Business and Production Guide for Dairy Cattle Operations

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WATER QUALITY MANAGEMENT

Authors: Jennifer Fetter, Kristen Kyler, Leon Ressler, Bryan Swistock, Sarah Xenophon

Runoff Water in the Barnyard

- The water from roof runoff should be directed away from foundations, structures, and contaminated areas (using gutters with surface drains, underground outlets or stone filled trenches under the dripline with underground outlets).
- Roof gutters should have a minimum top width of five inches and the supports should have no greater than 24-inch spacing.
- All downspouts, gutters, and outlets should be protected from damage by livestock and equipment.
- Any runoff water coming in contact with the barnyard should be captured as wastewater and treated as manure or dispersed through an improved vegetated strip. It should not be allowed to flow directly into streams and waterways.
- Have an appropriate Erosion and Sediment Pollution Control Plan or Conservation Plan.

Rainwater and other precipitation that falls at a farm will flow downhill and off rooftops towards the nearest stream, pond, or other waterway. As it passes over the land, water will pick up and carry anything that it contacts. It is important to keep the relatively clean rainwater from passing through barnyard and animal concentration areas on its way across the landscape. Runoff water in the barnyard is a potential source of erosion and pollutants (nutrients, sediment, bacteria, and other pathogens from animal waste). In addition, rain and snow that falls directly on the barnyard should be managed to prevent concentrated flows from exiting the area. A variety of options and structures exist to divert rooftop and uphill water from entering the barnyard. Dispersing the runoff water over a wide, properly vegetated area will prevent erosion and other property damage as well as minimize movement of pollution. Capturing barnyard wastewater is best.

Other Considerations:

- Look for evidence of erosion in areas where roof runoff water is discharging. Improved vegetation may be required in eroding areas.
- Inspect collection and storage devices, valves, gutters, outlets, and pipelines at least twice per year. Make repairs as needed.
- Make note of areas where gullies and concentrated flow are forming as water exits the barnyard. Consider the placement of terracing, vegetated swales, broad-based dips, water bars or conveyors, and through pipes to direct clean surface water away from erodible surfaces such as farm lanes, cattle walk ways, and the barnyard.
- Keep clean water and dirty water separate – clean water should stay clean.
- Additional guidance for barnyard clean water diversions can be found in the references section.

Streams on a Farm

- Establish and maintain forested streamside buffers at least 35 feet in width from stream edge adjacent to pastures, cropland, and wherever possible.
- Mature forested streamside buffers should have at least 60% canopy cover.
- Newly planted buffers should aim for an average of 200 trees or shrubs per acre.
- Exclude herd from stream access with fencing that is at least 10 feet away from the edge of stream.
- Stream access should be limited to improved stream crossings and improved watering areas only. (Where possible, off-stream watering systems should be installed.)

Streams and other waterways on a farm can provide many benefits as well as issues to manage. Protecting those waterways from erosion and the introduction of nutrients, sediment, and pathogens can be a win-win situation for a dairy operation. One of the most effective ways to reduce the flow of pollutants into the water is to establish a riparian buffer, or forested area adjacent to the stream. Runoff water has a chance to slowly filter and infiltrate before it hits the stream edge. The slower moving water and the network of tree roots also reduces streambank erosion, which can save property and protect streamside infrastructure. Buffers are important for all streams, whether crossing through cropland, pastures, or the homestead. In pastures, excluding the herd from accessing the stream is also a key practice. The herd causes issues for the waterway by eroding the stream banks and directly depositing animal waste which contains harmful pathogens and nutrients. Wading in these polluted water conditions can also lead to bacterial diseases for the herd, such as foot rot, diarrhea, and mastitis.

Other Considerations:

- Forested streamside buffers should be expanded to include important resource features such as wetlands, steep slopes, areas that are occasionally or seasonally flooded, or critical habitats.
- Newly established buffers require maintenance for three to five years including weed management, mortality replacement, and tree shelter inspections and repair.
- Control concentrated runoff water flow or mass soil movement before it enters a forest buffer to maintain function.
- Herds should not be using cattle crossings as loafing areas. Utilize temporary fencing and gates to rotate herd access points and reduce stress on waterways.
- If buffers and exclusions are not sufficient for stabilizing streambanks, consider seeking professional help with structural measures for stream restoration.
- Additional guidance for stream exclusions can be found in the references section.

Pennsylvania Nutrient Management

- Dairy farms need a nutrient management plan. The type of plan needed will be determined by the nutrient management classification of a farm. The number of animals and the number of acres in an operation will determine if it is a Concentrated Animal Feeding Operation (CAFO), a Concentrated Animal Operation (CAO), or an Animal Operation (AO). The plan requirements are different for these different groups.
- Nutrient management plans for CAFOs and CAOs require a soil test every three years. For AOs, soil tests are only required every three years if the manure management plan is nitrogen based.
- Manure tests are required annually for each manure group for CAFOs and CAOs. Manure tests are not required for AOs.
- Manure application rates are determined during the nutrient management planning process. Factors considered include the nutrient levels in the manure, the soil test levels, and crop nutrient removal.
- A plan to protect environmentally sensitive areas including private or public drinking water wells, steams, ponds or lakes, sinkholes, or areas of concentrated flow such as swales, ditches, and gullies needs to be included in the nutrient management plan.

A very critical part of environmental quality on many dairies is proper management of any animal concentration areas. These are often located near a stream and lack sufficient vegetated cover to prevent nutrient losses to streams. Additional guidance for management of animal concentration areas can be found in the references section.

Drinking Water Protection for Livestock and Farm Family

- Test wells and springs used for home drinking water
  - Annually for bacteria
  - Every few years for pH, total dissolved solids, and nitrates
  - Some other water tests may be warranted in certain cases
- Test wells and springs used for dairy herd drinking water
  - At least once for pH, TDS, iron, manganese, copper, nitrate, hardness, calcium, sodium, magnesium, chloride, sulfate, coliform bacteria, *E. coli* bacteria.
- Keep potential sources of contamination like fertilizers, pesticides, animals, vehicles, and septic systems at least 100 feet from any water well or spring.

Most dairy farms use groundwater wells or springs for both their home and herd drinking water supplies. These water sources are unregulated in Pennsylvania and can suffer from both naturally occurring pollutants and from contamination from nearby land-use activities, especially those directly uphill from the water supply. Penn State surveys have found that about 40% of home wells and springs have unsafe levels of at least one health-based water pollutant and a 2012 study of 174 dairy farms across the state found better milk production on farms with good water quality. Consider the guidance found above to protect drinking water supplies.

Other Considerations:

- Watch for changes in appearance, odor or taste of home or herd drinking water supplies. Have the water supply tested immediately if changes are noticed.
- Monitor water intake and milk production by dairy cows. Reduced intake or production could indicate a water quality problem causing water palatability issues. Consider installing water meters to measure water intake where milk production is low.
- Before investing in large water treatment systems for herd water supplies, consider segregating a few cows and provide them with an alternative water supply to monitor for improvement. This evidence will help to determine if water treatment costs will be worthwhile based on better herd performance.
- Always use a PA DEP accredited water testing lab to ensure accurate results.
- Additional guidance for drinking water protection can be found in the references section.

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Appendix A. Breakeven Cost of Production Worksheet Example

Name: Example Farm

Year-to-Date Totals with Accrual Adjustments

CASH INFLOWS:				Beg Accts. Receivable (-)	End Accts. Receivable (+)	Accrual Total	Per Cow	Per CWT
Total Cows	142					142	27,046	
Milking Cows	122					122	31,480	
Lbs Milk Sold Year-to-Date	3,840,540					3,840,540		38,405
	Cash Amount						86.2	Per Cow Per Day
Gross milk sales	$568,797					$568,797	$4,006	$14.81
Patronage dividends	$2,655					$2,655	$19	$0.07
Cull cow sales	$30,695					$30,695	$216	$0.80
Bull calf sales	$2,568					$2,568	$18	$0.07
Misc. dairy sales/income	$704					$704	$5	$0.02
Govt. dairy payments							$0	$0.00
Other govt. payments	$23,882					$23,882	$168	$0.62
Crop sales	$42,142					$42,142	$297	$1.10
Custom work income	$2,643					$2,643	$19	$0.07
Other farm income	$1,566					$1,566	$11	$0.04
TOTAL INFLOW	$675,652			$0	$0	$675,652	$4,758	$17.59

CASH OUTFLOWS:	Cash Amount	Beg Prepaid Expense (+)	End Prepaid Expense (-)	Beg Accts. Payable (-)	End Accts. Payable (+)	Accrual Total	Per Cow	Per CWT
Crop Direct Costs:								
Seed	$29,774	$10,000				$39,774	$280	$1.04
Fertilizer	$61,576				$15,000	$76,576	$539	$1.99
Chemical	$13,402					$13,402	$94	$0.35
Crop Custom Hire	$7,231					$7,231	$51	$0.19
Land rent	$8,375					$8,375	$59	$0.22
Total Crop Direct Costs	$120,358	$10,000	$0	$0	$15,000	$145,358	$1,024	$3.78
Purchased Milking Cow Feed	$192,114				$30,000	$222,114	$1,564	$5.78
Pur Dry Cow & Heifer Feed	$10,329					$10,329	$73	$0.27
Total Purchased Feed	$202,443	$0	$0	$0	$30,000	$232,443	$1,637	$6.05
Dairy Expenses:								
Breeding & Registration	$10,672					$10,672	$75	$0.28
Veterinary & Medicine	$24,048					$24,048	$169	$0.63
bST							$0	$0.00
Supplies	$5,312					$5,312	$37	$0.14
DHIA	$4,609					$4,609	$32	$0.12
Contract Heifer Raising							$0	$0.00
Dairy Custom Hire	$2,507					$2,507	$18	$0.07
Milk Hauling	$38,307					$38,307	$270	$1.00
Milk Marketing	$5,907					$5,907	$42	$0.15
Bedding	$10,631					$10,631	$75	$0.28
Total Dairy Expenses	$101,993	$0	$0	$0	$0	$101,993	$718	$2.66

Related Operating Expenses:	Cash Amount	Beg Prepaid Expense (+)	End Prepaid Expense (-)	Beg Accts. Payable (-)	End Accts. Payable (+)	Accrual Total	Per Cow	Per CWT
Fuel and oil	$29,407					$29,407	$207	$0.77
Repairs	$72,336					$72,336	$509	$1.88
Hired labor, withholding, ins.	$50,155					$50,155	$353	$1.31
Machinery leases	$13,590					$13,590	$96	$0.35
Building leases							$0	$0.00
Real estate taxes	$3,540					$3,540	$25	$0.09
Farm insurance	$10,129					$10,129	$71	$0.26
Utilities	$23,775					$23,775	$167	$0.62
Risk mgt.& advertizing							$0	$0.00
Dues and professional fees	$11,370					$11,370	$80	$0.30
Miscellaneous	$7,184				$60,000	$67,184	$473	$1.75
Total Related Operating	$221,486	$0	$0	$0	$60,000	$281,486	$1,982	$7.33

Appendix A. continued

	Cash Amount	Beg Prepaid Expense (+)	End Prepaid Expense (-)	Beg Accts. Payable (-)	End Accts. Payable (+)	Accrual Total	Per Cow	Per CWT
Family living/owner draw							$0	$0.00
Income taxes	$1,393					$1,393	$10	$0.04
Total Family Living & Income Taxes	$1,393	$0	$0	$0	$0	$1,393	$10	$0.04
Total Outflow	$647,673					$762,673	$5,371	$19.86
Operating Surplus	$27,979					-$87,021	-$613	-$2.27
CAPITAL SALES								
Capital Sales								
Total Capital Sales								
CAPITAL PURCHASES								
Capital Purchases	$13,222					$13,222		
Total Capital Purchases	$13,222					$13,222		
NEW BORROWING								
New Borrowing	$232,745					$232,745		
Total New Borrowing	$232,745					$232,745		
LOAN PAYMENTS (Principal & Interest)								
Loan Payments	$140,126					$140,126	$987	$3.65
Total Loan Payments	$140,126					$140,126	$987	$3.65
Surplus or Deficit	$107,376	$10,000	$0	$0	$105,000	-$7,624	-$54	-$5.91
							Total Outflow	$23.51
							Non-Milk Inflow	$2.78
							Milk Price Breakeven	**$20.72**

Cash Accuracy Check

Beginning cash balance		Ending cash balance	$ 8,658
Gross cash farm income	$ 675,652	Total cash farm expense	$646,280
Personal income		Family living expense	
Capital sales		Capital purchases	$13,222
Money borrowed	$232,745	Loan payments	$140,126
Capital contributions		Capital distributions	
Gifts and inheritances		Gifts given	
Beginning personal savings		Ending personal savings	
		Income taxes	$1,393
Total inflows	**$ 908,397**	**Total outflows**	**$ 809,679**
		Discrepancy (inflows-outflows) (or apparent Family living)	**$ 98,718**

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Appendix B. Beginning Balance Worksheet Example

Balance Sheet

Farm Name: Example | Dairy | Date: 1/1/2017

CURRENT FARM ASSETS		Value
Cash and checking balance		($ 16,053)
Prepaid expenses & supplies		$0.00
Growing Crops		$5,625.00
Accounts Receivable		
(1/2 Mos. Milk)		$18,191.00
Other Current Assets		$27,250.00
Purchased Feed Inventory	$20,000.00	
Supply Inventory (Dairy)	$3,350.00	
Fuel Inventory	$1,500.00	
Other Current Assets	$2,400.00	

Crop (Feed) Inventory	Quantity	Value Per Unit	
Corn silage	2,250	$40.54	$91,215.00
Grass baleage			$0.00
Straw	75	$110.56	$8,292.00
Barley baleage			$0.00
Grass hay	30	$147.42	$4,422.60
Mixed grass hay			$0.00
Soybeans			$0.00
Barley grain			$0.00
Subtotal Crop (Feed) Inventory			$103,929.60

Market Livestock	Number	Avg. Weight	Value Per Unit	
				$0.00
Other Current Inventories				
Total Current Farm Assets				$138,942.60

