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A New Profit-Based Genetic Selection Index in Canada

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Introduction

- **"Lifetime Profit" has various definitions**
- **Not all breeders/producers have the same sources of revenue**
  - Milk cheque only versus those "merchandizing" genetics
- **New industry realities since the LPI was introduced nearly 25 years ago:**
  - Wide spread recognition by producers that "genetics" is an important contributor to herd profitability
  - Producers want to speak in terms of dollars/economics
  - "One size fits all" mentality, in terms of a national selection index, seems to be less appropriate today

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Need was Driven by Industry (Not by Scientists…)

- **Action from CDN Strategic Planning Session in February 2014:**

  "Explore the development of a second national selection index, in addition to LPI, that would aim to maximize herd profitability for commercial dairy producers."

- **Research was driven by science…**

  - Based on current economic parameters
  - With input from producers & industry partners
  - Full industry support of research "concept" with decision to implement left to industry

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Defining the Profit Equation

- **Canada has two DHI service providers**
  - CanWest DHI (ON & West) and Valacta (QC & East)
  - Common national database for DHI data processing and the production of all reports, etc.
- **Jointly provide their customers across Canada with a Profitability Report for each cow as well as a Herd Summary Profitability Report**
  - Excellent source of cow profit values nationally
  - Economic parameters are updated annually to reflect:
    - Changes in milk pricing, quota, feed costs, labour, calf and salvage values, etc…

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Profit = Income - Expenses

Income

- Fat (kg)
- Protein (kg)
- Other solids (kg)
- Deduction for fluids (kg milk)

Expenses

- Heifer rearing cost (days)
- Overhead cost (days in milk)
- Overhead cost (days dry)
- Maintenance feed cost (days in milk)
- Maintenance feed cost (days dry)
- Marginal feed cost (/kg fat & protein)
- Quota opportunity cost (/kg fat)

