Residual feed intake (RFI) Research Trial Analysis data 2013

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NSERC RFI Producer Day
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Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Approach to Feed Efficiency: Historical

1. Feed Intake, Partial Efficiency of growth, Relative Growth Rate, Kleiber Ratio
2. Feed Conversion Ratio: DMI/ADG
3. All measures are related to body size, growth and composition of gain.

4. Thus selection to reduce post-weaning FCR will increase ADG and cow mature size with minimal affects on feed inputs (Bishop et al. 1991; Herd and Bishop 2000; Crews 2005)

Residual Feed Intake also called Net Feed Efficiency

FEED INTAKE ADJUSTED FOR BODY SIZE AND PRODUCTION

In growing cattle it is the difference between an animal's actual feed intake & its expected feed requirement for maintenance of body weight, growth and changes in fatness or RFI_{fat}.

- **Measurable with at least moderate repeatability**
- **Moderately heritable**
- **Few if any adverse genetic correlations**
- **Economically important**

Hereford RFI Project: Objectives

- Characterize 900+ purebred Hereford bulls for RFI and other feed efficiency trails
- Produce RFI_{EPDs} using both phenotypic and molecular information
- Use 50K genotyping to assist in the validation of existing RFI genetic marker panels

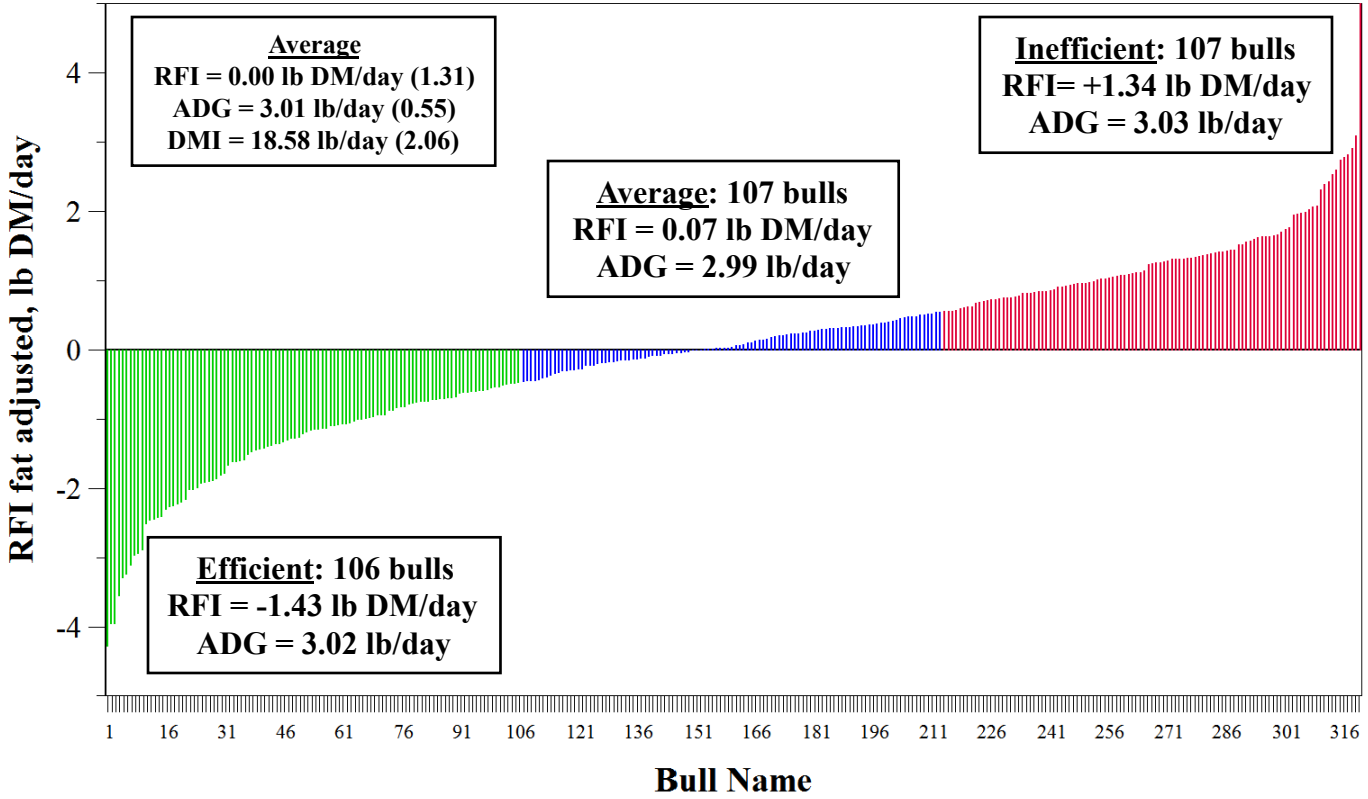
Deliverable: ID feed efficient sires that will produce feed efficient offspring

