with intention of selling for a profit is questionable.

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 - Heifer raising program (mortality, growth rates, etc.)
- Number of heifers produced annually
 - Reproduction program (pregnancies, type of semen, etc.)
- Costs of raising a heifer
 - Available alternatives (e.g., custom growers, purchase springers, etc.)
- Heifer market prices
 - Current vs long-run, at various stages of growth (calf → springer)
- Which heifers to sell, and which heifers to keep

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Factors impacting heifer replacement decisions

1. Number of heifers needed annually
2. Number of heifers produced annually
3. Costs of raising a heifer
4. Heifer market prices
5. Which heifers to sell, and which heifers to keep

Selectively culling heifers

- a) Random?
- b) Use genomic data?
- c) Use performance data?
- d) How does this impact costs of raising other heifers?
- e) Is this economical?

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Estimating the cost per heifer raised – Culling excess

Assumptions used in the model:

- Same baseline assumptions as before
- Same mortality risk by stage
- Performance culls after weaning 5.0%
- Performance culls after grower 4.2%
- Percent of heifers ultimately calving 77.8%
(due to mortality of 7.1%, 5.9% repro and 9.2% performance culls)
- Assumed labor costs had a fixed and variable component, but housing costs were completely fixed.
- Cull values based on projected body weight at time of culling and market values for Holstein heifers.

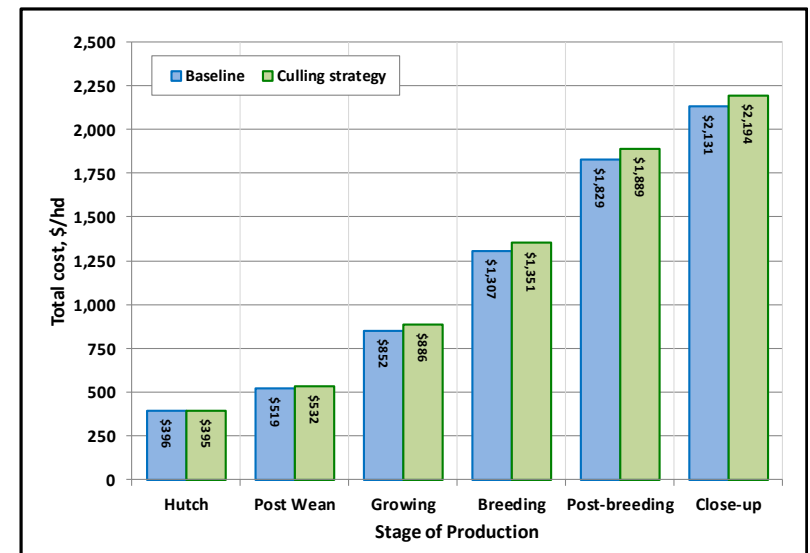
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Cost of raising a heifer – Culling strategy

Stage of Production Age in months	Culling strategy						
	Hutch Birth to 2	Post Wean 2 to 4	Growing 4 to 10	Breeding 10.0-15.7	Post-breeding 15.7-21.4	Close-up 21.4-23.4	Total Birth - 23.4
Colostrum Milk*	182.11						
Starter*	20.19						
Grain*		75.43					
Hay*		5.75					
Feed (TMR)*			231.88	287.83	338.55	185.28	
Total Feed*	\$202.31	\$81.18	\$231.88	\$287.83	\$338.55	\$185.28	\$1,433
Labor*	47.37	10.78	12.94	35.18	14.87	31.66	\$170
Vet Med/ Health*	10.22	2.49	8.43	2.90	2.65	16.14	\$47
Breeding & Culls*	0.00	-11.37	-14.58	35.89	-58.28	0.00	-\$49
Housing and Other*	29.31	19.27	62.12	67.72	88.22	49.08	\$337
Interest*	1.39	3.58	17.40	27.00	40.46	17.54	\$112
Total Cost*	\$291	\$106	\$318	\$457	\$426	\$300	\$2,050
Cost/ Day*	\$4.84	\$1.72	\$1.74	\$2.62	\$2.49	\$4.92	\$2.88
Entering Weight (lbs)	85	192	325	702	1,037	1,341	85
Exit Weight (lbs)	192	325	702	1,037	1,341	1,443	1,443
Average daily gain (lbs)	1.78	2.17	2.06	1.92	1.77	1.68	
Cumulative ADG (lbs)	1.78	1.97	2.03	1.99	1.93	1.91	1.91
Cumulative from birth							
Total Cost*	\$291	\$418	\$762	\$1,223	\$1,746	\$2,050	\$2,050
Cost/ Day*	\$4.84	\$3.44	\$2.50	\$2.55	\$2.69	\$2.88	\$2.88
Cost Including Wet Calf*	\$395	\$532	\$886	\$1,351	\$1,889	\$2,194	\$2,194

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Cost of raising a heifer – Baseline vs Culling strategy



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Factors impacting heifer replacement decisions

1. Number of heifers needed annually
2. Number of heifers produced annually
3. Costs of raising a heifer
4. Heifer market prices
5. Which heifers to sell, and which heifers to keep

Based on assumptions used, culling “extra” heifers results in cost of springer increasing (i.e., cull revenue was less than cost incurred up to point of culling and fixed costs diluted over fewer animals)

Based on an analysis of two herds, when culling was based on heifer growth (ADG) and genetics (PTAM), subsequent milk in first lactation was increased for remaining heifers. However, value of increased milk was not sufficient to offset the increased cost (data not shown).

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Summary

- There is a wide range of profitability across dairies (variability across dairies at a point in time > than average across time)
- This wide variability likely exists with regards to cost of raising replacement heifers as well
- Many factors impact how many heifers are needed and produced annually (also varies considerably across dairies)
- Producing and raising more heifers than are needed as replacements on a given dairy, generally will not be profitable
- Identifying an “optimal replacement heifer strategy” is complex due to the many variable factors. However, having an accurate estimate of the cost of raising a heifer by stage of production is critical for making informed decisions.

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Questions / Discussion

Thank You



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