INTERMEDIATE FARM ASSETS

Breeding Livestock	Number	Value/Hd (Cost)	Value/Hd (Mkt)	Cost Value	Market Value
Dairy cows	146	$1,400	$1,400	$204,400.00	$204,400.00
Bred heifers	35	$1,500	$1,500	$52,500.00	$52,500.00
Breeding age	24	$1,100	$1,100	$26,400.00	$26,400.00
3 mo to breeding	36	$800	$800	$28,800.00	$28,800.00
Weaning to 3 mos	11	$600	$600	$6,600.00	$6,600.00
Calves on milk	12	$500	$500	$6,000.00	$6,000.00
Subtotal Breeding Livestock				$324,700.00	$324,700.00
Farm Machinery & Equipt. (include draft horses or mules)				$153,923.00	$153,923.00
Titled Vehicles					
Other Intermediate Assets					
Other Intermediate Assets					
Total Intermediate Farm Assets				$478,623.00	$478,623.00

LONG TERM FARM ASSETS

Item	Acres	Value Per Acre	Cost Value	Market Value
Land	213		$680,000.00	$1,330,000.00
Residence				
Farm Buildings			$350,356.00	$350,356.00
Other Long Term Assets				
Total Long Term Assets			$1,030,356.00	$1,680,356.00
TOTAL FARM ASSETS			$1,647,921.60	$2,297,921.60
NONFARM ASSETS				
TOTAL ASSETS			$1,647,921.60	$2,297,921.60

CURRENT FARM LIABILITIES (accounts payable and loans under 1 year term)	Amount
Accounts payable:	
Purchased Feed	$15,470.00
Chemical	$23,830.00
Crop Custom Hire	$33,605.00
Dairy Custom Hire	$6,479.00
Total accounts payable	$79,384.00
Accrued Interest	$0.00

CURRENT LOANS	Interest Rate	Principal Balance	Accrued Interest	Princ & Int. Payment	Balance
LOC	5.25	$66,102.00		$3,470.00	$66,102.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
Government Crop Loans					
Principal due within 12 months on term liabilities					$61,404.00
Total Current Farm Liabilities					$206,890.00

Intermediate Farm Liabilities (Cows and Equipment – term of 1 to 10 years)

INTERMEDIATE LOANS	Interest Rate	Principal Balance	Accrued Interest	P & I Due	Principal Due	Final Year	Intermediate Balance
Cows & Eqt	4.80	$184,312.00					$184,312.00
Mixer	4.60	$15,290.00		$5,220.00	$4,604.00		$10,686.00
Skid Loader	4.75						$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
Total Intermediate Farm Liabilities							$194,998.00

Long Term Farm Liabilities (Land & Buildings – Term of more than 10 years)

LONG TERM LOANS	Interest Rate	Principal Balance	Accrued Interest	P & I Due	Principal Due	Final Year	Long Term Balance
Mortgage	4.80	$1,040,441.00		$106,179	$56,800		$983,641.00
							$0.00
							$0.00
							$0.00
							$0.00
Total Long Term Farm Liabilities							$983,641.00
TOTAL FARM LIABILITIES							$1,385,529.00
NON-FARM LIABILITIES							

NET WORTH CALCULATION:	Cost	Market
Total Farm and Non-farm Liabilities	$1,385,529.00	$1,385,529.00
Deferred Tax Liabilities		
TOTAL LIABILITIES		$1,385,529.00
Retained Earnings / Contributed Capital	$262,392.60	
NET WORTH		$912,392.60

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Appendix C. Ending Balance Worksheet Example

Balance Sheet

Farm Name: Example — Dairy — **Date:** 1/1/2018

CURRENT FARM ASSETS		Value
Cash and checking balance		($ 237)
Prepaid expenses & supplies		$0.00
Growing Crops		$6,300.00
Accounts Receivable		
(1/2 Mos. Milk)		$22,788.00
Other Current Assets		$27,250.00
Purchased Feed Inventory	$20,000.00	
Supply Inventory (Dairy)	$3,350.00	
Fuel Inventory	$1,500.00	
Other Current Assets	$2,400.00	

Crop (Feed) Inventory	Quantity	Value Per Unit	
Corn silage	2,200	$40.54	$89,188.00
Grass baleage			$0.00
Straw	2	$110.56	$199.01
Barley baleage			$0.00
Grass hay	14	$147.42	$2,063.88
Corn grain	5,500	$4.33	$23,834.80
Soybeans			$0.00
Barley grain			$0.00
Subtotal Crop (Feed) Inventory			$115,285.69

Market Livestock	Number	Avg. Weight	Value Per Unit	
				$0.00
Other Current Inventories				
Total Current Farm Assets				$171,386.69

INTERMEDIATE FARM ASSETS					
Breeding Livestock	Number	Value/Hd (Cost)	Value/Hd (Mkt)	Cost Value	Market Value
Dairy cows	157	$1,400	$1,400	$219,800.00	$219,800.00
Bred heifers	24	$1,500	$1,500	$36,000.00	$36,000.00
Breeding age	25	$1,100	$1,100	$27,500.00	$27,500.00
3 mo to breeding	26	$800	$800	$20,800.00	$20,800.00
Weaning to 3 mos	15	$600	$600	$9,000.00	$9,000.00
Calves on milk	20	$500	$500	$10,000.00	$10,000.00
Subtotal Breeding Livestock				$323,100.00	$323,100.00
Farm Machinery & Equipt. (include draft horses or mules)				$169,871.00	$169,871.00
Titled Vehicles					
Other Intermediate Assets					
Other Intermediate Assets					
Total Intermediate Farm Assets				$492,971.00	$492,971.00

LONG TERM FARM ASSETS				
Item	Acres	Value Per Acre	Cost Value	Market Value
Land	213		$680,000.00	$1,330,000.00
Residence				
Farm Buildings			$332,838.00	$332,838.00
Other Long Term Assets				
Total Long Term Assets			$1,012,838.00	$1,662,838.00
TOTAL FARM ASSETS			$1,677,195.69	$2,327,195.69
NONFARM ASSETS				
TOTAL ASSETS			$1,677,195.69	$2,327,195.69

CURRENT FARM LIABILITIES (accounts payable and loans under 1 year term)	Amount
Accounts payable:	
Crop Custom Hire	$64,358.00
Purchased Feed	$18,896.00
Veterinary & Medicine	$7,361.00
Dairy Custom Hire	$2,999.00
Total accounts payable	$93,614.00
Accrued Interest	$0.00

CURRENT LOANS	Interest Rate	Principal Balance	Accrued Interest	Princ & Int. Payment	Balance
LOC	5.25	$49,896.00		$3,470.00	$49,896.00
					$0.00
					$0.00
					$0.00
					$0.00
					$0.00
Government Crop Loans					
Principal due within 12 months on term liabilities					$66,409.00
Total Current Farm Liabilities					$209,919.00

Intermediate Farm Liabilities (Cows and Equipment – term of 1 to 10 years)

INTERMEDIATE LOANS	Interest Rate	Principal Balance	Accrued Interest	P & I Due	Principal Due	Final Year	Intermediate Balance
Cows & Eqt	4.80	$168,871.00					$168,871.00
Mixer	4.60	$10,687.00		$5,220.00	$4,824.00		$5,863.00
Skid Loader	4.75	$24,461.00		$4,255.00	$3,146.00		$21,315.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
							$0.00
Total Intermediate Farm Liabilities							$196,049.00

Long Term Farm Liabilities (Land & Buildings – Term of more than 10 years)

LONG TERM LOANS	Interest Rate	Principal Balance	Accrued Interest	P & I Due	Principal Due	Final Year	Long Term Balance
Mortgage	4.80	$1,007,517.00		$106,179	$58,439		$949,078.00
							$0.00
							$0.00
							$0.00
							$0.00
Total Long Term Farm Liabilities							$949,078.00

TOTAL FARM LIABILITIES		$1,355,046.00
NON-FARM LIABILITIES		
NET WORTH CALCULATION:	Cost	Market
Total Farm and Non-farm Liabilities	$1,355,046.00	$1,355,046.00
Deferred Tax Liabilities		
TOTAL LIABILITIES		$1,355,046.00
Retained Earnings / Contributed Capital	$322,149.69	
NET WORTH		$972,149.69

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Appendix D. Income Statement Example

Farm Type: Dairy

Income:

Milk sales	$664,283
Patronage dividends (coop)	$2,655
Cull cow sales	$30,695
Bull calf sales	$608
Misc. dairy sales/income	$704
Govt dairy payments (MPP/LGM)	
Other govt. payments	$23,882
Crop Sales	$42,142
Custom work income	$2,643
Other farm Income	$1,566

Expenses:

Crop Direct Expenses:	
Seed	$29,774
Fertilizer	$61,576
Chemical	$13,402
Crop custom hire	$7,231
Land rent	$8,375
Purchased Feed Expenses	
Purchased milking cow feed	$194,907
Pur dry cow & heifer feed	
Dairy Expenses	
Breeding and registration	$10,672
Veterinary & medicine	$5,255
bST	
Supplies	$5,312
DHIA	$4,609
Contract heifer raising	
Dairy custom hire	$2,507
Milk hauling	$38,307
Milk marketing	$5,907
Bedding	$10,631
Overhead Expenses	
Fuel and oil	$29,407
Repairs	$72,336
Hired Labor, withholding, ins.	$50,155
Machinery leases	$13,590
Building leases	
Real estate taxes	$3,540
Farm insurance	$10,129
Utilities	$23,775
Risk management & advertizing	
Dues and professional Fees	$11,370
Miscellaneous	$7,184
Interest Paid	$57,902
Payroll Expenses	
Reconciliation Discrepancies	

Gross cash income	$796,651	A
Total cash expense	$674,529	B
Net cash income	$122,122	C
	C = A - B	

If totals above include unpaid bills and invoices not yet received, un-check cash. Otherwise, leave cash checked. ✔ Cash

Inventory Changes:	Beginning Inventory		Purchases		Sales		Ending Inventory		Inventory Change	
Prepaid and supplies	$0.00	①					$0.00	⑮	$0.00	⑮- ①
Growing crops	$5,625.00	②					$6,300.00	⑯	$675.00	⑯- ②
Accounts Receivable	$18,191.00	③					$22,788.00	⑰	$4,597.00	⑰- ③
Other current assets	$27,250.00	④					$27,250.00	⑱	$0.00	⑱- ④
Crops and feed	$103,929.60	⑤					$115,285.69	⑲	$11,356.09	⑲- ⑤
Market Livestock	$0.00	⑥					$0.00	⑳	$0.00	⑳- ⑥
Breeding Livestock	$324,700.00	⑦		❶		❷	$323,100.00	㉑	-$1,600.00	(㉑+❷)-(⑦+❶)
Other Int./Long Term assets	$0.00	⑪		❸		❹	$0.00	㉕	$0.00	(㉕+❹)-(⑪+❸)
Accounts Payable	$79,384.00	⑬					$93,614.00	㉗	-$ 14,230	⑬–㉗
Accrued Interest	$0.00	⑭					$0.00	㉘	$0.00	⑭-㉘

Total inventory change	$ 798	D
Net operating profit	$ 122,920	E
	E = C + D	

Depreciation:	Beginning Inventory		Purchases		Sales		Ending Inventory		Depreciation	
Machinery and equipment	$153,923.00	⑧	$31,341.00	❺		❻	$169,871.00	㉒	-$15,393.00	(㉒+❻)-(⑧+❺)
Titled vehicles		⑨		❼		❽		㉓	$0.00	(㉓+❽)-(⑨+❼)
Buildings and improvements	$350,356.00	⑩		❾		❿	$332,838.00	㉖	-$17,518.00	(㉖+❿)-(⑩+❾)
Other Intermediate Assets	$0.00	⑫		⓫		⓬	$0.00	㉔	$0.00	(㉔+⓬)-(⑫+⓫)

Total depreciation	-$ 32,911	F
Net farm income	$ 90,009	G
	G = E + F	

Appendix D. Income Statement Example Continued

Loan Balance Reconciliation

Loan	Beginning Balance	Amount Borrowed	Principal Paid	Ending Balance	Liability Check
Current Liabilities					
Accounts Payable	$79,384.00			$93,614.00	
LOC	$66,102.00	$25,345.00	$41,551.00	$49,896.00	$ 0
					$ 0
					$ 0
					$ 0
					$ 0
					$ 0
Intermediate Liabilities					
Cows & Eqt	$184,312.00		$15,441.00	$168,871.00	$ 0
Mixer	$15,290.00		$4,603.00	$10,687.00	$ 0
Skid Loader		$24,973.00	$512.00	$24,461.00	$ 0
					$ 0
					$ 0
					$ 0
					$ 0
					$ 0
					$ 0
					$ 0
Long-Term Liabilities					
Mortgage	$1,040,441.00		$32,924.00	$1,007,517.00	$ 0
					$ 0
					$ 0
					$ 0
					$ 0
Non-Farm Liabilities					
					$ 0
	$ 1,385,529	$ 50,318	$ 95,031	$ 1,355,046	$ 0

Cash Accuracy Check

Beginning cash balance	($ 16,053)	Ending cash balance	($ 237)	$15,816
Gross cash farm income	$796,651	Total cash farm expense	$674,529	Accuracy check for
Personal income		Family living expense	$ 34,350	Cash Balance Planned vs Actual
Capital sales		Capital purchases	$13,222	
Money borrowed	$ 50,318	Principal payments	$ 95,031	
Capital contributions	$ 3,895	Capital distributions		
Gifts and inheritances		Gifts given		
Beginning personal savings		Ending personal savings		
		Income taxes	$1,393	
Total inflows	**$675,652**	**Total outflows**	**$23.51**	
		Discrepancy (inflows-outflows)	$ 98,718	

Liabilities Check

Beginning liabilities	$ 1,385,529
Money borrowed	$ 50,318
Principal payments	$ 95,031
Change in accounts payable	$ 14,230
Ending liabilities calculated	$ 1,355,046
Ending liabilities reported	$ 1,355,046
Discrepancy	$ 0

Value of Unpaid Oper Labor & Mgt.	$ 48,805		
Value of Farm Production	$ 616,097		
Family Living Expense	$ 34,350		
Number of Cows	160		
Amount of Operating Interest		$ 57,902	Interest Currently In Use
Personal (nonfarm) income		$ 49,995	Override Calculated Interest
Income taxes	$1,393		
Cash replacement allowance	$ 10,789		

Appendix E. Financial Ratios Example

Farm Finance Scorecard

Liquidity	Your Farm			Vulnerable	Strong
	Begin	End		1.1	1.7
1. Current ratio	0.67	0.82			
2. Working capital	-$ 67,947	-$ 38,532	$		
				10%	25%
3. Working capital to gross revenues	-8.4	-4.8	%		

Solvency	Begin	End		60%	30%
4. Farm debt-to-asset ratio	60	58	%		
				40%	70%
5. Farm equity-to-asset ratio	40	42	%		
				1.5	0.43
6. Farm debt-to-equity ratio	1.52	1.39			

Profitability	Cost	Market		Per Cow	
7. Net farm income	$ 90,009	$ 90,009	$	$ 563	$ 563
				4%	8%
8. Rate of return on farm assets	6.0	4.3	%		
				3%	10%
9. Rate of return on farm equity	14.1	4.4	%		
				15%	25%
10. Operating profit margin	16.1	16.1	%		
				Per Cow	
11. EBITDA	$ 180,822	$ 180,822	$	$ 1,130	$ 1,130

Repayment capacity					
12. Capital debt repayment capacity		$ 138,565	$		
13. Capital debt repayment margin		$ 27,166	$		
14. Replacement margin		$ 16,377	$		
				1.20	1.50
15. Term-debt coverage ratio		1.24			
				1.10	1.40
16. Replacement margin coverage ratio		1.134			

Financial efficiency	Cost	Market		30%	45%
17. Asset-turnover rate	37.1	26.6	%		
				80%	60%
18. Operating-expense ratio		77.7	%		
				15%	5%
19. Depreciation-expense ratio		4.1	%		
				10%	5%
20. Interest-expense ratio		7.1	%		
				10%	20%
21. Net farm income ratio		11.1	%		
Sum of 18 to 21					

[1] Adapted from "Farm Finance Scorecard" (Becker et al., 2014).

