



# Economic Analysis of Dairy Breeds

Which Breed is the Best

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## Executive Summary

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Jersey Canada engaged a team of researchers at the University of Guelph to perform an Economic Analysis of Dairy Breeds in Canada. This analysis focused on measuring Revenue, Operating Income and Return in Investments. A typical herd of each of the seven breeds in Canada, Jersey, Holstein, Brown Swiss, Guernsey, Milking Shorthorn, Canadienne and Ayrshire was established based on 90 kilograms of Quota. An investment of \$2,250,000 in Ontario at the time of writing.

This basis generated herds varying in size from 104 Holsteins to 155 Milking Shorthorns. There would be 116 Jerseys. Correspondingly the **Fixed Asset Investments** of the quota, barn, parlour, milk tank and manure storage ranged from a low of \$2,756,725 for Jerseys to a high of \$3,066,990 for Shorthorns. These prices were based on industry data from DHI, CDN and suppliers to the industry. All the equipment was priced at new or replacement values.

**Revenue** was tabulated to include: milk, cull cows and manure. Bull calves were excluded due to the thin market for such animals. The researchers did not expect the result of Milking Shorthorns to be the top revenue generator of \$585,016 but the component value was the deciding factor. Holsteins were third at \$544,200 after Brown Swiss and Jerseys were lowest with revenue of \$507,142.

After factoring in operating expenses of feed, milking labour, reproduction costs and veterinary charges, (only available for Holstein and Jerseys) and milk cheque deductions, Jerseys were the top **Income Generator** at \$161,451 versus Holsteins at \$141,388 in second place and Canadienne in third with a likely income of \$133,000 should they face similar Veterinary costs as the Jerseys.

The final measure of economic performance was **Return on Investments**. Due to the above findings the Jersey breed was the top performer with an ROI of 5.86% versus 4.98 for Holsteins and Canadienne estimated at 5.00%. An interest expense proxy was factored in at 6% on the investments calculated by breed for further comparison. The findings placed Jerseys as the **only breed** that came close to a profit after interest of \$(3,917).

In summary, the Jersey breed is the most economical and financially viable dairy breed. The smaller size is a benefit due to efficient conversion of feed, lower labour costs, higher components, lower health and reproduction costs and lower investment in fixed assets.

Should a potential producer wish to consider what breed to use in their operation, the **Jersey Breed should be the preferred breed** for lower investment, higher profit and higher return.

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## Introduction to Report

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Over the recent history of agriculture in Canada, the cost to enter into the Dairy Producing sector has become an ever more expensive investment. These costs can become prohibitive to new entrants to the industry and to those already in the industry trying to expand or find a buyer for their operation as they approach retirement. This issue can be most troublesome when there is a desire to transfer the farm operation to the next generation and costs may prohibit children from accessing the necessary funds to acquire the farm from their parents.

As in all sectors of agriculture, there is an ever increasing effort to operate a dairy farm in the most profitable and efficient manner. To be successful benchmarks are necessary for comparison and demonstration of best practices

In Canada, there are currently seven breeds of cattle used in producing commercial milk for processing as fluid milk and processed into other forms of dairy products and as components of other food products. Data currently used for the comparison of farm operations and price setting by Dairy commissions rely almost wholly on data from Holstein Herds. This is to be expected as approximately 95% of all dairy cattle in Canada are Holsteins. Jerseys represent approximately 3% of all dairy cows and the remaining breeds (Ayrshire, Guernsey, Canadienne, Milking Shorthorn and Brown Swiss) comprise the balance of the Canadian dairy herd in Canada.

In an effort to assist dairy farmers across Canada access financing based on the different breeds and assist in differentiating between different breeds and Jerseys in particular, Jersey Canada engaged a team from the University of Guelph from Accounting, Finance and Agricultural Economics to determine which breed of Dairy Cow in Canada generates the highest profit and return on investment.

This paper looks to determine the "Best" breed of dairy cow in Canada based on Revenue, Income and Profit Margin, and Return on Investment.