PROFITABILITY REPORT

Herd Summary

NAME
CanWest DHI
Sample Herd

HERD NUMBER

PAGE
1 of 1

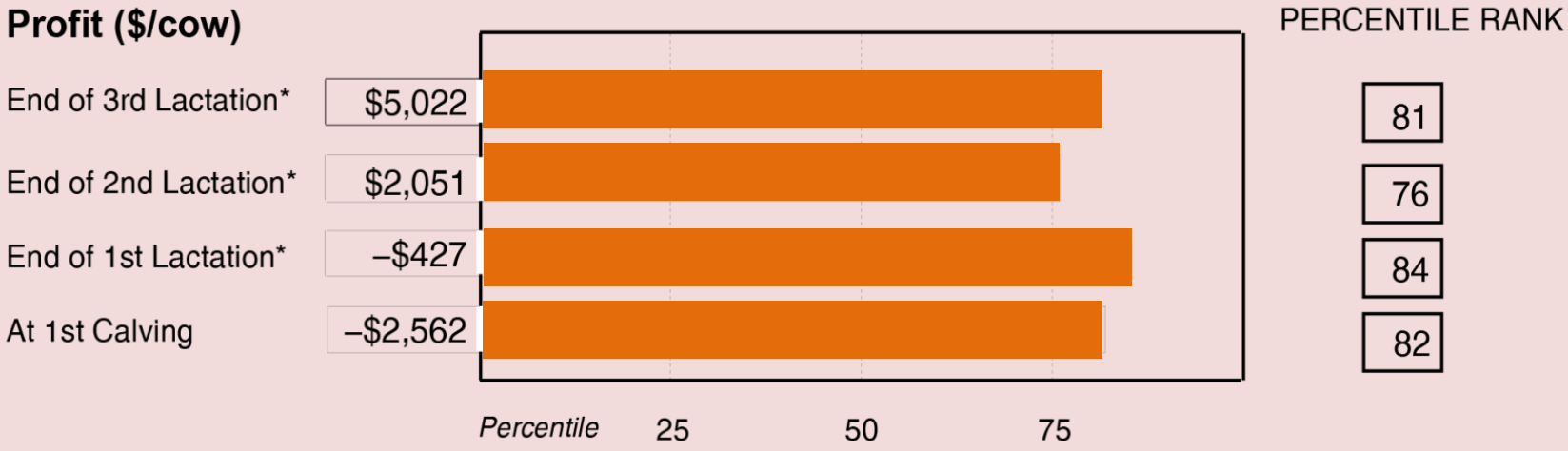
PROFIT DATE
31 Dec 2014

SERVICE
P12

HERD AVERAGES

Lactation Group	Cows		At 1st Calving		End of 1st Lactation*		End of 2nd Lactation		End of 3rd Lactation*		Lifetime*	
	#	%	Age mm.m	Profit ($/cow)	Age * mm.m	Profit ($/cow)	Age * mm.m	Profit ($/cow)	Age * mm.m	Profit ($/cow)	Profit/Day of Life ($/d)	Profit Rank
Herd	107		23.8	–2540	36.1	–523	49.1	2088	62.5	5022	1.06	81
End of 3rd Lactation	17	16	25.7	–2745	38.1	–623	50.1	2139	62.5	5022	2.94	79
End of 2nd Lactation	24	22	23.4	–2502	36.0	–559	48.3	2051			1.37	80
End of 1st Lactation	27	25	22.6	–2415	35.0	–427					– .41	83
At 1st Calving	39	36	24.0	–2562								

HERD PERCENTILE RANKINGS



PERCENTILE RANK

81
76
84
82

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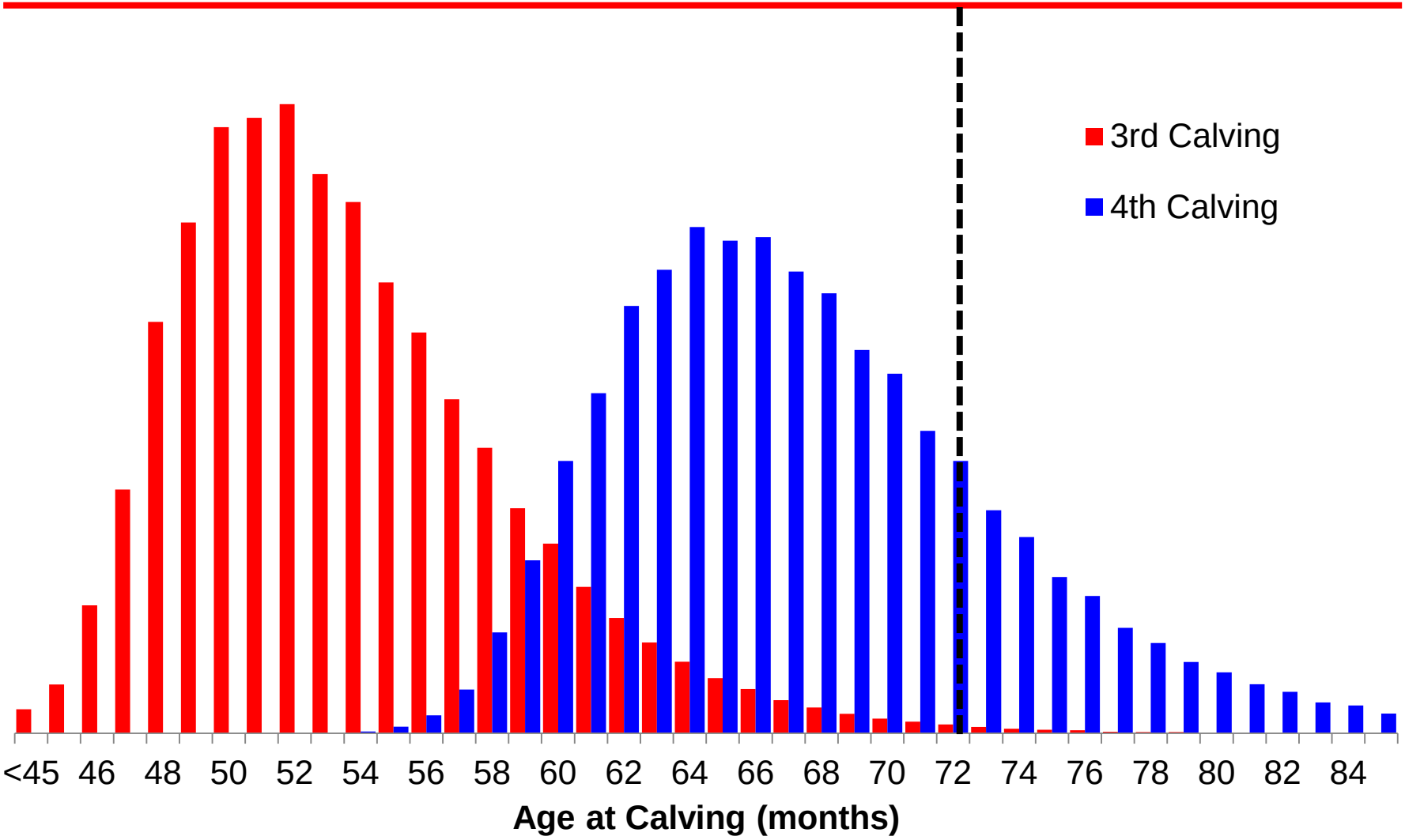
Accumulated Profit to 6 Years of Age