Appendix F. Reasonable Goals or Benchmarks for Some Common Parameters

	Suggested Benchmarks			
Parameter	**Holstein**	**Jersey**	**Brown Swiss**	**Crossbred**
Production				
Average milk per cow, lbs.	2x ≥ 75	2x ≥ 52.5	2x ≥ 63.75	2x ≥ 69.38
	3x ≥ 85	3x ≥ 59.5	3x ≥ 72.25	3x ≥ 78.63
% Protein (true)	3.0	3.6	3.3	3.2
% Fat	3.7	4.6	4.0	≥ 3.8
Average days in milk	175 to 180			
% of herd in milk	> 88			
Components shipped/cow/day	> 5.5 lbs.			
Average days dry	50 to 60 days			
Average daily milk, lbs.				
< 100 DIM	> 100			
100 to 199 DIM	80			
200 to 305 DIM	60 to 65			
Average peak milk, lbs.				
Heifers	> 80 (75% compared to 3rd lactation or greater)			
Cows	> 110			
All	> 95			

Nutrition and Feeding Management

NOTE: Since IOFC is highly dependent on milk price and feed price changes, there is not a standard benchmark provided. You should use the current year's data to evaluate how well a farm was performing rather than historic values. Also, we saw dramatic shifts increases in IOFC in 2014 due to higher milk prices. PLEASE USE CURRENT conditions for IOFC, rather than historic numbers.

Average total feed costs representing 2016 and 2017 from 25 dairy operations using FINPACK®

	High	Low	Average
Total feed costs/cow/year (home-raised and purchased)	$3,208	$1,683	$2,295
Milk income and cattle sales/cow/year	$5,894	$3,361	$4,637
Feed costs/milk income and cattle sales	78%	33.5%	50%

[1]Based on 25 PA farms participating in two-year (2016-2017) Crops to Cow project (Ishler et al., 2018), and analyzed with FINPACK software ((Minnesota, 2018a).

Parameter	Suggested Benchmarks Holstein		
Nutrition and Feeding Management			
Dry matter intake, lbs./cow	48 to 55 per cow (lactating cows)		
Bunk space, inches/cow	24 for lactating cows; 18 minimum; 30 minimum for prefresh cows		
Feed available	21 hours/day; push up at least 4x		
Water	3 linear inches per cow or space for 15% of group to drink at one time		
Particle size of TMR	2-Sieve	3- Sieve, 1.18 mm[1]	3-Sieve, 4 mm[1]
Upper	8 to 15%	2 to 8%	2 to 8%
Middle	35 to 45%	30 to 50%	30 to 50%
Lower (1.18 mm)	--	30 to 50%	10 to 20%
Pan	< 50%	< 20%	30 to 40%
Cud chewing index	> 40% of cows lying down		
Milk urea nitrogen	8 to 12 mg/dL		
Dry matter intake efficiency	> 1.45 (ECM/DMI)		
Body Condition Score (5-point scale)			
30-day post-partum	2.75 to 3.0		
120-day post-partum	2.75 to 3.0		
Dry off	3.0 to 3.25		
Calving	3.25		
Maximum loss in first 30 days	0.5 point		

[1]Note: There are two different 3-Sieve systems. Be sure to apply the appropriate distribution based on the system used for separation.

Parameter	Suggested Benchmarks Holstein	Jersey	Brown Swiss	Crossbred
Reproduction				
21-day pregnancy rate	> 24%	> 28%	> 20%	> 24%
Percent of herd pregnant	> 50% on average for the year			
Services/conception				
Pregnant cows	< 2.5			
All cows	< 3.25			
Days to 1st service	< 80 days			
1st service conception rate	≥ 40%			
Average days open to conception	≤ 120 days			
Calving interval	< 13.5 months			
Average age at 1st calving	22 to 24 months			
Heat Detection/Submission Rate	≥ 65%			

Parameter	Suggested Benchmarks Holstein
Mastitis and Milk Quality	
Cows with LS > 4.0	< 20% of herd
Cows with SCC ≤ 200,000 cells/mL (LS < 4)	80% of herd
Cows with SCC ≤ 400,000 cells/mL (LS < 5)	95% of herd
Bulk tank SCC	< 200,000 cells/mL
Cows with clinical mastitis	< 3% of herd
Standard plate count (SPC)	< 10,000 cu/mL
Pre-incubation (PI) count	< 50,000 cfu/mL

Parameter — **Suggested Benchmarks Holstein**

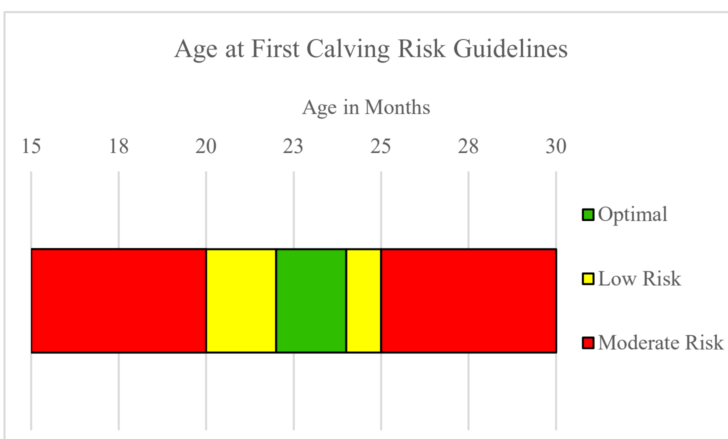
Herd Turnover and Replacements

Herd turnover rates are reliant on available replacements, and each farm has a unique relationship of the two and should be evaluated as such.

Turnover Rate	Goal	Intervention Level
Overall Herd	≤ 26%	> 36%
Biological	≤ 10%	> 13%
Mortality	≤ 6%	> 10%
Economic	≤ 10%	> 13%

Age at First Calving

*The optimal AFC depends on the farms heifer management practices, and the monitoring lactation 1 production to ensure adequate performance is achieved.



Parameter	**Suggested Benchmarks[1]** **Holstein**		
Disease/Health	Goal	Intervention Level	Cost/Case
Milk fever	< 3%	> 5%	$335
Retained placenta	< 5%	> 10%	$285
Displaced abomasum	< 3%	> 5%	$340
Ketosis	< 2%	> 10%	$145
Acidosis			$150
Subclinical acidosis			$75
Lameness	< 25%		$302 to 400
Abortions	< 4%		
Metritis	< 5%		$354
Cystic ovaries	< 10%		

[1]Adapted from “Impact of lameness on behavior and productivity of lactating Holstein cows” (Juarez, Robinson, DePeters, & Price, 2003) and “Transition cow nutrition and feeding management for disease prevention (Van Saun & Sniffen, 2014).

Business Measure	Suggested Benchmarks[1] Average	Leaders	Goal
Profitability			
Return on assets (ROA)	2 to 4%	12 to 15%	8 to 10%
Cash Flow			
Term debt and lease coverage ratio	1 to 1.15	> 2.0	> 1.5
Solvency			
% Equity	50 to 55%	50 to 55%	50 to 60%
Financial Efficiency			
Operating expense ratio	75 to 80%	< 80%	< 75%
Capital Efficiency			
Asset turnover ratio	0.4 to 0.45	> 0.65	> 0.6 (dairy and crop) > 1.0 (dairy only)

[1]Adapted from "Analyzing your dairy business" (Hilty, Hyde, & Tozer, 2008).

Recommended feed efficiency (FE) for cows in various lactation groups and stages of lactation. [1]

Group	Days in milk	Feed Efficiency
One group, all cows	150 to 225	1.40 to 1.60
First-lactation group	< 90	1.50 to 1.70
First-lactation group	> 200	1.20 to 1.40
Second-plus lactation group	< 90	1.60 to 1.80
Second-plus lactation group	> 200	1.30 to 1.50
Fresh cow group	< 21	1.30 to 1.60
Problem herds/groups	150 to 200	< 1.30

1Adapted from "Practical approaches to feed efficiency and applications on the farm" (Hutjens, 2007).

Business Efficiency Parameter	**Suggested Benchmarks**	
<u>Labor</u>		
Parlor turns per hour	4 to 5	
Milk per worker	> 1.2 million lbs.	
Cows per worker	45 to 50 (dairy and crop)	
	90 to 100 (dairy only)	
<u>Investment</u>		
Investment per cow	$8000	
Machinery investment per cow	< $1200	
<u>Debt</u>		
Debt per cow	< $2500 (not expanding)	< $4000 to 5500 (expanding)
Debt payment per cwt	$2.50 to $2.85	
Debt payment as a % of milk income	< 17 to 20% of gross income	

Average Actual Costs of Production for 2016-2017[1, 2]	**$/cwt**	**$/cow/day**
Total Purchased and Home Raised Feed[3]	$9.64	$6.29
Home Raised Feed	$5.44	$3.53
Purchased Feed	$5.50	$3.60
Dairy Expenses	$3.70	$2.41
Overhead Expenses	$6.85	$4.47
Labor and Management Charge	$0.66	$1.01
Dairy Enterprise Cost of Production- Direct and Overhead	$20.19	$13.17
Dairy Enterprise Cost of Production- w/ Labor and Management	$19.76[4]	$12.88

[1]Note: Some of the financial benchmarks will vary with size or dairy and crop enterprise balance of operation. Evaluate accordingly.
[2]Based on 25 PA farms participating in two-year (2016-2017) Crops to Cow project (Ishler et al., 2018).
[3]The averages of Home Raised Feed and Purchased Feed do not equal the average of Total Feed since each farm has a unique combination of home raised and purchased feed costs.
[4]Cost of production- direct and overhead with adjustments for cattle inventory changes and labor and management.

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Other Resources

Animal Waste Storage and Management:
https://extension.psu.edu/programs/nutrient-management/educational/manure-storage-and-handling/copy4_of_nutrient-management-technical-manual-webinar

The Basics of Agricultural Erosion and Sedimentation Requirements:
https://extension.psu.edu/programs/nutrient-management/manure/overview-of-deps-manure-management-manual/the-basics-of-agricultural-erosion-and-sedimentation-requirements

Conservation Practice Standard Heavy Use Area Protection PA561:
https://efotg.sc.egov.usda.gov/references/public/PA/PA561_HUAPStandardFinalApril2016revisedFeb2018.pdf

Construction Specification 635. Vegetative Treatment PA635-SP1:
https://efotg.sc.egov.usda.gov/references/public/PA/PA635Spec715.pdf

Chesapeake Bay Program Resource Improvement Practice Definitions and Verification Visual Indicators Report:
https://www.chesapeakebay.net/documents/Appendix_H--CBP_Resource_Improvement_Practice_definitions_and_visual_indicators_document_8-8-14.pdf

Dairy Idea Plans:
https://abe.psu.edu/extension/idea-plans/dairy

Designing and Building Dairy Cattle Freestalls:
https://extension.psu.edu/designing-and-building-dairy-cattle-freestalls

DEP Manure Management Manual:
https://extension.psu.edu/programs/nutrient-management/manure/overview-of-deps-manure-management-manual

Drinking Water Interpretation Tool:
https://extension.psu.edu/drinking-water-interpretation-tool-dwit

Drinking Water Tests for Dairy Cows:
https://extension.psu.edu/interpreting-drinking-water-tests-for-dairy-cows

Is my operation a CAFO?:
https://extension.psu.edu/programs/nutrient-management/manure/understanding/is-my-operation-a-cafo

Laboratory Accreditation Program:
http://www.dep.pa.gov/Business/OtherPrograms/Labs/Pages/Laboratory-Accreditation-Program.aspx

Large Dairy Herd Management:
http://ldhm.adsa.org/

NRCS-391 Riparian Forest Buffer Conservation Practice Standard Overview:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1255022.pdf

NRCS-558 Roof Runoff Structure Conservation Practice Standard Overview:
https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1263410.pdf

PA Chapter 102 Erosion and Sediment Control:
https://www.pacode.com/secure/data/025/chapter102/chap102toc.html

The Penn State Agronomy Guide:
https://extension.psu.edu/the-penn-state-agronomy-guide

Penn State Center for Dirt and Gravel Roads Technical Bulletin:
https://www.dirtandgravel.psu.edu/general-resources/informational-and-technical-bulletins

Penn State Dairy Herd Metrics Tool:
https://extension.psu.edu/penn-state-dairy-herd-metrics

Pennsylvania Nutrient Management Program:
https://extension.psu.edu/programs/nutrient-management

Pennsylvania Soil Quality Assessment Worksheet:
https://extension.psu.edu/pennsylvania-soil-quality-assessment-worksheet

Proper Well Construction:
https://extension.psu.edu/proper-water-well-construction

Protecting Your Water Well:
https://extension.psu.edu/protecting-your-water-well

Testing Your Drinking Water:
https://extension.psu.edu/testing-your-drinking-water

What Type of Plan Do You Need for Your Farm?:
https://extension.psu.edu/programs/nutrient-management/manure/understanding/what-type-of-plan-do-you-need-for-your-farm

Abbreviations and Definitions

ADG: Average daily gain. The daily rate of weight gain during a specific time.