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## Method and Limitations

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Financial data and production data was gathered from The Dairy Farmers of Ontario (DFO), The Canadian Dairy Network (CDN), the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), CanWest Dairy Herd Improvement (DHI) as well as various industry associations and government agencies across Canada. These input figures were used to establish a base for the analysis and then the various prices paid for the milk by the marketing boards and the costs for the inputs, feed etc. were varied by province with input from industry representatives in each province.

The input factors were based and calculated representing costs to raise and maintain a herd on a breed by breed basis. A comparative cost break down was prepared in an Income Statement format to determine Net Income and the Return on Investment (ROI) on a Breed by Breed Basis.

The initial Investment for Quota was the same for all breeds, \$2,250,000. Other Direct Investments included the barn, parlour, and Milk Bulk tank and manure storage.

A major limitation was the thin amount of data on breeds other than Holstein and Jerseys. In particular the veterinarian and pharmaceutical costs were lacking for the other 5 breeds. The value of Cull Bull Calves was also difficult to obtain. As a result the value of bull calves was omitted at this time. The current value of some larger bull calves are being reported in some markets but no consistent data has been determined, further warranting the elimination of this form of revenue.

Reproductive costs were based on industry data and varied by breed, not by cost per insemination which was established at the \$37 industry rate, but by the number of inseminations required per breed.

Any costs not obtainable were omitted. The majority of all data was available for the Holstein and Jersey breeds permitting accurate tabulations for these two breeds. An example is that there is data for Veterinarian costs for the two primary breeds but not for the other breeds. This calculation was retained for comparison purposes.

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## Assumptions and Foundations

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The primary Assumption and foundation of the analysis was to base the comparative herds on the need to fill 90 kilograms of quota. This quota of 90 kilograms then generated various herd sizes based on average productivity measures.

Revenue was based on all 3 measures: butterfat, protein and other solids plus the value of Cull animals. Cull cows were valued at \$0.61 per pound. In addition the value of the manure was included. Expenses; Feed, milking labour, reproductive costs and veterinarian and pharmaceutical costs were all input at market rates to provide fair representation of the value of all inputs.

The major Direct Fixed Assets: the barn, the parlour, the milk tank, and the manure storage were valued at replacement cost to provide direct comparison for each breed. Land prices, other farm equipment and other sundry investments were excluded as these factors can vary greatly by location, acreage and managerial decisions regarding operating practices.

Financial costs were also excluded as each operation may be financed in a different manner that reflects the history and management decision of each producer. For argument sake, the income statement does apply a 6% interest factor on all the investments factored in the model assuming the balance of all the equipment and land of each producer is financed in another manner, such as equity or leasing.

Please refer to Appendix A for a list of assumptions.

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## Findings

The Quota basis of the analysis generated herd sizes that varied considerably. The number of cows to be milked using standard production figures generated milking herds of 77 for Holsteins, 82 for Brown Swiss, 88 for Jersey up to 121 Milking Shorthorns. The total herd size ranged from 104 Holsteins to 155 Milking Shorthorns when the number of dry cows were factored in. (see line 51 of the Excel Page MODEL FACTORS). The following tables are based on Ontario Data.

Table 1. Herd Sizes

Ontario Data	Holstein	Jersey	Brown Swiss	Ayrshire	Milking Shorthorn	Guernsey	Canadienne
Milking Cows	76.89	87.98	82.19	96.31	120.93	100.92	106.40
Herd Size	103.61	116.25	110.75	129.16	154.63	136.65	136.74
Dry Cows	26.72	28.27	28.56	32.84	33.70	35.74	30.35

Based on these herd sizes the size of Barn, Parlour, Milk Bulk Tank and Manure Storage were calculated. (See Work Sheet Capital Costs). Costs were based on current market prices. The Total Fixed Investments for all current market priced capital costs nets a range \$2.75 million for Jerseys to \$3.07 million for the Milking Shorthorn herd. This direct effect of the size of herd will be reflected later in the return on the investment calculations. While the Quota value does not vary between the breeds the value was left in for reference purposes and as it is a direct investment specific to the dairy investment. (see Table 2. below and lines 33 to 39 on the Financial Performance Spread sheet.) Space per cow does diminish for the smaller breeds but this advantage is offset by the larger herd size of Shorthorns and Canadienne. See the Spreadsheet "Capital Costs" for detailed calculations of size and cost of a barn, parlour, milk tank and manure storage facilities.