Measurable: Individual Animal Feed Intake Facilities

body weight
production
- ✓gender
- ✓age
- ✓season
- ✓temperature
- ✓physiological status
- ✓previous nutrition

Global GrowSafe capacity: ~68,000 animals; facilities in Canada (8%), US (76%), UK, Brazil, Aus (16%); Sunstrum 2012.

Residual Feed Intake (RFI_{fat}) for Hereford bulls tested in 2012-2013

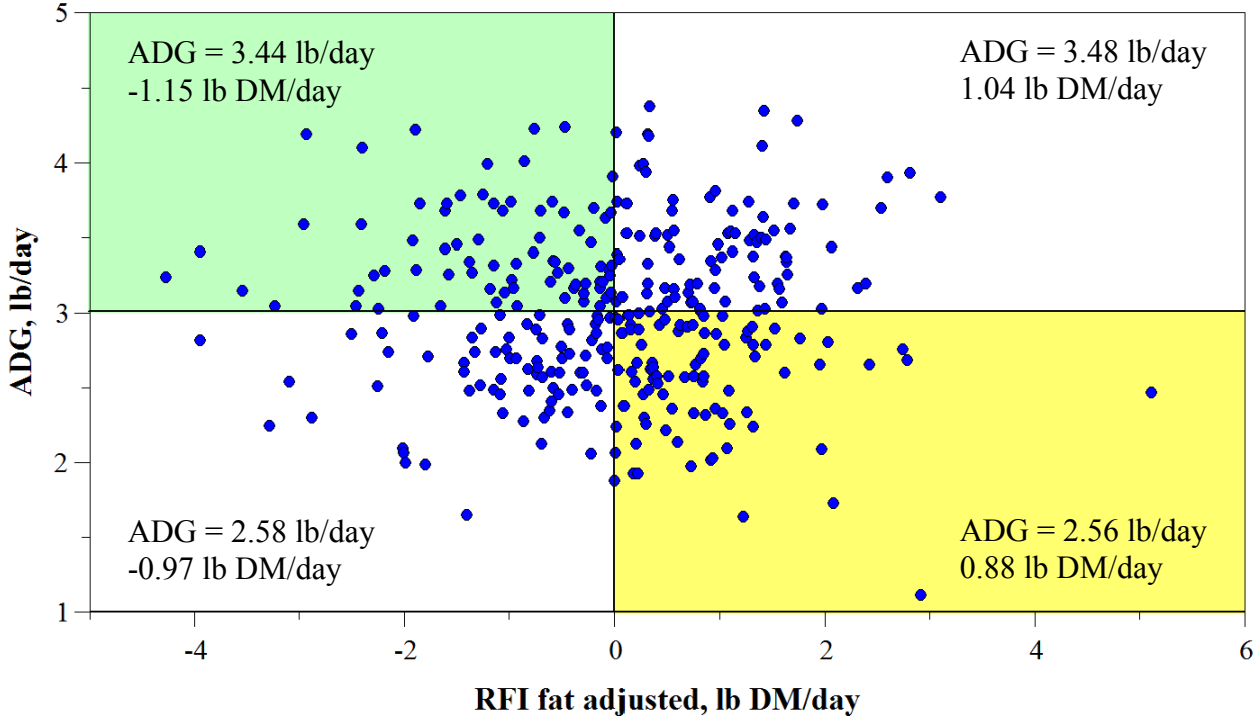


Feeder progeny
Feed cost difference over 150 days

Efficient:	-$7/head
Average:	$0/head
Inefficient:	+$6/head

Assume: $0.15/lb DM

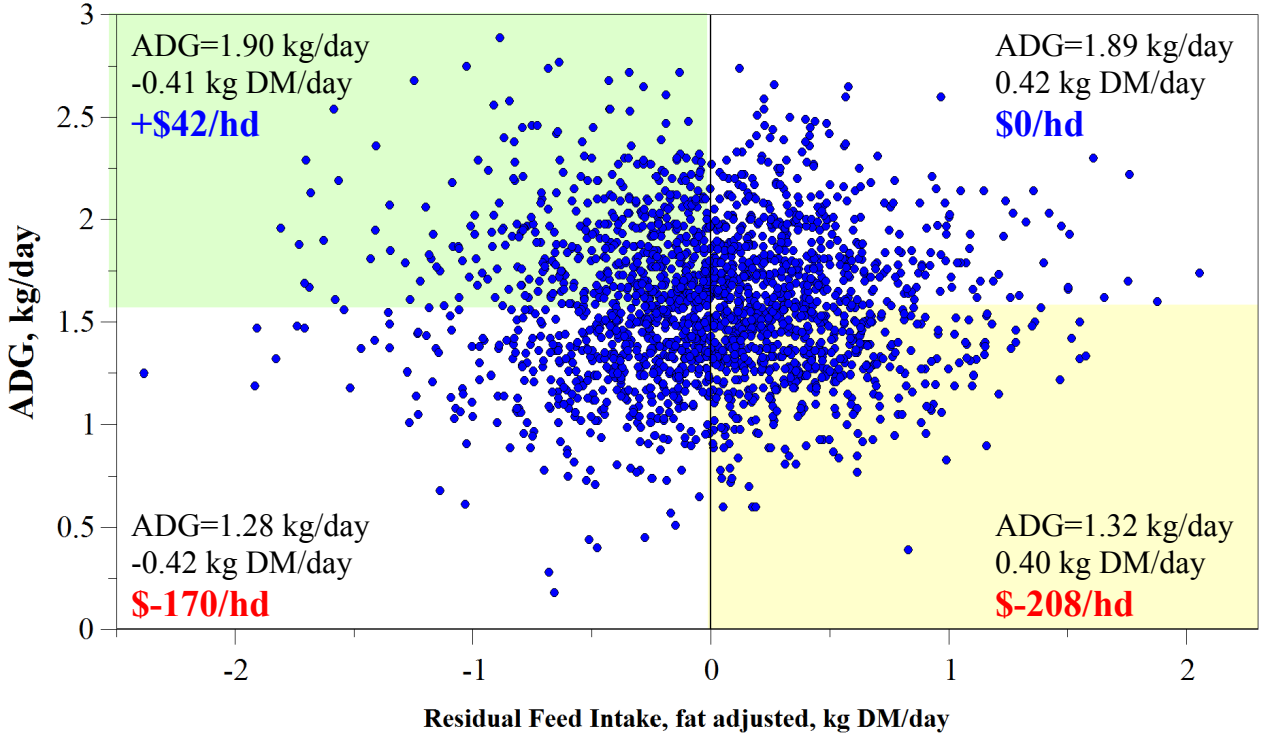
Relationship between RFI_{fat} and growth in 320 Hereford bulls



Phenotypic correlations = 0.00, P = 0.99

Arthur et al. 2001;
Basarab et al. 2003;
Crews et al. 2003;
Jensen et al. 1992
Basarab et al. 2013

Correlation: growth & animal size



Correlations (r_p & r_g) are near zero

N = 2029 feeder heifers and steers

Arthur et al. 2001; Basarab et al. 2003; Crews et al. 2003; Jensen et al. 1992 Basarab et al. 2013

NOTE: Same feeder cost (650 lb) and price, transportation, vet & medicine, interest, yardage, death loss and marketing costs

Breeding goals and selection indices

Maternal Productivity Index (MPI): consistently wean heavy calves over a sustained herd life, while controlling cow feed costs.

Feedlot profitability Index (FPI): Increase genetic potential of market progeny for feedlot profit.

Maternal Productivity Index (MPI)	
- Calving ease, birth wt	25%
- Direct & maternal wean wt	40%
- RFI-fat adjusted	25%
- Cow weight (negative)	10%
- Age at first calving	
- Ability to produce at least 3 calves	

Feedlot Profit Index (FPI)	
Post-weaning ADG	60%
RFI-fat	20%
365-day weight (negative)	5%
Carcass grade fat	5%
Carcass REA	5%
Carcass marbling	5%

Repeatability of RFI across diets

Grower diet vs. finisher diet, steers and heifers, r_g = 0.45-0.62

example, 75% barley-silage vs. 75% barley grain, as fed basis

Crews et al. 2003; Kelly et al. 2010; Duranna et al. 2011.