AFC: Age at first calving. The age in months of a heifer when she delivers her first calf and enters the milking herd.

Biological (involuntary) cull rate: HTR focused on biological (e.g., reproduction, injury) culls excluding mortality.

CMT: California Mastitis Test. Test performed cow side to determine the somatic cell count in milk.

CWT (hundredweight): A unit of measure equal to 100 pounds.

DEP: Department of Environmental Protection. State agency responsible for environmental laws and regulations.

DIM: Days in milk. The number of days from calving date until dry date. If a cow is currently in milk, then it is the number of days between the calving date and today.

DMC: Dairy Margin Coverage Program. A voluntary risk management program authorized by the 2018 Farm Bill which offers protection to dairy producers when difference between milk price and average feed cost fall below a selected threshold.

Economical (voluntary) cull rate: HTR focused on economical (e.g., dairy or low production) culls.

FE: Feed efficiency. The ratio of how much milk (typically energy corrected) is produced per pound of dry matter intake.

HTR: Herd turnover rates (e.g., mortality turnover rate, biological turnover rate). The number of animals culled within the year divided by the mean cow inventory for the year, expressed as a percent (Fetrow et al., 2006).

IgG: Immunoglobulin G. Type of antibody found in milk that can be used as a barometer of colostrum quality.

IOFC: Income over feed costs. Is calculated by taking milk income per cow minus the lactating feed cost per cow.

Mortality rate: HTR focused on the number of mortalities within the herd.

PI: Preliminary incubation count. Measure of milk quality to detect bacteria. It is a unique test that has the ability to detect bacteria that grow in cold environments called psychrotrophic bacteria.

ROA: Return on assets. The profitability of a farm relative to its total assets.

SCC: Somatic Cell Count. Indicator of the quality of milk. White blood cells (leukocytes) constitute the majority of somatic cells in milk.

TDS: Total dissolved solids. Amount of minerals, metals, organic material and salts that are dissolved in a certain volume of water.

REVIEWERS

Lisa Holden, Associate Professor of Dairy Science, 814-863-3672, lah7@psu.edu
Dr. Holden is an Associate Professor of Dairy Science within the Department of Animal Science. Her area of focus is dairy management. Dr. Holden has an emphasis on integrated dairy management and working with dairy advisory teams.

Coleen Jones, Research Associate, 540-997-5809, cjones@psu.edu
Coleen manages the annual Penn State Dairy Cattle Nutrition workshop. She also assists with research and extension activities related to calves, heifers and forages.

Tammy Perkins, Office Assistant, 814-865-9973, tap10@psu.edu
Tammy is an Office Assistant in the Department of Animal Science. She provides technical assistance for programs, publications, and promotional materials to the Penn State Extension Dairy Team.

AUTHORS

Adrian Barragan, Assistant Clinical Professor, 814-863-5849, axb779@psu.edu
Dr. Barragan is an Extension Veterinarian within the Department of Veterinary and Biomedical Sciences. His areas of expertise are transition cow management, cow comfort, reproduction and personnel management

Tim Beck, Extension Educator, 717-840-7408, tbeck@psu.edu
Tim is a Dairy Business Management Educator based in York, Pennsylvania. He works with dairy producers to study cost of production and prepare business plans for their operations.

Jennifer Fetter, Extension Educator, 717-921-8803, jrf21@psu.edu
Jennifer is a Water Resources Educator based in Dauphin County. She focuses on safe drinking water, storm water management, and agricultural water resources in Pennsylvania.

Robert Goodling, Jr., Extension Associate, 814-863-3663, rcg133@psu.edu
Rob is an Extension Associate in the Department of Animal Science. His programs include evaluating dairy data sources for management decisions and implementing financial management practices within financial software environments.

Jud Heinrichs, Professor of Dairy Science, 814-863-3916, ajh@psu.edu
Dr. Heinrichs is a Professor of Dairy Nutrition within the Department of Animal Science. His area of focus is dairy nutrition and management. Dr. Heinrichs has an emphasis on calves, heifers and forages for dairy cattle.

Ron Hoover, Senior Project Associate, 814-865-6672, rjh7@psu.edu
Ron serves as a coordinator of on-farm research; he conducts soil and crop management research and extension as a member of the Penn State Agronomy extension team.

Virginia Ishler, Extension Dairy Specialist, 814-863-3912, vishler@psu.edu
Ginny is an Extension Dairy Specialist covering topics related to nutrition, feeding, business, and nutrient management. She is in the Department of Animal Science.

Heather Karsten, Associate Professor of Crop Production / Ecology, 814-863-3179, hdk3@psu.edu
Dr. Karsten is an Associate Professor of Crop Production. Her research interests include advancing agroecological research to design sustainable cropping systems and the role of perennials in cropping system sustainability.

Kristen Kyler, Extension Educator, 717-948-6609, klk343@psu.edu
Kristen coordinates initiatives in the Lower Susquehanna Region that assist municipalities, farmers, organizations, and private landowners to implement water quality improvement projects.

Dan McFarland, Extension Educator, 717-840-7408, dfm6@psu.edu
Dan is an Agricultural Engineering Educator with program emphasis on animal structures and environmental system design. His area of interest is in improving animal health, comfort, and well-being.

Leon Ressler, Extension Specialist, 717-394-6851, ljr6@psu.edu
Leon is an Agronomy Educator based in Lancaster County. His program is focused on nutrient management and water quality.

Mauricio Rosales, Extension Educator, 717-394-6851, amr486@psu.edu
Mauricio is an Extension Educator based in Lancaster County. Mauricio's educational programs focus on transition cow management, dairy business management, and training for Spanish-speaking dairy employees.

Andrew Sandeen, Extension Educator, 724-465-3880, ats415.psu.edu
Andrew is an Extension Dairy Educator in Indiana County. Andrew has industry experience and expertise in bovine reproductive physiology and management.

Bryan Swistock, Senior Extension Associate, 814-863-0194, brs@psu.edu
Water Resources Extension Specialist focused on human and livestock drinking water, irrigation water quality, pond/lake management, water conservation, and watershed management.

John Tyson, Extension Educator, 717-248-9618, jtt107@psu.edu
John is a Regional Extension Agricultural Engineer. In this position he has conducted educational programming in dairy housing, cow comfort, farmstead layout, feed storage design, manure handling, and agricultural ventilation.

Cassie Yost, Extension Educator, 717-263-9226, clm275@psu.edu
Cassie is an Extension Dairy Educator in Franklin County. Her expertise is in calves and heifers.

Amber Yutzy, Extension Educator, 814-643-1660, anl113@psu.edu
Amber is an Extension Dairy Educator in Huntingdon County. She has been an educator with Penn State Extension for 14 years. She specializes in milk quality, udder health and dairy herd management.

Sarah Xenophon, Research Technologist, 717-702-3505, skx5000@psu.edu
Sarah is a technician at the Penn State Agricultural and Environment Center. She helps farmers determine which conservation practices best suit production goals while addressing property needs.

FINANCIAL ASSESSMENT

Authors: Tim Beck, Robert Goodling, Jr., Virginia Ishler

The dairy industry has been subjected to extreme market volatility in grain and milk prices over the past decade, causing moderate to severe financial distress on dairy farms in Pennsylvania and across the country. In 2009, the industry experienced extremely low milk prices and in 2012 extremely high feed costs. Figure 1 shows the volatility of the milk margin per cwt (gross milk price – feed cost) over the past decade. There was a seven-year gap between the two highest margins, and in many cases high milk prices were not frequent enough to compensate for the extremely low margin years. Since 2012, feed costs have remained relatively flat and have only recently started a downward trend in 2016 (Figure 2). The global economy has a direct influence on dairy operations in the United States and the three-year cycle of high, medium and low prices is no longer relevant.

Monitoring only milk income or feed costs per cow or per hundredweight (cwt) does not provide enough insight to make well-informed decisions. Wolf (2010) showed that income over feed cost (IOFC) could be used to monitor profit by including gross milk income and feed cost. Using IOFC accounts for the volatility in milk and feed markets, giving the producer a better metric for evaluating profit margin, especially as it relates to milk production (milk income). Income over feed cost can be used to evaluate nutrition and pasture management, the amount spent on purchased feeds or the cost of home-raised feeds against the current milk production, (Ishler, Beck, Bailey, Cowan, & Dickenson, 2015).

In animal agriculture most farms are easily divided into two enterprises, the crops and the livestock. For the dairy operation it is important for the dairy enterprise to be sustainable. However, in today's market environment income from other enterprises is often needed to make the whole farm sustainable. Similar to other businesses, the breakeven cost of production number is needed to make smart and sustainable decisions. This publication will provide guidelines for determining the key financial metrics necessary for short- and long-term viability. Production parameters are closely associated with the financial health of the dairy operation, so benchmarks are provided to help set goals and develop action plans.

Figure 1. Pennsylvania Milk Margin/cwt (2007-Present)

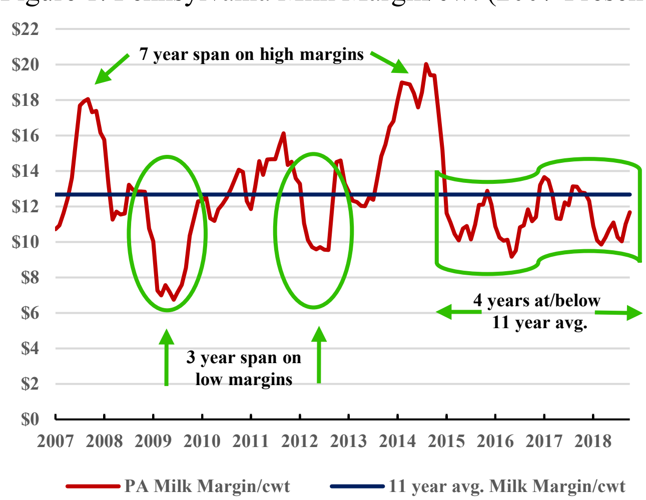
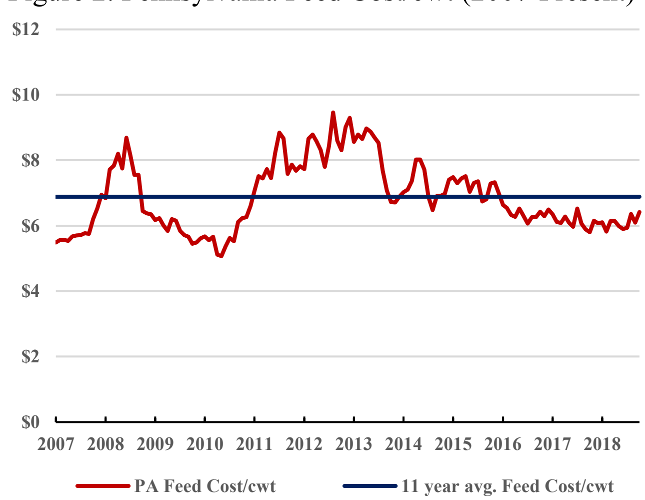


Figure 2. Pennsylvania Feed Cost/cwt (2007-Present)



Know Your Numbers: Breakeven Cost of Production and Financial Ratios

The first step is to determine the operation's breakeven cost of production on a cash flow basis (see Appendix A). The ideal time frame is at the end of the year when actual numbers can be used. This will provide the framework to plan a cash flow for the upcoming year. Once the breakeven margin (per cwt) or income over feed cost (per cow) is determined, the value of monitoring one or both of these metrics monthly makes more sense. Adjustments to expenses or strategies to improve income can be implemented more quickly to avoid severe deficits.

The income statement and beginning and ending balance sheets are needed next. These statements provide the numbers to update financial ratios and examine trends over multiple years (see Appendices B, C and D). These worksheets encompass all assets and liabilities of the operation. Inventories of animals and crops are an essential component. Liabilities include accounts payable, lines of credit and intermediate and long-term loans. The balance sheets and income statement are used to determine the financial ratios (see Appendix E). To identify problem areas for an operation, the following four measures will provide a great deal of insight:

- return on assets – profitability;
- current ratio – liquidity;
- operating expense ratio (cost-basis) – efficiency;
- debt-to-assets ratio – solvency.

Financial Efficiency

The ratios for operating-expense, depreciation-expense, interest-expense, and net farm income most closely reflect the strength of the farm production system. All four of these ratios add up to 100 percent. Compared to the typical benchmark of 80 percent, for dairy operations a more realistic operating-expense ratio is less than 70 percent because feed costs typically make up 50 percent. When these ratios fall into the yellow and red zones, they are a symptom of low revenue. Examining these ratios over multiple years, it is not unusual to see yellow and red scores when the milk price or milk income is low. However, during good years this area should show yellow and green ratings. Poor efficiency can be the result of outdated technologies or technologies that are not properly implemented. A poor match of cow numbers to the cropland base can be a primary cause of poor financial efficiency.

Rate of Return on Assets = Profitability

The rate of return on assets (cost basis) is determined by taking net farm income plus interest minus the value of labor and management divided by average farm assets.

Green	Strong	Greater than 8%
Yellow	Caution	8% to 4%
Red	Vulnerable	Less than 4%

Areas in the operation that affect profitability are high or rising costs, declining sales of crops and livestock, or natural disasters such as a drought that have negatively impacted crop yields and animal performance. Consistently low profitability leads to liquidity and solvency problems. The two major areas to investigate are the total feed costs including both home-raised and purchased feed, as well as labor costs including owner draw and hired labor.

Current Ratio = Liquidity

The current ratio is determined by taking the total current farm assets divided by total current farm liabilities. This shows the extent to which current farm assets, if liquidated, would cover current farm liabilities.

Green	Strong	Greater than 1.7
Yellow	Caution	1.7 to 1.1
Red	Vulnerable	Less than 1.1

Paying bills on time is a sign of strong liquidity versus late payments where interest and penalties accrue. An increase in accounts payable (e.g., feed, fertilizer, repair bills) can undermine the current ratio. Strategies to correct poor liquidity are usually not too palatable. These can include generating additional income from an off-farm job, reducing family living expenses, reducing farm production expenses within reason, or consolidating all current debt into one loan. Evaluate the implications of any strategy to the bottom line and the future long-term viability of the operation, especially if intermediate or long-term assets will be sold.