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Data & Analysis

- **Accumulated Profit to 6 Years of Age:**
  - Included cows born from January 2005 to Sept. 2008 to allow the opportunity to reach 6 years of age
  - 690,553 Holsteins with actual profit data
  - Similar profit data was also calculated for other breeds
- **Steps:**
  1. Calculate accumulated profit to 6 years for each cow
  2. Average “Profit to 6 Years” across all daughters by sire
  3. Identify the group of 830 sires with at least 100 daughters with profit data for analysis

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Three Main Components of the Profit Analysis

1. Quantify the relationship between the current LPI of sires and the realized average Accumulated Profit to 6 Years of Age of their daughters
2. Develop the best equation possible that uses sire proofs for various traits to predict the realized average Accumulated Profit to 6 Years of their daughters
3. Compare the “Expected Response” for various traits when selection is based on the new profit index versus the current LPI

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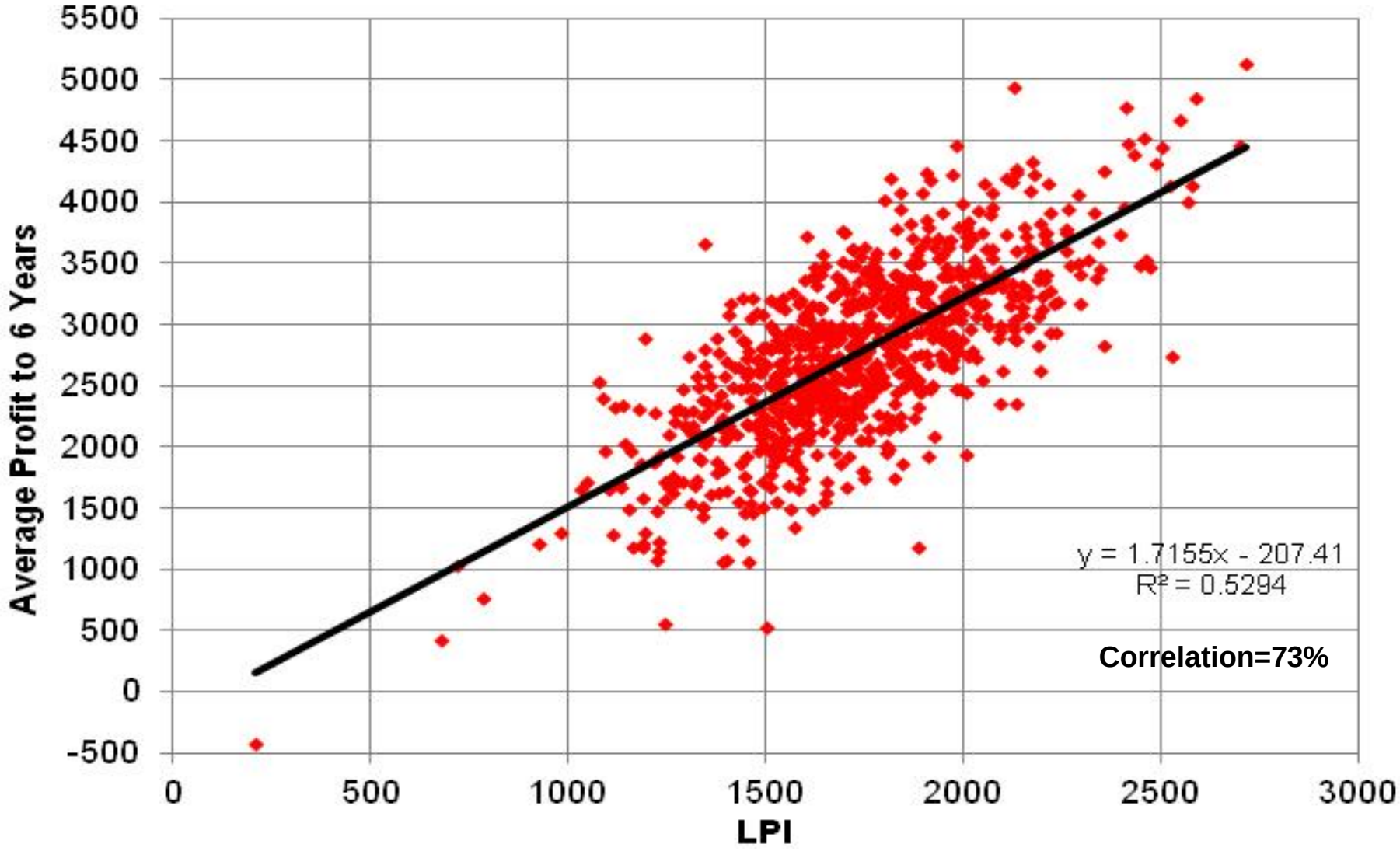
Sire LPI and Average Daughter Profit to 6 Years - HO