**Table 2. Fixed Direct Investments**

Direct Investments		Holstein	Jersey	Brown Swiss	Ayrshire	Milking Shorthorn	Guernsey	Canadienne
Barn		\$ 349,057	\$ 305,793	\$ 435,096	\$ 375,122	\$ 507,192	\$ 421,073	\$ 414,580
Parlour		\$ 145,323	\$ 123,173	\$ 155,331	\$ 145,324	\$ 194,689	\$ 165,507	\$ 156,401
Tank		\$ 30,000	\$ 25,900	\$ 30,000	\$ 25,900	\$ 25,900	\$ 25,900	\$ 25,900
Quota		\$2,250,000	\$2,250,000	\$2,250,000	\$2,250,000	\$2,250,000	\$2,250,000	\$2,250,000
Manure Storage		\$ 67,934	\$ 51,821	\$ 72,612	\$ 68,077	\$ 89,032	\$ 65,386	\$ 68,934
Total Fixed Investment		\$2,842,617	\$2,756,725	\$2,954,524	\$2,864,406	\$3,066,990	\$2,928,051	\$ 2,914,979



In Table 3 below, Revenue by Breed, Excluding Cull Bull Calves, used DHI data as the basis of calculations. The revenue section of the "Financial Performance" Spreadsheet calculates the revenue based on solids by provincial rates. As well the values of Cull Cows were factored in at a "reasonable" rate of \$0.61 per pound based on Quebec data available at the time of writing. Bull calves on the other hand were excluded as no reliable price could be determined. It was verbally reported that some Holstein bull calves may fetch 60 to 80 dollars but these rates vary greatly and on many farms the bull calves are not considered of any economic value and hence disposed of. The value of Manure was included as there is a noticeable financial impact if used to replace purchased nutrients or as reported by some, the sales value that the manure warrants or generates. As expected the revenue numbers vary considerably and Milking Shorthorn generate the greatest total revenue \$585,373 due to the value of the solids and manure produced. Jerseys generate the least total revenue at \$507,251 but to fully analyze the revenue it is necessary to compare these figures with the costs and expenses incurred to generate the revenue and net profits. It may come as a surprise to many that Holsteins were the third largest revenue generator at \$544,952 behind Milking Shorthorn and Brown Swiss.

Table 3. Revenue by Breed, Excluding Cull Bull Calves

Revenue	Holstein	Jersey	Brown Swiss	Ayrshire	Milking Shorthorn	Guernsey	Canadienne
Butterfat	\$ 278,846	\$ 278,846	\$ 278,846	\$ 278,846	\$ 278,846	\$ 278,846	\$ 278,846
Protein	\$ 190,837	\$ 177,931	\$ 192,990	\$ 189,951	\$ 229,390	\$ 170,356	\$ 192,047
Other Solids	\$ 15,057	\$ 10,062	\$ 12,788	\$ 11,292	\$ 9,529	\$ 9,471	\$ 9,440
Milk Revenue	\$ 484,740	\$ 466,840	\$ 484,625	\$ 480,089	\$ 517,765	\$ 458,673	\$ 480,334
Cull cows	\$ 24,649	\$ 14,182	\$ 24,320	\$ 24,581	\$ 22,401	\$ 27,508	\$ 27,526
Bull Calves	\$ -	\$	\$	\$	\$	\$	\$
Value of Manure	\$ 34,809	\$ 26,120	\$ 37,478	\$ 35,480	\$ 44,849	\$ 33,572	\$ 34,609
Total revenue	\$ 544,200	\$ 507,142	\$ 546,424	\$ 540,151	\$ 585,016	\$ 519,754	\$ 542,470