Term-Debt Coverage Ratio = Repayment Capacity
This ratio is calculated by taking net farm operating income plus net non-farm income plus interest on term debt including family living and taxes divided by term debt principal and interest.

Strong	Greater than 1.5
Caution	1.5 to 2.0
Vulnerable	Less than 1.2

This ratio determines the farm's ability to generate enough income to cover all scheduled intermediate and long-term debt payments. This does not include line of credit payments. Lenders will typically accept a ratio of at least 1.25 or greater.

Farm Debt to Asset Ratio = Solvency
The debt to asset ratio is the total farm debt divided by total farm assets. It is the proportion of total farm assets owed to creditors.

Poor solvency can result in lenders denying any future loans. The implications are very significant as the future viability of the farm is in jeopardy as well as any plans for retirement.

Strong	Less than 30%
Caution	30% to 60%
Vulnerable	Greater than 60%

Breakeven Cost of Production Per Hundredweight
There are two main ways of calculating a dairy's breakeven cost of production on a per cwt weight basis. This can result in numbers that will not match exactly. However, both values will result in similar assessment of the farm's financial health. This measure is appropriate as a metric based on an annual basis.

Cash flow basis: This approach is the simpler of the two. This considers any pre-paid expenses and accounts payables for any category. Loan payments, including principal and interest as well as family living expenses, are used to calculate the breakeven number.

Profitability basis: This approach is more complex as it considers depreciation, changes in animal and feed inventories and a standard calculation for determining a cost for labor and management.

FINPACK® is an example of a program that calculates cost of production in this manner (Minnesota, 2018a). In this approach depreciation is calculated by using a 5% rate for buildings, 10% for machinery, and 15% for titled vehicles. The economic depreciation is calculated by taking the beginning cost (book) value, plus new purchases (book), less book value of items sold, multiplied by the appropriate percentage rate. The value of unpaid operator labor is calculated using the following formula: for sole proprietors and partnerships, labor and management are valued at $25,000 per operator plus 5% of the Value of Farm Production, with a minimum of $30,000 for a full-time farm operator.

Example Types of Cost of Production (per cwt):

Dairy farm A's cost of production on a cash flow basis in 2017 was \$18.64/cwt compared to a profitability basis of \$18.04/cwt. This herd milks 300 cows.

Dairy farm B's cost of production on a cash flow basis in 2017 was \$16.44/cwt compared to a profitability basis of \$17.41/cwt. This herd milks 1000 cows.

Breakeven Income Over Feed Cost Per Cow and Milk Margin Per Hundredweight

These metrics are sometimes used interchangeably and create confusion on a herd's status due to the nature of how they are determined and what they are relaying. The breakeven IOFC can be calculated for the dairy enterprise only or it can include the whole farm. Penn State's program calculates this number by taking the total outflow minus milk cow feed (home raised and purchased) minus non-milk income. The monies left over must cover all other expenses including the feed for dry cows and heifers. This metric can easily be used monthly to evaluate how the herd is doing on both production and financial performance. Monitoring IOFC on a per cow basis is useful because it relates how well the cow is converting feed into milk.

Another metric to determine the margin per cwt uses the feed cost from all animal groups. Using this method means the breakeven margin is \$1.50 to \$2.00 per cwt lower compared to using the number representing only the lactating cows. This margin is used by the 2018 Farm Bill's Dairy Margin Coverage (DMC) program (Agriculture Improvement Act of 2018, 2018). For example, a \$10.25 per cwt margin based on lactating cows would be adjusted to \$8.25 to \$8.75 per cwt for comparison to the 2018 Farm Bill Program.

Example Income over Feed Cost (per cow per day):

A herd's breakeven IOFC for the dairy enterprise only is \$8.58/cow.
April 2018 milk price - \$15.84/cwt.
Average milk production per cow per day based on milk pounds shipped - 81 pounds
Average feed cost per cow per day - \$4.53 (farm cost of home raised feeds) or \$6.17 (market cost of home raised feeds)

Cost basis: $(15.84/100 \times 81) - 4.53 = \$8.30$/cow/day
Market basis: $(15.84/100 \times 81) - 6.17 = \$6.66$/cow/day

On a cost basis, this herd is losing \$0.28/cow/day in April. On a market basis this operation would be losing \$1.92/cow/day. Even though the feed expense on a cost basis is reasonable and cows are performing well, the milk price is not adequate to provide cash surplus.

Example Milk Margin (per cwt):

The breakeven milk margin per hundredweight is calculated by taking the per cow number divided by the average milk production. For example: $\$8.58/81 \times 100 = \$10.59$/cwt

The monthly milk margin is determined by taking the milk price/cwt minus the feed cost/cwt. Using the same example from income over feed cost/cow:

Cost basis: $\$15.84 - (4.53/81 \times 100) = \$10.25$/cwt
Market basis: $\$15.84 - (6.17/81 \times 100) = \$8.22$/cwt

In April, this farm would have a deficit of \$0.34/cwt on a cost basis or \$2.37/cwt on a market basis.

CROP PRODUCTION ASSESSMENT

Authors: Ron Hoover, Virginia Ishler, Heather Karsten

Quality Metrics for Crop Dry Matter Content at Harvest

Suggested dry matter levels based on silo structure

	Corn Silage	Alfalfa Silage	Grass Silage	HM Shell Corn	HM Ear Corn
Bunker/Pile	28 to 33%	30 to 35%	28 to 33%	68 to 74%	60 to 66%
Stave/Bags	32 to 37%	35 to 40%	32 to 37%	68 to 74%	62 to 68%
Oxygen Free	40 to 50%	40 to 50%	40 to 50%	72 to 78%	64 to 70%

Quality Metrics for Home-raised Feeds

Ideal neutral detergent fiber (NDF), starch (corn silage), and digestibilities

Forage	DM%	NDF % of DM	NDFD, 30hr % of NDF[1]
Legume silage	56	44	high 50's
Upright (oxygen), range	51 to 62	36 to 51	
Legume silage	37	47	high 50's
Horizontal, range	30 to 43	40 to 55	
Mixed legume silage	55	48	high 50's
Upright (oxygen), range	51 to 60	40 to 56	
Mixed legume silage	35	52	high 50's
Horizontal, range	27 to 42	45 to 59	
Grass silage[2]	31	62	60+
	21 to 41	55 to 68	
Mixed grass silage[2]	36	56	60+
	28 to 45	50 to 63	

Forage	DM%	NDF % of DM	NDFD, 30hr % of NDF[1]
Corn silage[2]	33	45	Conventional - 55 to 60
Range	25 to 40	38 to 51	Brown mid-rib - 60 to 70+
	Starch - 17 to 50%		
	Starch digestibility 7hr - 65 to 81%		

[1]Note: Values reflective of procedures used at Dairy One Forage Lab and Cumberland Valley Analytical Services.

[2]The low dry matter percent would be appropriate for horizontal structures and the high dry matter percent for upright structures.

Quality Metrics for Recommended Fermentation Profile
Corn silage pH - 3.5 to 4.5
Hay-crop silage pH - 4.0 to 5.5
Lactic acid - 70% of total acid produced (3 to 8% on a DM basis)
Acetic - 1 to 4 % DM
Propionic - < 0.50% DM
Butyric - < 1% DM is ideal, up to 5% DM may cause palatability problems and is not considered ideal.

Quantity Metrics to Minimize Purchased Feed
Approximately 1.5 acres/cow (at a minimum)
Example:

Animal Unit	Individual Weight (lbs.)	Cow Equivalent	Total Cows
70 cows	1350	1.00	70
11 dry cows	1500	1.11	12
20 calves	350	0.26	7
20 heifers < 12 mos.	650	0.48	10
40 heifers > 12 mos.	850	0.63	25
Total animals			124

124 × 1.5 acres = 186 acres (owned and rented)

A minimum of two months carryover of corn silage is recommended.

There are several key areas of the dairy operation to benchmark that help identify opportunities for improvement. After evaluating the financial measures, the next steps are to determine the underlying problems related to generating sufficient income or reducing expenses appropriately. The main production areas are cropping, feeding, production, reproduction, milk quality, and culling and replacements. There are certain metrics that can be used to monitor herd performance over time. Tying these together with a financial metric like IOFC per cow helps determine if the operation is moving in the right direction.

Factors Affecting Soil Health
Soil Fertility: Soil pH, phosphorus, potassium, and magnesium levels should be in the optimum soil test range and this will vary with soil series and soil analytical methods. Refer to the soil test recommendations of the Land Grant University for your soil and region. For example, in Pennsylvania, the Penn State recommendations are:

- Soil pH: 6 to 7 for most agronomic crops; 6.5 to 7 for alfalfa and barley
- Phosphorus (P): 30 to 50 ppm
- Potassium (K): Forage crops: 100 to 200 ppm; Grain crops: 100 to 150 ppm
- Magnesium (Mg*):* Grass forage crops: 120 to 180 ppm; Other agronomic crops: 60 to 120

Nitrogen (N): Use an objective research-based N recommendation method to determine crop N needs (ex. local Land Grant University method for your region). Nitrogen is a key plant nutrient for optimal crop yield and quality. Nitrogen available for crops and N amendments needed for crop yield goals can be estimated based on past organic N amendment history (e.g., legumes, manure, cover crops, compost), soil organic matter levels, cover crop N or estimates of C:N ratio, and tests such as PSNT (Pre-Side dress Nitrate Test), plant N sensors (e.g., Greenseeker, NDVI (Normalized Difference Vegetation Index), leaf chlorophyll tests), and decision-support weather and management tools such as Adapt N. Soil N measured at any one time is not an ideal indicator of how much N will be available to crops over the growing season. Crop-available soil N can change frequently as soil organic N mineralization rates change with soil temperature and moisture. Further, inorganic N can be lost via leaching and de-nitrification when soil is saturated.

Soil Organic Matter: Maintaining or improving soil quality implies that soil organic matter is being maintained or increased over time. Soil organic matter provides many soil health benefits and possible organic matter level varies with soil texture and climate. This test is not always included in standard agronomic soil tests but is available from most soil testing labs. Soil organic matter levels change slowly; it is advisable that samples only be collected and tested every three to five years. To minimize variability that will occur between times of the year, strive to sample the soil at the same time of year, and preferably at the same time in the crop rotation. If soil organic matter levels are declining, consider adopting soil management practices that can sustain and increase soil organic matter. Example practices that reduce soil erosion and add organic matter are:

- Reducing tillage
- Leaving crop residue on the field rather than removing it
- Including perennial crops in rotations with annual crops
- Planting cover crops after harvested annual crops such as winter cereal rye after corn and soybeans
- Applying manure and compost to fields

Soil Structure, Porosity: Well-structured soils are important for numerous reasons:

- They contain sufficient pore space necessary for soil gas exchange
- They are capable of storing and making available to crops the large quantities of water necessary for high yields
- They resist compaction (and loss of pore space), especially when field operations must occur when soils are wet
- They reduce the potential for soil and nutrient losses from fields due to water erosion

Soil structure or soil aggregate stability can be improved by:

- Increasing soil organic matter
- Reducing tillage
- Avoiding field operations when soils are wet
- Modifying cropping systems to include living crops during more days throughout the year

An increasingly popular way to evaluate soil structure and additional soil quality indicators would include using the NRCS Soil Quality Indictor sheets that can be downloaded at: https://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/health/assessment/?cid=stelprdb1237387

Compaction: Compaction damages soil structure and reduces porosity, resulting in suboptimal crop performance (see above). Avoid wheel traffic when fields are wet; however, soils that have well-developed soil structure have increased traffic ability and will incur less damage when field operations (harvest, manure hauling) simply must take place. Hand-held penetrometers can identify compacted zones in soils. Measurements should be taken when soils are moist, but not excessively wet. Avoid measurements during drought conditions. Readings of 300 pounds per square inch are recognized as very compacted. Ideally, readings should be 200 pounds per square inch or less for optimal crop performance. Some soils with a long no-till history can have higher penetration resistance measures, especially heavier soils.

Soil Biological Activity: Although in the past little attention has been paid to the numerous forms of life that existed in our soils, more recent and ongoing research is finding that soil biological activity and diversity enhances crop productivity and stability, often contributing to greater profitability. Soil biological diversity aids in conserving and cycling crop nutrients and improving soil structure and overall quality. Increased biology in and on the soil can increase populations of biological controls of various crop pests, potentially leading to reduced inputs necessary to manage various crop pests. Soil biology is often improved when practices that improve soil organic matter, structure, and quality are incorporated into cropping systems.

Yield and Quality of Home Raised Feeds

Whether they be weeds, insects, or diseases, crop pests in quantity will reduce crop yield, often reduce crop quality, and in the case of perennial forages, reduce longevity of the stand. While it is nearly impossible to eliminate all pests, it is desirable to monitor crops for their presence and manage as appropriate. Economic thresholds (that population of a pest where the cost of control is comparable to the value of crop lost if NO control measure is applied) for major crop pests along with possible control measures, are typically available from your local Land Grant University such as The Penn State Agronomy Guide. Knowing which pests are in a field, and if they are approaching economic threshold will require occasional scouting of fields.

Weeds: A large population of weeds in the crop will compete for crop growth resources and result in lowered crop yields. Also, the presence of some weed species in forage can reduce forage quality and some weed species introduce toxins into the feed stream. Knowing the weed species is important and requires scouting fields. While the presence of a few weeds may not reduce crop yield or quality, allowing many weeds to mature and produce seed can result in increased problems for future crops.

Insects: There are numerous insect pests on both perennial and annual forage crops. Consult resources from your local Land Grant University such as The Penn State Agronomy Guide and extension.org for more information about insect pests. For instance, historically, the most damaging dairy crop insect pests of corn, European corn borer and corn rootworm, are easily controlled with hybrid traits. However, care should be exercised to not use traits, or chemical controls, when they are not required. Overuse has been shown to result in development of pest populations that are resistant (or tolerant) to the control. Management and control research for many insect pests continues. Managers who wish to remain up-to-date on these challenges can find information from the local Land Grant University, in farm press, and at crop meetings.

Diseases: Many diseases in agronomic crops are managed with crop rotation or planting density, as chemical control application is often not cost effective. Of increasing interest is late season leaf disease control in corn. Gray leaf spot and northern corn leaf blight can dramatically reduce the effective leaf area of infected plants during grain fill. These diseases are more troublesome during wet growing seasons, when corn is grown repeatedly, in low-lying areas where crop humidity is high for extended periods, when corn stover remains after grain harvest, and when no-till production practices are used. While recent research demonstrates value in applying fungicide onto maturing corn for improving grain yields, the value of these treatments is less certain in silage situations, especially if the disease pressure is low.