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Defining the Profit-Based Index

- **A 2-step regression analysis was used to predict Daughter Average Profit to 6 Years using Sire's proof for various traits**
- **Step 1 included 14 traits:**
  - Production: Milk, Fat and Protein yields
    - Fat & Protein Deviations are a linear function of these
  - Major Scorecard Type: Mammary System, Feet & Legs, Dairy Strength and Rump
    - Conformation is a combination of these
    - Descriptive linear traits are used to derive the major scorecards
  - Functional: Somatic Cell Score, Daughter Fertility, Body Condition Score, Milking Speed, Milking Temperament, Calving Ability, Daughter Calving Ability
    - Herd Life is mainly a combination of these and other traits

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Defining the Profit-Based Index

- **Applied the resulting Step 1 regression equation to the group of 830 Holstein proven sires included**
- **Subtracted "Predicted Profit" from actual Average Daughter Profit to 6 Years**
  - Referred to a "Residual Profit from Step 1 Prediction"
- **Step 2 regression analysis was conducted to test significance of the "extra" variance in Average Daughter Profit explained by only Conformation or only Herd Life**
  - Conformation not significant
  - Herd Life was significant
- **Final regression equation used coefficients from Step 1 plus coefficient for Herd Life from Step 2**

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Prediction R-Square

Regression Analysis	Adjusted R-Square
Step 1 based on 14 traits	.57
Step 2 including Herd Life to predict the “Residual Profit” not explained by Step 1	.09
Regression of $Y = \hat{Y} + e$	.61
Directly using all 15 traits in regression analysis (Step 1 + Herd Life)	.67

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Why 2-Step Regression?

- **Normally, aim to maximize Adjusted R^2**
- **Generally, resulting coefficients are less important, even when some input variables are highly correlated**
- **In this situation, the coefficient on Herd Life varies significantly from 1-step vs 2-step approaches**
  - With 1-Step, Herd Life coefficient is extremely high while coefficients for strongly correlated traits are near zero
    - Ex: Somatic Cell Score, Daughter Fertility, Calving, Mammary, Feet & Legs
  - With 2-Step, coefficient on Herd Life explains the leftover variance not already explained by the correlated traits
- **Use of the regression coefficients to build the Pro$ index requires application to all animals, even young bulls with only an indirect prediction of Herd Life**