In the following calculations the expenses were again based on purchasing all feed and services to enable fair comparisons from one farm operation to another. (See Feed Cost Calculations Spreadsheet) In these calculations the size of the animal and the fertility of each breed are significant in their impact on overall expenses. The expenses for Veterinary and Pharmaceutical costs were only available for Holsteins and Jerseys. Discussions with the Ontario Veterinary College and Department of Population Medicine at the University of Guelph gave rise to the realization that figures for the other breeds are either not being tabulated or available at this time. (See spreadsheet Veterinary Costs) Regardless of the exclusion of these expenses for the most breeds and the inclusion for Holsteins and Jerseys, Jerseys still realized the lowest operating expenses. This was in part due to having 1/3 the number of difficult births as Holsteins, fewer inseminations and eating less. Should the other Breeds face similar medical expenses only the Guernsey breed would likely be as low in total expenses as Holsteins who face a disadvantage of over \$55,000 per year in expenses compared to the Jerseys. Labour costs were directly scaled to the time necessary to milk the herds. Again the smaller the volume of milk the lower the labour costs. (see Labour Costs spreadsheet) The Canadienne breed generated the second highest operating income of the seven breeds.

**Table 4. Expenses and Net Operating Income by Breed**

Feed	Holstein	%	Jersey	%	Brown Swiss	%	Ayrshire	%	Milking Short	%	Guernsey	%	CDN	%
<b>Cows</b>	201,644	37	170,200	33	243,508	44	202,953	37	201,201	34	191,314	37	215,189	39
<b>Heifer</b>	112,931	20	104,187	21	125,017	22	139,161	26	169,073	29	124,424	24	113,224	21
<b>Calves</b>	8,175	1.5	5,298	1.0	8,752	1.6	9,573	1.8	11,590	2.0	9,386	1.8	9,997	1.8
<b>Milk Labor</b>	21,473	3.9	16,469	3.2	19,225	3.5	18,170	3.4	17,370	3.0	16,355	3.1	16,607	3.1
<b>Cheq. Ddn.</b>	34,689	6.4	27,015	5.3	31,724	5.8	32,727	6.1	34,595	5.9	28,939	5.6	30,418	5.6
<b>Repro</b>	8,733	1.6	8,921	1.8	8,762	1.6	11,566	2.1	11,210	1.9	12,062	2.3	10,805	2.0
<b>Vet &amp; pharm</b>	15,163	2.8	13,598	2.7	\$		\$		\$		\$		\$	
<b>Total Exp</b>	402,811	74	345,691	68	436,992	80	414,153	77	445,042	77	382,483	74	396,242	73
<b>Opg Inc.</b>	141,388	26	161,451	32	109,431	20	125,997	23	139,974	23	137,271	26	146,227	27

The Return on Investments (ROI) and Financing costs displayed in Table 5 compare expenses to revenue and net revenue collectively and per cow to the actual investment tabulated above. The ROI excludes any financing costs and the highest percentage recorded is for the Jerseys at 5.86%. The lowest is Brown Swiss that has an ROI of 3.71%. Holsteins are third at 4.98%. The revenue per cow is based on the revenue per producing cow and is highest for Shorthorn, ultimately though price and hence revenue is the major aspect of dairy that is to a large extent outside the direct influence of each producer. The operating costs and the financing costs are two significant managerial decisions that are reflected in the operating income reported in Table 4 and below in Table 5. For discussion purposes an interest figure was calculated at 6% on all the listed Direct Investments. After deducting "interest charges", even the Jersey breed did not generate adequate operating income to realize a profit, a loss of \$3,917 was calculated. However the Holstein breed was the second best performer, (loss of \$28,964) ahead of the Canadienne which nets out a loss of \$29,221 after interest charges.

Table 5. Return on Investment and Financing of Investments

	Holstein	Jersey	Brown Swiss	Ayrshire	Milking Shorthorn	Guernsey	Canadienne
<b>Total Fixed Investment</b>	<b>\$2,842,617</b>	<b>\$2,756,725</b>	<b>\$2,942,524</b>	<b>\$2,864,406</b>	<b>\$ 3,066,990</b>	<b>\$ 2,928,051</b>	<b>\$ 2,914,979</b>
<b>Invest per cow</b>	37,902	36,756	39,234	38,192	40,893	39,041	38,866
<b>Revenue per cow</b>	7,256	6,761	7,285	7,202	7,800	6,930	7,232
<b>Return on Invest</b>	<b>4.98%</b>	<b>5.86%</b>	<b>3.71%*</b>	<b>4.38%*</b>	<b>4.57%*</b>	<b>4.69%*</b>	<b>5.00%*</b>
<b>REV/INV per cow</b>	19.2%	18.4%	18.5%	18.8%	19.1%	17.8%	18.5%
<b>Int.</b>	<b>6%</b>	<b>156,750</b>	<b>153,329</b>	<b>159,427</b>	<b>157,052</b>	<b>163,981</b>	<b>159,043</b>
<b>Earnings after Interest</b>	(28,964)	(3,917)	(67,372)*	(46,279)*	(43,957)*	(38,300)*	(29,221)*
<b>Earnings per cow</b>	<b>(386)</b>	<b>(52)</b>	<b>(898)*</b>	<b>(617)*</b>	<b>(586)*</b>	<b>(511)*</b>	<b>(390)*</b>