Seeding Rates and Plant Populations: Decades of field research have resulted in recommended seeding rates for the various grain and forage crops grown in a region. Details can be found in extension resources of your local Land Grant University such as The Penn State Agronomy Guide. In general, corn grown for silage can be planted at slightly higher populations than that grown for grain. While a yield-limiting stress (drought) will reduce yields, it will have less impact on corn silage yield than on grain. Less grain in the resultant silage will lower forage quality, but the deficit can be corrected by adding grain to the ration**.**

Harvest Stage of Development

Perennial and Annual Grass Forages (excluding corn and other seed grain producers): In general, forage quality of these species begins a slow decline until appearance of the seed head (boot stage) when stem secondary cell walls reduce digestibility and protein concentration. Then the rate of forage quality decline increases dramatically. When forage of high quality is desired, graze or harvest prior to the development of seed head and stem elongation. If subsequent harvests are desired, avoid frequent harvests and leave sufficient stubble (leaf area and energy reserves that enable regrowth).

Alfalfa and Other Perennial Legumes: Similar to grasses, quality declines as the crop matures. However, frequent harvest of these species at pre-bud or early bud stages to maintain forage quality can result in reduced regrowth vigor, resilience to weather and pest stress, and competition with other species in the sward, especially weeds. When stand longevity is desired, recommendations include allowing the forage (especially alfalfa) to mature until at least 10% bud and early flower stages at least once during the year (during one of the later cuttings is preferred.) This is necessary to allow replenishment of the plant energy stores in roots and crowns that fuel regrowth and enable winter survival.

Corn Harvest: The primary driver of when to harvest corn and other grain bearing annuals is crop moisture at harvest. Recommendations for when to harvest, based on storage structure for the crop, are outlined in other sections of this guide.

Crop Costs

The cost to produce home-raised feeds is calculated by taking the direct costs (seed, fertilizer, chemicals, custom hire, land rent) and indirect costs (overhead costs, labor). The forage crop enterprise and grain crop enterprise tables provide the average cost based on the profitability of 25 dairy operations over two years for the cropping enterprise, which were sorted by return over labor and management. For the forages, the high profit herds had the highest yield and the lowest cost per ton compared to the low and medium groups. This trend did not follow for the corn and soybeans. The medium and high profit groups had similar yields but very different costs. The main reason appeared to be high costs for land rent and fertilizer for the medium profit group. The high profit group was spending much less and achieving good yields. The value of growing corn and beans should be closely examined if they are being produced on rented land. Typically, these fields are located at a distance not suitable for manure application and thus inorganic fertilizer is used to achieve high yields.

Forage crop enterprise analysis combined for years 2016 and 2017 and sorted by return over labor and management.[1]

	Low profit	Medium profit	High profit
Corn silage			
Number of farms	16	17	17
Acres, average	212	306	152
Yield per acre (as-fed tons)	15.25	19.83	21.60
Cost per ton, $	40.51	31.43	22.58
Cost per acre, $	617.78	623.31	487.65
Alfalfa haylage			
Number of farms	8	9	9
Acres, average	112	74	91
Yield per acre (as-fed tons)	6.89	11.90	14.38
Cost per ton, $	78.81	51.35	35.50
Cost per acre, $	542.64	611.52	510.40
Small grain silage			
Number of farms	13	13	14
Acres, average	176	184	270
Yield per acre (as-fed tons)	5.52	5.67	8.20
Cost per ton, $	61.60	40.12	33.85
Cost per acre, $	340.30	227.45	277.56
Grass hay			
Number of farms	11	12	12
Acres, average	32	106	47
Yield per acre (as-fed tons)	2.10	2.84	3.92
Cost per ton, $	231.95	111.87	64.45
Cost per acre, $	487.53	317.39	252.33

[1]Based on 25 PA farms participating in two-year (2016-2017) Crops to Cow project (Ishler, Goodling, & Beck, 2018), and analyzed with RankEm software (Minnesota, 2018b).

Grain crop enterprise analysis combined for years 2016 and 2017 and sorted by return over labor and management.[1]

	Low profit	Medium profit	High profit
Corn grain			
Number of farms	11	12	13
Acres, average	76	240	126
Yield per acre (as-fed bushels)	104.65	200.06	192.33
Cost per bushel, $	4.62	3.18	2.37
Cost per acre, $	483.93	635.42	456.38
Soybeans			
Number of farms	10	10	11
Acres, average	89	152	99
Yield per acre (as-fed bushels)	42.37	56.93	57.93
Cost per bushel, $	9.25	7.46	4.48
Cost per acre, $	391.88	424.99	259.76

[1]Based on 25 PA farms participating in two-year (2016-2017) Crops to Cow project (Ishler et al., 2018), and analyzed with RankEm software (Minnesota, 2018b).

PRODUCTION AND FEEDING MANAGEMENT
Authors: Tim Beck, Robert Goodling, Jr., Virginia Ishler

Milk Production Metrics	
Average pounds of milk per cow, bulk tank	2x milking ≥ 75; 3x milking ≥ 85
Pounds of components	> 6 (5.5 at a minimum)
Average peak milk, pounds	
Heifers	> 80 (75% compared to 3rd lactation or greater)
Cows	> 110
All	> 95

The most important number as it relates to production is the total pounds of milk shipped. This coupled with the milk price will generate the income needed to cash flow a dairy operation. The pounds of milk shipped is heavily dependent on maintaining the appropriate number of milk cows and production for the operation. In the Northeast, milk price can be heavily influenced by percent milk fat and milk protein. An achievable goal is producing over six pounds of components to take advantage of the price per pound of both.

Example Pounds of Components:

A herd averages 90 pounds of milk per milk cow per day, with a 3.8% fat and 3.2% protein.

Pounds of components: (90×.038) + (90×.032) = 6.3 pounds of components/milk cow/day.

Maintaining adequate milk cow numbers is highly correlated with reproduction, culling and the heifer program. The management practices affecting average milk production are forage quality, forage quantity, cropping program, feeding management, cow comfort and the formulated ration.

Feed Costs[1]

Average total feed costs representing 2016 and 2017 from 25 dairy operations using FINPACK®

	High	Low	Average
Total feed costs/cow/year (home-raised and purchased)	$3,208	$1,683	$2,295
Milk income and cattle sales/cow/year	$5,894	$3,361	$4,637
Feed costs/milk income and cattle sales	78%	33.5%	50%

[1]Based on 25 PA farms participating in two-year (2016-2017) Crops to Cow project (Ishler et al., 2018), and analyzed with FINPACK software ((Minnesota, 2018a).

Note: On average feed costs can make up 40 to 60% of milk income. Data from the Penn State Extension dairy business management team illustrates there can be a wide range. Herds with low feed costs can typically maintain a competitive margin, however the operations with extremely high feed costs usually have very low margins that are not sustainable over the long term.

PennState Extension

1/15/19

Clear Form

Determining milk income needed	Dairy Enterprise Only*	*Do not include custom work or other farm income	
Number of milking cows	170		
Expenses:		Farm Total	Dairy Enterprise Percentage
Direct costs	$ 159,953		
Overhead costs	$ 141,606	$ 170,610	83.00
Family living expense	$ 34,350		
Taxes			
Loan payments (principal + Interest)	$140,126		
Total feed cost	$ 452,807	home raised and purchased feed	
Total outflow	**$23.51**		
Non-Milk Income	$ 69,610		
Minus non-milk income	**$ 828,333**		
Average milk price	**$ 17.50**		
Minimum pounds of milk shipped/year	4,733,333		
Average production, lbs/day	**76.28**		

Feeding Management Metrics

Dry matter intake	48 to 55 lbs./cow/day (75 to 85 lbs. milk)
Bunk space	24 inches/lactating cow; 18 inches minimum; 30 inches minimum for prefresh cows
Feed available	21 hours/day; push up at least 4x
Water	3 linear inches per cow
Cud chewing index	> 40% of cows lying down
Milk urea nitrogen	8 to 12 mg/dL
Dry matter intake efficiency	> 1.45 (ECM/DMI)

Calculating Energy Corrected Milk (ECM):

	Milk Lbs.	Fat%	Protein%	3.5% Fat Corrected Milk (FCM)	Energy Corrected Milk (ECM)	lb fat	lb prot	Total lbs of components
Example	**75.0**	**3.70**	**3.10**	77.4	**76.4**	2.775	2.325	5.10
Your Farm	**85.0**	**3.70**	**3.10**	87.8	**86.6**	3.145	2.635	5.78

ECM equation: (12.82 * fat lbs) + (7.13 * protein lbs) + (0.323 * milk lbs)

REPRODUCTION

Authors: Adrian Barragan, Robert Goodling, Jr., Andrew Sandeen

Reproduction Metrics	Short Definition	Goal
Heat Detection Rate / Submission Rate (HDR)	# of cows detected in heat or serviced ÷ # eligible	≥ 65%
1st Service Conception Rate (CR)	# of cows pregnant ÷ # of cows serviced	≥ 40%
Pregnancy Rate (PR)[1, 2]	Percentage of eligible cows that become pregnant within a specified time period PR = HDR × CR (typically in 21-day window)	≥ 24%
Average Days Open (ADO)	Average number of days between calving and new pregnancy	≤ 120 days

[1]Note: With an overall average CR of 30%, HDR would need to be 80% to achieve a 24% PR.

[2]Note: With an overall average CR of 40%, HDR would need to be 60% to achieve a 24% PR.

Genetics and performance for reproductive measures in United States dairy herds have improved in recent years. As a result, the bar keeps moving higher for benchmarking and goals. A 20% pregnancy rate used to be an aggressive goal. Now some herds are consistently topping 30%. Currently, a goal of 24% is reasonable for most Holstein herds. Jersey herds may want to aim for a goal of at least 28%.

Reproductive performance in a dairy herd has a definite impact on dairy profitability. As reproductive performance improves, a dairy operation tends to see:

- More calves
- A shorter period of time that heifers are on feed
- Earlier and more prolonged milk income per animal
- Less need for replacement heifers
- Increased flexibility and opportunity to market animals for beef or dairy purposes
- Less use of labor and supplies for reproductive tasks
- Increased herd genetic improvement

Pregnancy Rate

Pregnancy rates are often presented as 21-day PR. Looking at the data separated into 21-day windows of time allows for an evaluation of trends over time. Some seasonal fluctuations can easily be explained but may be difficult to correct (e.g., hot weather effect in the summer). Other trends, when recognized, may reveal significant opportunity for improvement. There can be differences in how pregnancy rate is calculated and reported, depending on the data source. It is important to compare pregnancy rates over time from the same source to ensure differences are a result of changes in pregnancy rate and not changes in calculation method. Increasing the herd pregnancy rate by 1% is expected to provide an economic net return between $3.20 and $14.40 per cow per year (Cabrera, 2014). For a 100-cow herd, an improvement in PR from 20% to 24% would equate to an annual expected net return of approximately $3400. Changes in breeding programs in dairy herds achieving pregnancy rates above 25% may not yield an economic advantage (De Vries, Steenholdt, & Risco, 2005; Plaizier, King, Dekkers, & Lissemore, 1998; Risco, Moreira, DeLorenzo, & Thatcher, 1998)

Heat Detection Rate

Heat detection rate defines the percentage of eligible cows detected in estrus or inseminated even if not visually observed in estrus. Submission rate is a better term to use when evaluating a timed AI program where estrus is not always detected before artificial insemination (AI). Some of the burden for constant heat detection can be alleviated by using timed AI, however, there is almost always good opportunity to use traditional heat detection methods (with or without the use of special heat detection aids) between services, which may be economically advantageous. Following first service, anything that can be done to reduce the interval between successive services generally results in better economics returns; savings are estimated to be $37 to $47 per cow per year for each week the interval between services is shortened (Cabrera, 2014).

Conception Rate

Conception rates can be influenced by a wide variety of factors – weather, cow health, cow comfort, semen handling, timing of insemination, stage of lactation, breed, etc. They can even be influenced by the all too common loss of pregnancy that is realized more and more as early diagnosis options are increasingly utilized. Generally, the success rate for first-service inseminations is of interest in evaluating the success of a particular reproductive management approach, as even the most fertile cows will be serviced a first time. Maximizing the number of pregnancies established at first service lessens the need to deal with the hassle and expense of subsequent services. There are timed AI approaches that have been developed in recent years that commonly exceed what can be achieved by more traditional heat detection methods in terms of conception rate, consistently reaching close to 50% in some herds. There is a cost of more than $2 per cow per day for each day a cow goes beyond 120 days open (Ribeiro, Galvão, Thatcher, & Santos, 2012; Smith, Gilson, Ely, & Graves, 2009).

Achieving the Goals

Any improvement to conception rates or heat detection rates will also improve pregnancy rates. Achieving good pregnancy rates after a reasonable voluntary waiting period (VWP) will almost always keep average days open in a good place.

To increase **Submission Rate**:

- Use proven heat detection aids that suit the system.
- Invest in employee training for protocol implementation.
- Schedule adequate time for detecting estrus and provide an efficient system for recording heats.
- Comply with synchronization shot protocols.
- Consider purchasing an activity monitoring system for more accurate, around-the-clock heat detection.
- Consider using more timed AI to eliminate some of the need for heat detection.
- Diagnose pregnancies earlier or more frequently to allow for quicker re-insemination.
- Use a more aggressive resynchronization strategy that shortens the time between services.

To increase **Conception Rate**:

- Ensure that the transition cow program (nutrition, health management) is working well.
- Only use semen that is proven to be of high quality.
- Regularly monitor liquid nitrogen levels and inspect semen storage tanks for frosting.
- Evaluate semen handling techniques and note any differences between technicians. Make sure semen is deposited just beyond the cervix in the uterine body.
- Check that timing of insemination is appropriate relative to onset of standing estrus or whatever timed AI protocol is being followed.
- Consider using one of the more successful timed AI protocols.

To decrease **Average Days Open**:

- Ensure that the transition cow program (nutrition, health, management) is working well.
- Service every eligible cow by 100 DIM.
- Maximize conception rates.