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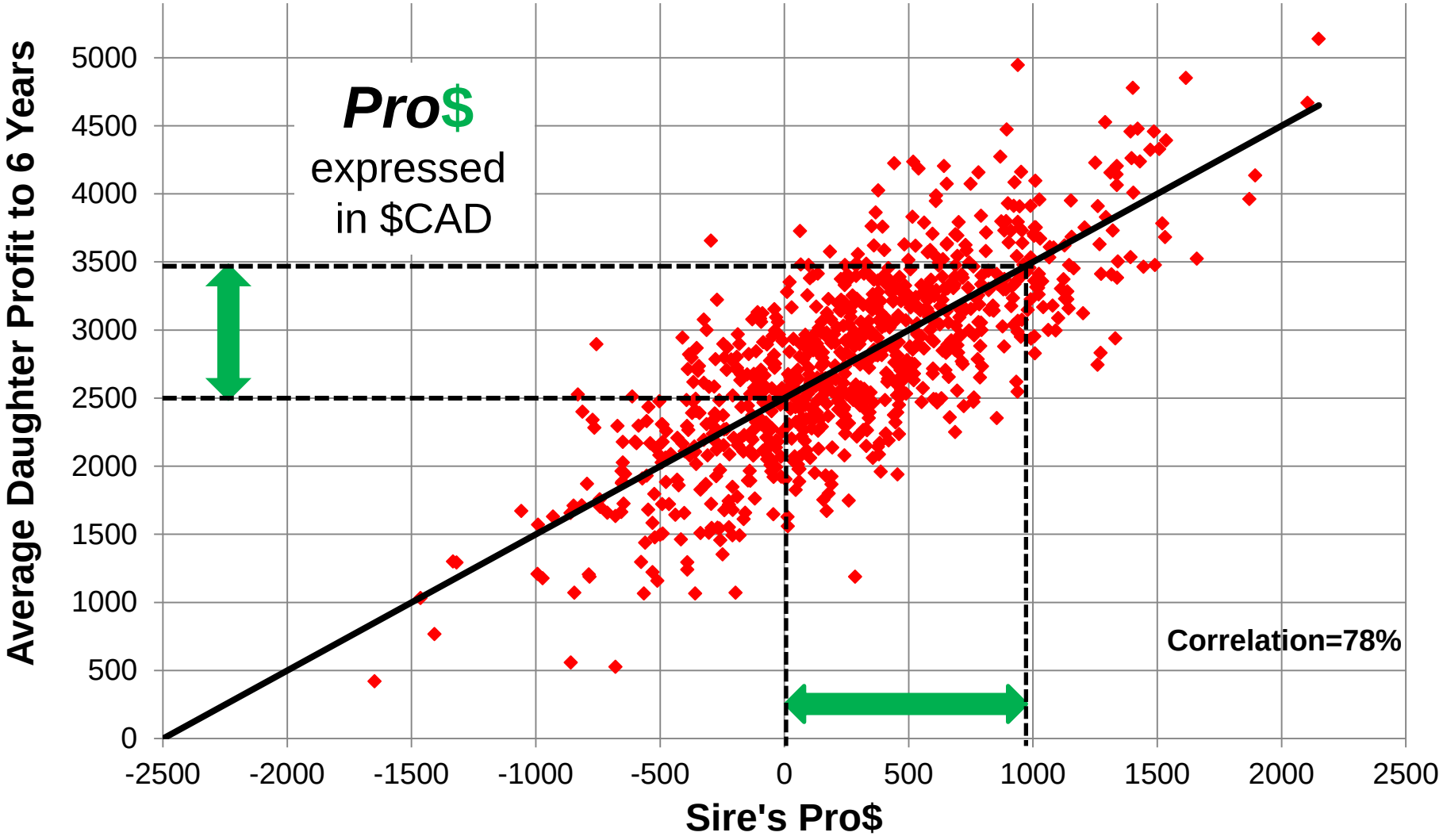
Sire's Pro$ vs Average Daughter Profit to 6 Yrs



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Expected Response

- **Software developed by Professor Julius van der Werf, U. of New England, Armidale, AUS**
  - Multiple Trait Selection Index (20 trait version)
- **Input list of traits, correlation matrix and economic weights**
  - For Pro$, used regression coefficients
  - For LPI, used relative emphasis/weights
- **Output is the expected response per trait, expressed in standard units, for each standard unit gain for the selection index**