\* not adjusted for Veterinary bills, earnings overstated and expenses understated by approximately \$13,000

## Conclusions

Based on the calculations presented, the best breed of Dairy Cow, if basing the determination strictly on Total revenue, would be the Milking Shorthorn at \$585,016. Second would be Brown Swiss at \$546,424 and third would be Holstein at \$544,200. Jerseys would be last at \$507,142, based on 90 kilograms of Quota.

Based on Milk revenue alone, the Shorthorn would remain number one with \$518,081 in revenue, Holstein second at \$485,408 and Brown Swiss third at \$483,559. Jerseys would be 6<sup>th</sup> out of 7 breeds at \$466,940.

Based on operating income, Jerseys are the best breed with a 32% margin netting \$161,487 versus 27% for Canadienne (\$145,678) in second rank and 26% for Holstein (\$141,593). As the Veterinary costs for the Canadienne breed were not included, the last two breeds would likely reverse ranking with the Canadienne facing a similar veterinary bill to Jerseys of \$13,598. Correspondingly all the other Breeds would face similar declines of \$13 to 15,000 in operating income. This would result in Jerseys and Holsteins being the most profitable breeds, but Jerseys surpassing Holsteins by \$20,000 in profit despite having a \$37,000 disadvantage in revenue compared to Holsteins. Jerseys are simply put, more efficient. The Jerseys were the only breed that came close to a profit after factoring for financing costs. (-\$52 per cow)

Based on ROI, once again the Jerseys are on top. Jerseys generate a 5.86% Return on Investment versus a 4.98% ROI for Holsteins. It is reasonable to expect that Canadienne would be second with an ROI of 4.55% after factoring veterinary costs. (\$132,678 profit versus \$2,914,979 Total Fixed Investment).

The smaller breeds are winning on the small items.

The smaller breeds are:

1. More efficient in converting feed to milk;
2. More fertile requiring fewer inseminations;
3. Fewer birthing and health issues;
4. Fewer still births;
5. Can be bred at a younger age and milked sooner (Jerseys are milked 30 days sooner than Holsteins), generating revenue sooner and;
6. Require less labour to milk.

Jerseys overall are the calculated superior breed due to the overall higher profit, all generated on lower investment. It is this superior financial performance that should be the significant factor when comparing performance between breeds and when seeking financial investment in a dairy operation.

Size does matter and the smaller breeds are financially better performers.



## Appendices

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### Assumptions

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1. Cull Cows are sold at \$0.61 per pound
  2. Labour is \$15 per hour plus remittances, CPP, IE etc.
  3. Dairy Farmers of Ontario Component Pricing applies using a 12 month rolling average, see Model Factors spreadsheet
  4. DFO milk cheque deductions apply
  5. DHI 2013 component estimates apply to the herd sizes calculated.
  6. Breeding costs are \$37 per Breeding, as per industry quotes
  7. Dry Matter feed costs are quotes from industry and apply across the province
  8. Feed regimen as calculated applies, see Feed Costs Spreadsheet
  9. Manure is valued for components of Nitrogen, Phosphorus and Potassium, see Capital Cost Spreadsheet.
  10. Milking parlour and Robot facilities are average costs per size of animal and variable by breed.
  11. Milk bulk tanks are based on 2 days of production plus 25% safety capacity
  12. Barn Sizes are strictly a factor of the size and number of animals, See Capital Costs Spreadsheet.
  13. An interest factor of 6% is a reasonable proxy for long term financing rates.
  14. There are no significant revenues from Cull Bull Calves
  15. Revenue from genetic sales are excluded
  16. All other labour costs are Producer input and not paid for
  17. All other fixed asset investments are financed strictly by the owner of the dairy farm.
  18. All other investments vary considerably in cost by location, operation and management and hence are excluded from the analysis.
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## Bibliography