MILK QUALITY
Author: Amber Yutzy

Milk Quality Metrics			
Herd		**Bulk tank**	
Cows with linear score (LS) > 4.0	< 20%	Bulk tank SCC	< 200,000 cells/mL
Cows with somatic cell count (SCC) ≤ 200,000 cells/mL (LS < 4)	80%	Standard plate count (SPC)	< 10,000 cfu/mL
Cows with SCC ≤ 400,000 cells/mL (LS < 5)	95%	Pre-incubation (PI) count	< 50,000 cfu/mL
Cows with clinical mastitis	< 3%		

Mastitis
Mastitis is the number one cost concern in milk production. Many factors play a role, but the number one loss associated with mastitis can be attributed to reduced milk production. Mastitis is a bacterial infection of the udder that causes a persistent, inflammatory reaction of the udder tissue. This potentially fatal mammary gland infection is the most common disease in dairy cattle in the United States. Bacteria enters the teat and causes inflammation in a quarter. The inflammation increases the number of white blood cells that come to the udder to attack the bacteria. White blood cells are also known as somatic cells. Cows suffering from mastitis have an increased somatic cell count (SCC) in their milk. The higher the SCC, the more serious the infection. A cow infected with mastitis early in lactation will have reduced milk production for the remainder of her lactation compared to what her potential production would have been without the infection. Recent estimates suggest each case of mastitis can cost $231 to $289 per cow, which translates to over $1 billion per year loss for the United States dairy industry. Common areas associated with lost income include:

- Reduced milk production
- Quality premium loss
- Discarded milk
- Treatment costs
- Increased labor
- Veterinarian costs
- Culling and replacements

Simple calculations can be done on farm to help determine the amount of income being lost due to mastitis. The graphs on the following page will assist with those calculations.

Clinical vs. Subclinical: There are two types of mastitis found on dairy farms: sub-clinical and clinical. Sub-clinical mastitis is also called the hidden mastitis. This is because the milk appears normal; however, it contains excessive numbers of somatic cells. Performing a few extra tests on farm will help to determine the number and type of bacteria present.

The second kind of mastitis is called clinical. Clinical mastitis causes visible abnormalities in the milk, such as white flakes, a bloody tint, or discolored (e.g., yellow, clear) milk. Milk from cows experiencing this level of mastitis should not be sold for human consumption. A cow with clinical mastitis might show additional symptoms such as fever, loss of appetite, lower milk production, inflamed udder, or swollen quarters.

Investments in mastitis control can affect economic returns. Early detection of mastitis can result in a higher cure rate.

Calculation of Milk Quality Premium Opportunity[1]

	$ per cwt	Example
A. Maximum available SCC premium (at 100,000 to 150,000 cells/mL)		**$0.70**
B. Currently received SCC premium/penalty (last milk check)		**- $0.20**
Potential Premium Difference	**(A - B)**	**$0.90**
C. Hundredweight's shipped last month		**1,068**
Current Monthly Premium Opportunity	**(A - B) × C**	**$961.20**

Estimated Production Losses Due to Subclinical Mastitis[1]

Lactation Group	Number of Cows	Average Linear Score	Goal	Milk Lost per Group (lbs.)	Milk Lost per Group (lbs.)	Monthly Production Losses Due to Subclinical Mastitis
1			- 2.0	× 200		
1 (example)	**50**	**4.0**	- 2.0	× 200	**20,000**	
2+			- 2.5	× 400		
2+ (example)	**50**	**5.5**	- 2.5	× 400	**50,000**	
Milk Price per lb.: **$0.16** × Total lbs. Lost					**70,000**	÷ 12 = $**933**

Calculation of Cost of Clinical Mastitis[1]

		Example
A. Average cost of drugs used (include all drug costs)		**$18.00**
B. Avg. number of days milk discarded		**6 days**
C. Avg. milk/cow/day discarded		**65 lbs.**
D. Milk price per lb.		**$0.16**
Total Cost of Discarded Milk	**(B × C × D)**	**$62.40**
E. Estimated labor and vet costs/cow		**$20.00**
Total Cost per Clinical Case of Mastitis	**A + (B × C × D) + E**	**$100.40**
F. Number of clinical cases treated per month		**4**
Monthly Cost of Clinical Mastitis	**F × Total Cost**	**$401.60**

[1]Adapted from "Premiums, production, and pails of discarded milk. How much money does mastitis cost you?" (Ruegg, 2005).

Identifying subclinical mastitis can be challenging. Individual cows should be routinely monitored for subclinical mastitis infection. Milk from subclinically infected quarters appears normal, even when millions of somatic cells are present. A quarter with an SCC level of > 200,000 cells per mL is evidence of subclinical mastitis. One valuable tool that all farms should utilize daily is the California Mastitis Test, or CMT. The CMT will help determine whether a cow has mastitis and which quarters are infected. Another valuable tool is monthly SCC on each cow through the DHIA program.

Bacteria live everywhere, so many areas on the farm can cause mastitis. When trouble shooting focus on:

- Cleanliness of housing and animals
- Bedding type
- Cow handling
- Consistency with standard operating procedures
- Milking procedure and prepping
- Milking equipment
- Records

Pre-Incubation Counts

Preliminary incubation (PI) count for raw milk is a number that affects milk price. The bacteria count is determined by incubating a milk sample at 55ºF for 18 hours, then plating it and performing a standard plate count (SPC). The number of bacteria present are then estimated. The PI (18 hours) count is compared to the regular SPC, which is a bacteria count on the fresh sample. The idea is that bacteria that grow in the udder do not grow well at 55ºF, but certain bacteria that originate outside the udder can. If the PI count is high compared to SPC, it suggests some undesirable practice on the farm allowed these bacteria to enter the milking equipment and grow somewhere between the milking unit and the bulk tank. When diagnosing high PI counts on a farm, the following areas should be examined:

- Slow cooling bulk tank or temperature above 40°F (bulk tanks should be < 40°F within two hours of milking and kept below 45°F during subsequent milkings.
- Failure to thoroughly clean equipment after each use or neglecting to sanitize equipment before using (a major cause).
- Problems with debris build-up in plate coolers and chillers.
- When milking fresh and problem cows in bucket milkers, hoses need to be kept clean.
- Dirty animals; udder hair may need removed
- Poor udder sanitation practices.
- Contaminated water supply.
- Equipment wash water temperature should start at 155 to 170°F and drain at above 120°F.
- Gaskets and rubber parts need to be clean, free of cracks and deposits, and replaced when necessary
- Improperly drained milking equipment.
- Teat cup liners should be clean and free of cracks; changed on schedule.
- Pulsator and main vacuum supply lines need cleaned on a regular basis.

REPLACEMENTS AND HERD TURNOVER

Authors: Robert Goodling, Jr., Jud Heinrichs, Cassie Yost

Calf and Heifer Metrics

Calf Benchmarks (S. Gelsinger & Heinrichs, 2017; Jones & Heinrichs, 2006)

- 4 quarts high quality (> 50 grams IgG /Liter) colostrum within 1 to 2 hours after birth
- Double birthweight in 80 to 90 days
- Grain consumption: .5 lbs./day for 28 to 30 days for adequate rumen development
- Calf mortality < 5%
- For each day left untreated with a respiratory illness, a calf will lose 278 lbs. of production in the 1st lactation (Heinrichs & Heinrichs, 2011)

Suggested Average Daily Gains (ADG): (S. L. Gelsinger, Heinrichs, & Jones, 2016; Zanton & Heinrichs, 2005)

- Birth to Weaning (~60 days of age): 1.3 to 1.8 lbs./day
- Post Weaning: 1.6 to 1.8 lbs./day
- Post Puberty (10 to 23 months.: 1.8 to 2.4 lbs./day (as needed to achieve 75 to 85% mature BW at calving)

Total heifer costs (birth to freshening) $/heifer

	Pennsylvania (Heinrichs et al., 2013)	Wisconsin (Akins et al., 2016)
• Feed	$1,317.86 ± 281.16	$ 909.52 ± 426.90
• Labor	$ 202.51 ± 98.90	$ 178.13 ± 287.26
• Total Cost	$1,808.23 ± 338.62	$1,366.26 ± 630.50

Every heifer calf born on a dairy farm represents an opportunity to maintain or increase herd size, to improve the herd genetically, or to improve economic returns to the farm. The objectives of raising the newborn calf to weaning age are optimizing growth and minimizing health problems.

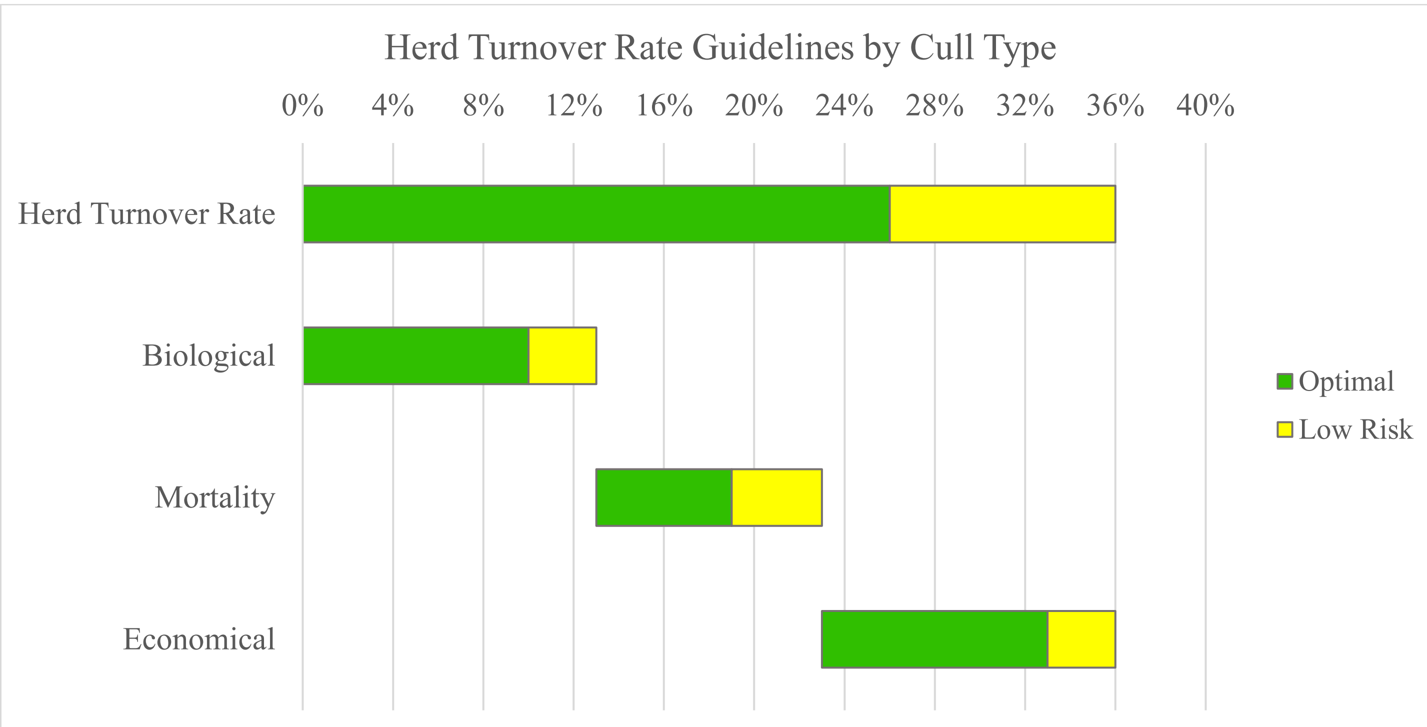
Herd Dynamics

Dairy operations have a unique symbiotic relationship between their heifer and cow enterprises. The lactating herd is reliant on the heifers to supply replacement animals to maintain and grow the operation. The heifer enterprise is reliant on the cows to supply female calves as future replacements for older animals leaving the herd. The Herd Metrics Tool, developed by the Penn State Extension Dairy Team, is an online tool designed to determine the annual balance for both the heifer and cow enterprise (Goodling, 2014).

Herd Turnover Rates (HTR)

When evaluating herd turnover on a dairy farm, the accuracy of culling records and timing of culling are key economic drivers. Without accurate reasons for culling listed, it is difficult to assess the impact of herd turnover on the operation. Median herd turnover rates between 2000 to 2006 for eastern United States dairy herds as part of a dairy herd improvement (DHI) records system were reported to be 30 to 35% (De Vries, Olson, & Pinedo, 2010). There are several ways to define and calculate culling activities within a herd. Overall herd turnover rate is important, but to really assess an operation the reason for the cull is more critical. Attention should be paid to culling that occurs less than 60 days in milk (DIM) as this is the costliest time for culls. Forty-two percent of mortality culls happen within the first 60 days of lactation (Dechow & Goodling, 2008; Hadley, Wolf, & Harsh, 2006). Early lactation, less than 30 or 60 DIM, is a critical time to maximize herd milk yield and recoup costs from the dry period.

Three key areas to monitor routinely are: biological and economical cull rates, mortality rate, and age at first calving.