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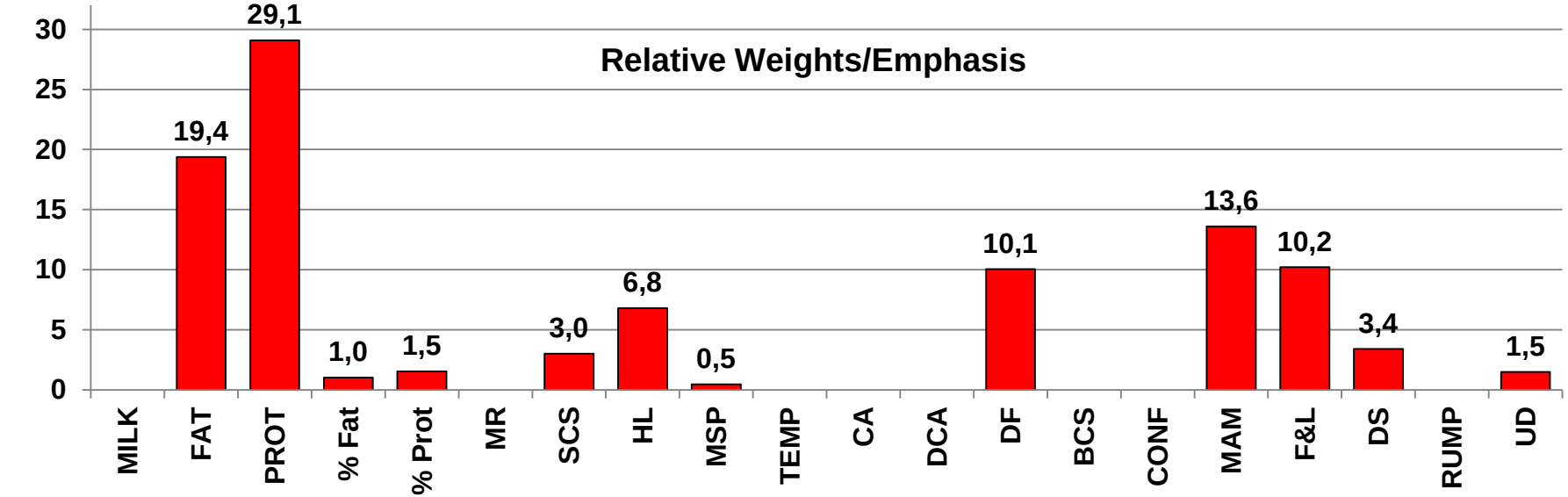
Relative Weights in Current LPI vs Selection Response – HO



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Key Principles

- **Relative weights in a specific selection index formula are less important than perceived**
  - Arguably, they create confusion!
- **Lesson has been learned from LPI**
- **For Pro$ in Canada:**
  - CDN will not publish the formula details
  - Focus on the expected response per trait resulting from selection based on Pro$
    - Same shift in extension effort applies to LPI
  - Pro$ is expressed in Canadian dollars as a deviation from a “cow genetic base”
    - Apply Holstein prediction but scaled appropriately by breed

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Pro$ and LPI

- **LPI be renamed to Lifetime Performance Index**
  - To reduce confusion, otherwise will have two indexes referring directly to “profit”
- **Pro$ has been approved by industry for August 2105 implementation in Holstein and Jersey breeds**
  - Other breeds, with smaller populations, have modified current LPI formula to target a similar selection response as for Pro$
- **New Holstein LPI formula has relative weights of 40% PROD, 40% DUR and 20% H&F**
  - Change from weights of 51:34:15 since 2008