1. A. Koeck, F. Miglior, D.F. Kelton and F.S. Schenkel, Health Recording in Canadian Holsteins: Data and genetic Parameters, *Journal of Dairy Science* 2012,
2. T.F.-O. Neuenschwander, F. Miglior, J. Jamrozik, O. Berke, D.F. Kelton and L.R. Schaeffer, Genetic Parameters for producer-recorded health data in Canadian Holstein cattle, 2011, The Animal Consortium
3. National Linear Model Non-Return Rate Bull Evaluations, April 2013, Canadian Dairy Network
4. Monitoring Dairy Heifer Growth, 2008, The Pennsylvania State University
5. Dairy Statistical Handbook 2010-2011, copyright 2012, Dairy Farmers of Ontario
6. Producer Milk Prices, Screen Shot 2013-03-06, Dairy Farmers of Ontario
7. Annual Report 2012, Dairy Farmers of Ontario
8. Statistics of Canada's Animal Genetics, 2012 Edition, Animal Industry Division, Agriculture and Agrifood Canada
9. Canadian Dairy Trade Bulletin, 2012 Edition, Agriculture and Agri-food Canada
10. World Dairy Export Prices, 2009 to 2012, Agriculture and Agri-food Canada
11. The Fall Run: Cull Cows and Trading Calves, September 2011, Canfax Research Services, Canadian Cattlemen's Association
12. Dairy Cattle Housing and Equipment, Rev 06:05, The Canada Plan Service
13. Direct Payments to Agricultural Producers, November 2012, Catalogue no. 21-015-X, Statistics Canada
14. Farm Financial Survey, 2010, Catalogue no. 21F0008X, Statistics Canada
15. Culling and Replacement Rates in Dairy Herds in Canada, 2006-2011, Agriculture and Agrifood Canada
16. W. Minchin, M. O'Donovan, D. Kenney, F. Buckley and L. Shalloo, 2007, An Economic Evaluation of Four Finishing Strategies for Cull Dairy Cows,
17. Farm Milk Composition 2012 Average Test, Canadian Dairy Commission
18. Provincial and National Averages Used as Benchmarks for Genetic Herd Inventory Reports, Milking Shorthorn, Canadienne, Guernsey, Brown Swiss, Jersey, Ayrshire, Holstein, December 2012, Canadian Dairy Network,
19. Guide to Good Dairy Farming Practice, 2011, FAO
20. J. Jamrozik, J. Fatehi, J. and L.R. Schaeffer., 2008, Comparison of models for genetic evaluation of survival traits in dairy cattle: a simulation study
21. Dairy Report 2011, International Farm Comparison Network
22. Adopting Innovation, The Evolution of Valacta Atlantic Dairy Production, 2011, Dairy Production Centre of Expertise
23. Ontario Dairy Farm Accounting Project, Annual Report 2011, Canadian Dairy Commission and Dairy Farmers of Ontario
24. G.R. Wiggans, P.M. vanRaden and J. Zuurbier, 1995, Genetics and Breeding; Calculation and Use of Inbreeding Coefficients for Genetic Evaluation of United States Dairy Cattle, [Dairy Science](#).

25. K. Gunjal, L Menard & R. Shanmugam, Economic Analysis of Crossbreeding Dairy Cattle, 1997, Agricultural Systems, vol. 54, no 3
26. G. Banos, L.R. Schaeffer & E.B. Burnside, Genetics and Breeding, Genetic Relationships and Linear Model Comparisons Between United States and Canadian Ayrshire and Jersey Bull Populations, 1991, Journal of Dairy Science
27. G.R. Wiggans, N. Gengler and J.R. Wright, Type Trait (Co)Variance Components for Five Dairy Breeds, 2004, Journal of Dairy Science
28. Understanding Your Profitability Reports, 2011, Canwest Dairy Herd Improvement