Biological and Economical Cull Rates

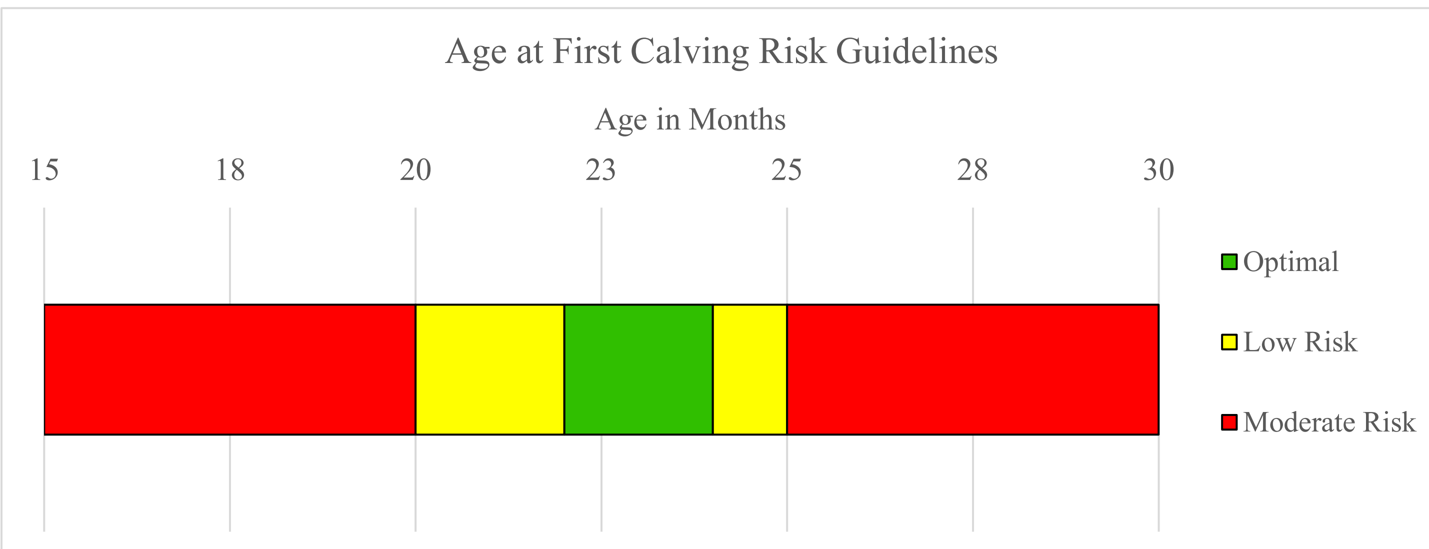
Fetrow et al. describes a need to move away from the terms “involuntary” and “voluntary” culls to “economical” and “biological” culls (Fetrow, Nordlund, & Norman, 2006). Biological culls would be similar to involuntary culls in that the cow had a health event that forced her out of the herd (e.g., poor fertility, lameness, mortality, poor milk quality). These types of culls occur regardless of the economic value of replacing that cow. Economical culls (e.g., dairy or low production) would be those that potentially improve the economic position of the herd. Numerous studies have reported 50 to 80% of culls were biological, typically for low fertility and udder health (Ahlman, Berglund, Rydhmer, & Strandberg, 2011; Hadley et al., 2006; National Animal Health Monitoring System, 2007). For better monitoring of a herd’s progress, mortality rates and biological rates have been separated. Successful herds should be able to maintain biological and economical cull rates at or below 10% annually. If levels exceed 13% the operations’ ability to remove cows from the herd for economic reasons may be limited.

Mortality Rates

Mortality rates are critical to both the cow and heifer enterprises. The average cow mortality rate for United State and Pennsylvania Holsteins, regardless of herd size, was around 5.7 to 6.4% (Dechow & Goodling, 2008; National Animal Health Monitoring System, 2007). It has also been shown that there is a correlation between mortality rates and culls less than 60 DIM (Dechow & Goodling, 2008). Successful dairy operations should maintain a cow mortality rate less than 6%. If mortality rates increase past 10%, this can be a significant economic loss to the dairy and investigations into causes of the higher rate are warranted.

Age at First Calving

Age at first calving (AFC) is a combination of an efficient heifer raising system and successful targeting of age at first breeding. Research indicates that calving significantly below 22 months can compromise production, except in extremely well managed herds. Additionally, looking at the distribution of AFC not just the average for the herd is critical to assess adequate management. Herds with an AFC above 24 months are economically disadvantaged due to the dollars invested in feed, labor, etc. and the extended payback to cover those expenses. The optimal AFC depends on the farms' heifer management practices, and the monitoring of first lactation production to ensure adequate performance is achieved.



FACILITIES

Authors: Dan McFarland, John Tyson

Facility Metrics

The following risk factors can be used as a guideline to evaluate dairy shelters. The values in the "Low Risk" category are generally accepted to provide positive environmental and management results. Factors that fall in the "High Risk" category are often a limit to health, production, and performance.

Feeding

Feed Space (inches of feed space per head)

Low	Medium	High
≥ 24 inches	16 to 24 inches	< 16 inches

Feed Availability

Low	Medium	High
≥ 22 hours	20 to 22 hours	< 20 hours

Height of Feed Table

Low	Medium	High
2 to 6 inches	6 to 18 inches	< 2 or > 18 inches

Feed Frequency: Defined as number of times fresh feed is presented per day.

Low	Medium	High
3 or more times	2 to 3 times	Once or less per day

Water Availability

Water Space per Cow in Freestall Shelter

Low	Medium	High
≥ 3 inches	3 to 1.5 inches	< 1.5 inches

Water Space per Cow in Tiestall Shelter including flow rate

Low	Medium	High
≥ 3 inches	3 to 1.5 inches	< 1.5 inches

Water Flow Rate in Tiestall Shelter

Low	Medium	High
≥ 3 gallons per minute	1.5 to 3 gallons per minute	< 1.5 gallons per minute

Environment

Air Quality: Temperature difference between stall area and outside.

Low	Medium	High
≤ 5 degrees	5 to 10 degrees	> 10 degrees

Heat Abatement

Low	Medium	High
Tunnel Ventilation or Circulation Fans PLUS Evaporative Cooling	Tunnel Ventilation or Circulation Fans Only	No heat abatement used

Management

Overcrowding (% cows to stalls)

Low	Medium	High
≤ 5%	5 to 20%	> 20%

Free Stall Dimensions for Holsteins (Jerseys)

Width

Low	Medium	High
≥ 48 inches (≥ 45 inches)	46 to 48 inches (43 to 45 inches)	< 46 inches (< 43 inches)

Length (Closed Front): Closed front defined as having an obstruction within the area from 6 inches above stall surface to 30 inches above stall surface. Length is measured from alley side of curb to stall side of support post.

Low	Medium	High
≥ 9 feet (≥ 8 feet)	7.5 to 9 feet (6.5 to 8 feet)	< 7.5 feet (< 6.5 feet)

Length (Open Front): Open front defined as having no obstruction within the area from 6 inches above stall surface to 30 inches above stall surface. Length is measured from alley side of curb to stall side of support post.

Low	Medium	High
≥ 8 feet (≥ 7 feet)	7 to 8 feet (6 to 7 feet)	< 7 feet (< 6 feet)

Neck Rail (horizontal): Measured from alley side of curb to the cow side of the neck rail.

Low	Medium	High
≥ 68 inches (≥ 64 inches)	64 to 68 inches (60 to 64 inches)	< 64 inches (< 60 inches)

Neck Rail (vertical): Measured from the stall surface if mattress or from stall curb is sand bedded to the bottom of the neck rail.

Low	Medium	High
≥ 48 inches (≥ 44 inches)	44 to 48 inches (40 to 44 inches)	< 44 inches (< 40 inches)

Brisket Locator (board): Measured from the alley side of the curb if mattress or from cow side of curb if sand-bedded to the bottom of the brisket locator.

Low	Medium	High
≥ 70 inches (≥ 66 inches)	66 to 70 inches (62 to 66 inches)	< 66 inches (< 62 inches)

To minimize housing related stress the dairy shelter must provide the following basics: good seasonally adjusted ventilation, free access to water, free access to feed, a dry comfortable resting area, and confident footing. Providing these basics enhances cow comfort and allows cows to reach their genetic milk production potential.

Natural Ventilation

Cold Weather: The inside temperature should be no greater than 10°F higher than shaded outside temperature. There should be no condensation, dripping or fogging in the facility. The recommended adequate ridge opening is a minimum of three inches per 10 feet of building width for mature animals and two inches per ten feet of building width for young stock. Adjustable sidewall openings are preferred.

Hot Weather: The inside temperature should be no greater than 5°F higher than shaded outside temperature. Heat stress relief measures should begin at 60 to 65°F and should be fully implemented by 70°F.

Mechanical Ventilation

Cold Weather: Inside temperatures should not exceed 50°F. There should be no condensation, dripping or fogging in the facility. Multiple fans with a control system are needed to adjust ventilation rate to match outside conditions.

Hot Weather: The inside temperature should be no greater than 5°F higher than shaded outside temperature. The goal during hot weather ventilation should be to provide a 45-second air exchange with a minimum air speed of 3.5 miles per hour.

Water Space

Lactating animals should be provided free access to good quality water. Providing three inches of linear water space per cow or space for 15% of a group to drink at the same time is the goal. A minimum of two watering stations per group of lactating cows should be provided with a maximum distance of 80 feet between watering stations. Each watering station should provide a minimum capacity of 50 gallons of water with a depth of three to five inches and allow for easy cleaning and drainage. The water supply system should provide a refill capacity of five to ten gallons per minute.

Feed Space

Lactating cows should be provided with a minimum of 18 inches of feed space per cow, and 24 to 27 inches per cow is preferred. Prefresh cows should be provided 30 inches per cow minimum. Feed should be available a minimum of 21 hours per day meaning cows should be away from the pen no more than three hours per day. This applies to both 2x and 3x milking.

Resting Area

Providing a dry, comfortable resting area for dairy cattle is essential to their health, well-being and performance. Cows typically rest 10 to 14 hours per day in five or more resting bouts. Well designed and managed stalls can reduce excessive standing, allow more efficient rumination, improve cleanliness, and minimize injury.

Stall Base

Mattress and Mat-Based Stalls: should provide a resilient base with an additional one to three inches of bedding material. Avoid pulling bedding material from front to rear, but rather remove wet dirty bedding and replace with clean dry bedding. This should be done daily for best results.

Generously (Deep) Bedded Stalls: should provide a minimum of four plus inches of bedding at the rear of the stall and slope upward one to two inches from rear to front. Bedding stalls two to three times per week by adding smaller amounts has several advantages. 1) Stall bed relationship to stall structure remains similar 2) Less waste due to cows ‘digging’ to get in stall 3) More consistent manure mixture and 4) May use less total bedding than only bedding heavily once per week. Stall beds must be leveled on non-bedding days to maintain a level side-to-side stall base and avoid piles or humps of bedding material building up in the front of the stall where it will reduce the lunge and lying area. The goal is to maintain a consistent stall bed to stall structure relationship.

Stall Hygiene: Groom a minimum of three times per day. This applies to both tie stall and free stall barns. This is especially important when pens are overcrowded.

Stall Refusal: There should be no cows lying in the alleys. Less than 10% of cows should stand in or part way in stalls one to two hours after milking and feeding. Perching, cows standing with two feet in the stall and two feet in the alley, may be an indication of stall structure or dimensional issues. Cows standing completely in the stall may indicate stall bed or bedding issues.

Floors

No cows should slip when walking and manure should be removed two or more times daily. Good quality grooves or textured floor surface needs to be provided. Adequate traction can be provided with 3/8 to 1/2 inch wide and deep grooves 2-1/2 to 3-1/2 inches on center in a parallel arrangement. A diamond pattern should be used for cow traffic turns such as crossovers and lane turns. Most cow alleys typically require periodic resurfacing to ensure good traction.

Bedded or Compost Pack Pens

Pack area must be sized appropriately for the animals being housed. Recommendations include 80 to 90 square feet per head for dry cows, a minimum of 125 square feet for lactating animals, and 175 to 200 square feet per animal in a maternity pack. A manure scrape alley and feed driveway are necessary for long-term housing. However, the alley area is not included in the resting area sizing. Individual pens should be 12 feet by 12 feet with “all in and all out” manure handling. Bedding needs to be added to maintain a clean, dry, and comfortable resting area.

Hospital

Area where animals are easily segregated for examination, treatment and convalescence. Feed, water and resting area must be provided when cows are held longer than one hour. The hospital pen should be separate from the maternity area and include a method of restraining cows for assessment and treatment.

ANIMAL HEALTH

Authors: Adrian Barragan, Mauricio Rosales

Common Diseases in Dairy Cattle

During the first weeks of lactation, post-partum cows are more susceptible to diseases since their immune system and metabolic status are compromised due to the stress caused by the calving process and lactation. Cows that experience more inflammation and stress around calving, probably due to poor management, are more likely to suffer metritis and milk fever (Goff & Horst, 1997); (Huzzey et al., 2009). Therefore, it is crucial to manage cows properly (e.g., adequate cow comfort, availability of fresh water and feed) to prevent the occurrence of these undesirable events. Cows that develop diseases during the transition period are at a higher risk of poor performance during their lactation. For instance, cows that experience common health events, such as retained placenta and metritis, have a decrease in milk production, ranging between 3 and 12 pounds per day (Rajala & Gröhn, 1998). Similarly, cows that experience one or more health events during the first 60 DIM have lower cyclicity and pregnancy per breeding, and greater pregnancy losses (Santos et al., 2010). Cows experiencing diseases not only have impaired production and fertility, but also impaired well-being. A recent study reported that cows with metritis had increased concentrations of biomarkers of inflammation and pain, suggesting that metritis cows experience visceral pain (Barragan et al., 2018). The recommended goals for these conditions are indicated in the following table. Higher incidences indicate that there may be issues in management and a veterinarian should be consulted.

Common Diseases Affecting Post-Partum Cows, Incidence and Estimated Costs (Treatment and Lost Milk)

Disease	Short Definition	Group at high risk	Goal (%)	Median incidence (%)	Estimated cost per cow[1] ($)
Clinical Hypocalcemia or Milk Fever	Low levels of Ca (< 1.5 mmol/L) in bloodstream **with** observed clinical signs (e.g., down cow)	Lactating multiparous cows, 12 to 24 hours after calving	< 5	6.5	335
Subclinical Hypocalcemia	Low levels of Ca (< 1.5 mmol/L) in bloodstream **without** observed clinical signs	Lactating multiparous cows, 12 to 24 hours after calving	< 30	22	125
Clinical Ketosis	High levels of ketones bodies (BHBA > 3.0 mmol/L) in bloodstream with observed clinical signs	Lactating cows 5 to 50 days in milk	< 2	4.8	145
Subclinical Ketosis	High levels of ketones bodies (BHBA > 1.2 mmol/L) in bloodstream without observed clinical signs	Lactating cows 5 to 50 days in milk	< 10	43	67

Metritis	Inflammation of all the layers of the uterus and the presence of watery, foul smelling, reddish or brownish vaginal discharge.	Lactating cows 4 to 21 days in milk	< 5	10.1	354
Retained Placenta	Failure of expulsion of the fetal membranes within 24 hours after parturition.	Lactating cow 24 hours after calving	< 5	8.6	285
Lameness	Any condition affecting the walking ability of the cow. The cost presented in this table accounts for severe cases of lameness (e.g., locomotion score of 4 to 5), while milder cases (e.g., locomotion score of 2 to 3) may be less costly.	Any cow	< 25	7.0	302 to 400
Displaced Abomasum (DA)	Abomasum is filled with gas and is displaced into the abdominal cavity compromising the blood circulation and function of the organ. It can be a left DA (95% of the cases), or right DA (5% of the cases).	Lactating cows presenting other health issues	< 3	5	340

[1]Based on "Transition cow nutrition and feeding management for disease prevention" article (Van Saun & Sniffen, 2014).