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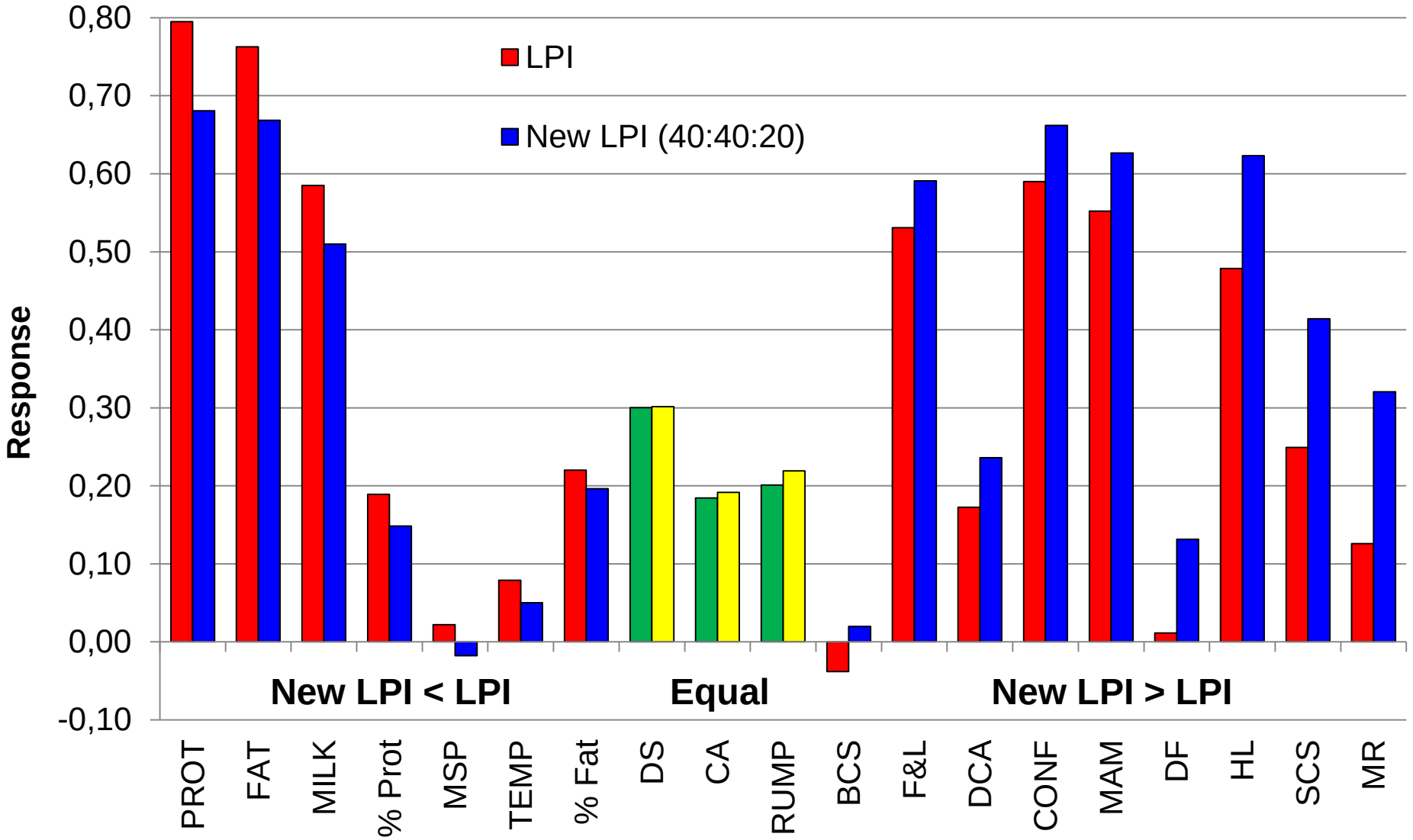
Selection Response for LPI - Current vs New in Aug'15 -



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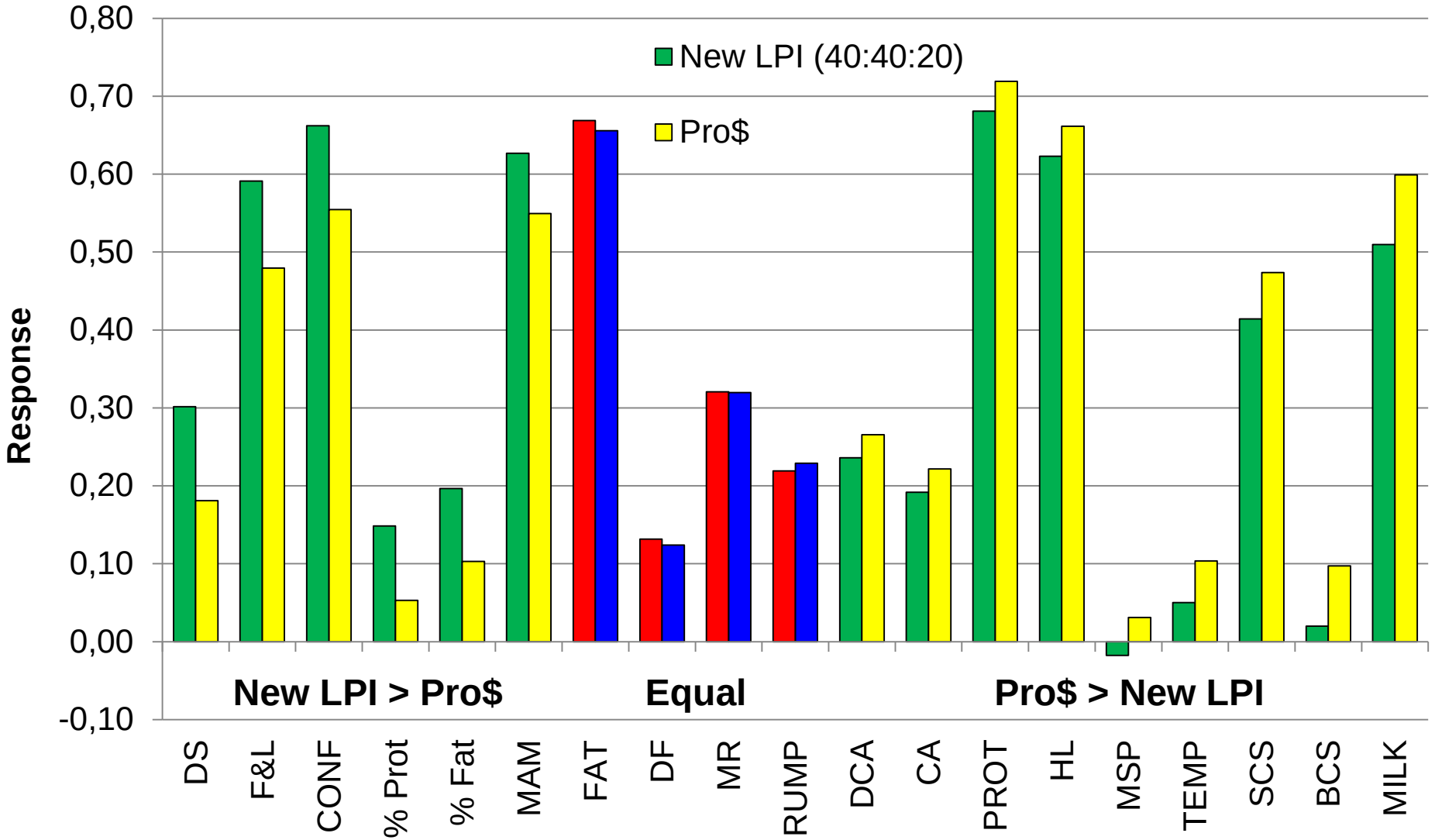
Selection Response for New LPI vs *Pro*$ - Holstein



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Top 15 Sires for *Pro$*
- Holstein Proven Sires, April'15 -

Current LPI		New LPI in Aug.		*Pro$*		SHORT NAME
RK	LPI	RK	LPI	RK	$	
2	3110	4	2936	1	2335	SUDAN
10	2951	3	2958	2	2285	PINKMAN
1	3203	1	3108	3	2275	BREWMASTER
7	2969	5	2930	4	2251	GILLESPY
36	2816	26	2775	5	2230	FREDDIE
8	2964	22	2805	6	2131	MANIFOLD
12	2931	7	2921	7	2104	STARGAZER
23	2877	16	2844	8	2047	ALTACALIBER
16	2906	14	2863	9	2045	SUPERSONIC
13	2924	12	2879	10	2031	SNOWMAN
10	2951	17	2838	11	2023	MOGUL
30	2843	11	2881	12	2009	JETT AIR
38	2798	58	2696	13	1982	BRONCO
5	2989	2	2970	14	1979	LEGO
6	2972	9	2907	15	1973	FORK

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Summary

- **LPI has been used as the primary genetic selection index in Canada since 1991**
- **New LPI formula in August for all breeds**
- **New profit-based index, *Pro*$, to be introduced in August, expressed in dollars, for the Holstein and Jersey breeds**
  - Other breeds have modified the existing LPI to get closer to the “profit-based” index
- **Industry-wide promotional and extension campaign has been active for both *Pro*$ and LPI**