Heifers to 1st, 2nd and 3rd parity cows; r_p = 0.2-0.4 (Lawrence 2012)

Low RFI as growing heifers consumed 23% less forage during 2nd trimester (Halfa et al. 2013)

Conclusion:

High & positive genetic association between RFI-g and RFI-f when cattle are consuming roughage vs. grain, but traits are not biologically equivalent

More importantly, no convincing evidence that bull and heifer RFI would be antagonistic to progeny RFI or feed intake as a cow.

Repeatability of RFI in heifers to cows

Preliminary data, Basarab et al. 2013

Traits	RFI measured as a heifer	
	High	Low
RFI, kg DM/day		
Number of females	12	11
8-12 mo old heifers	0.365	-0.373
4-7 year old cows	0.459	-0.375

Heifers fed 90:10 barley silage:barley grain, free choice
Cows fed 70:30% grass hay:barley straw cube, restricted to gain at 0.25-0.50 kg/day

Feed savings: Heifers: 0.74 kg DM/day x $0.15/kg DM x 365 = $40/heifer/yr

Cows: 0.83 kg DM/day x $0.15/kg DM x 365 = $46/cow/yr

Repeatability of RFI_{fat} during summer grazing

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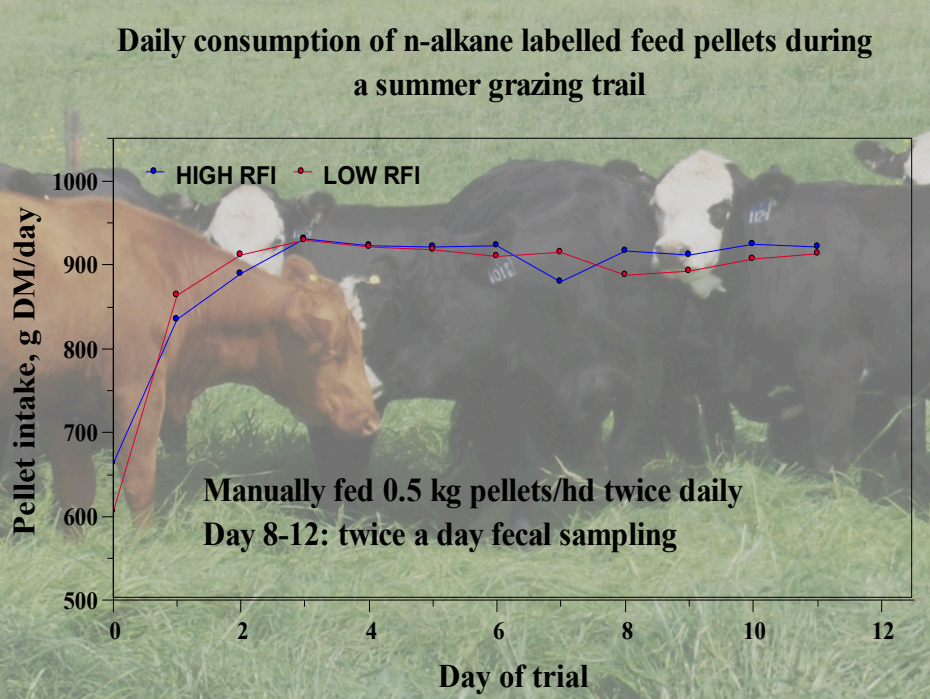
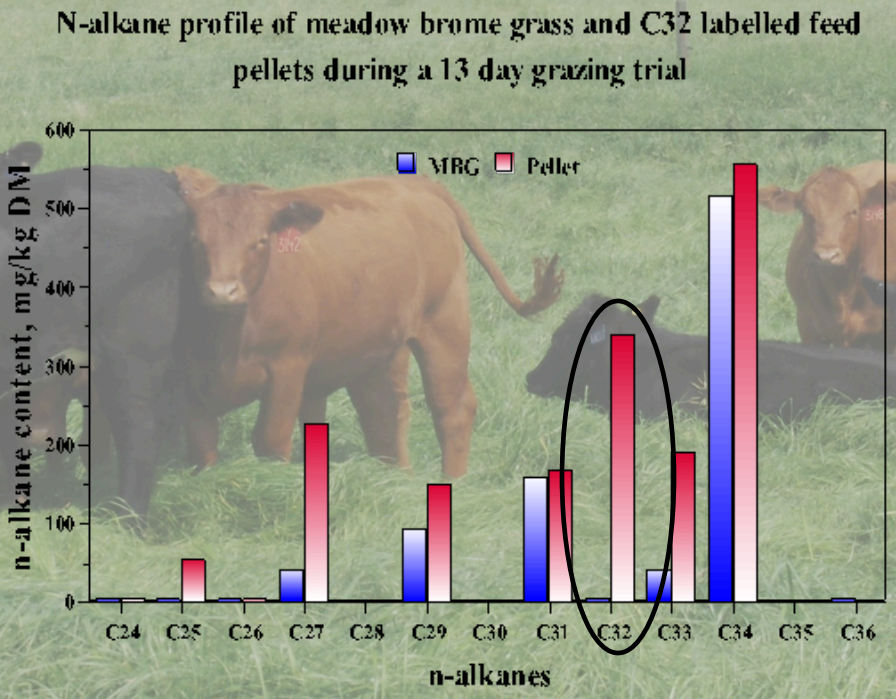
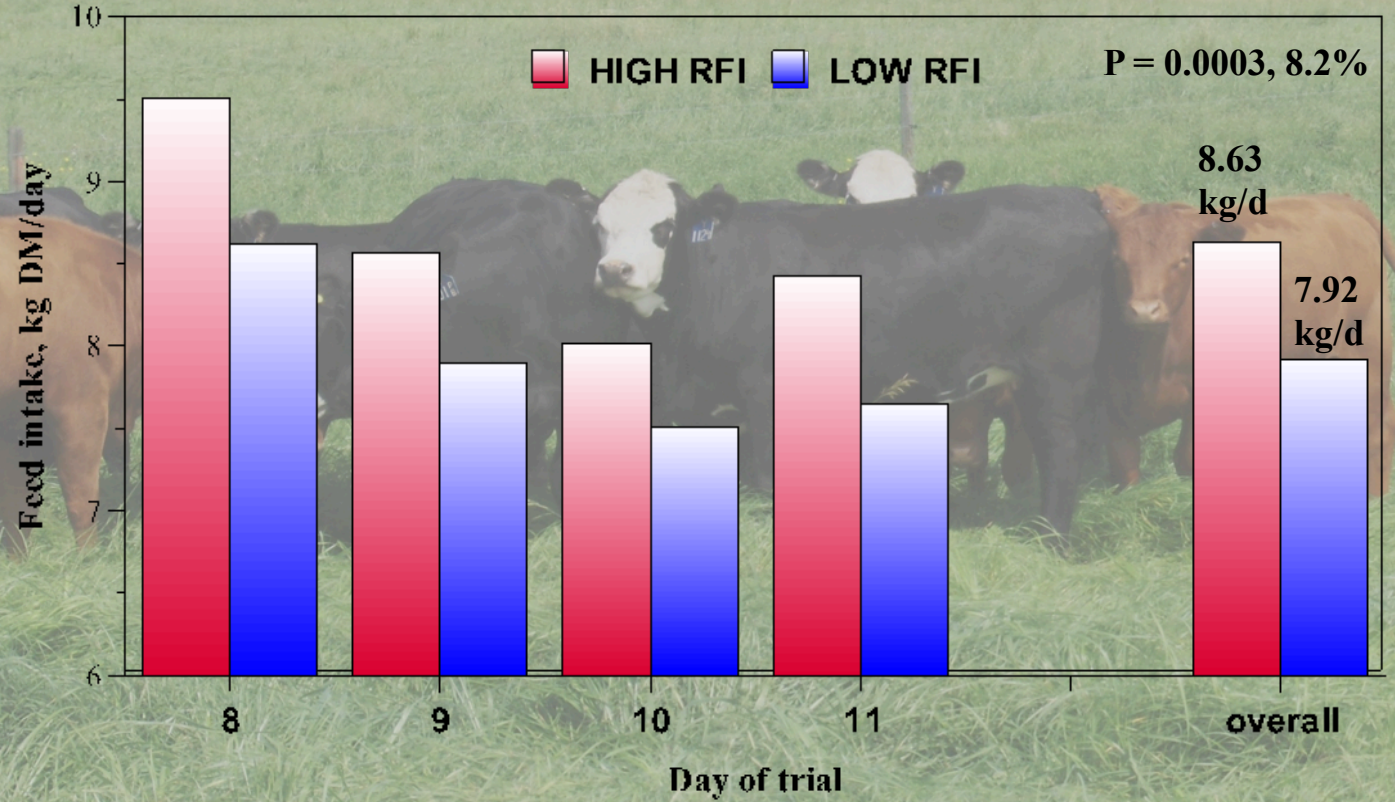




DMI calculated based on forage, supplement and fecal content of C31 and 32, intake of supplement and dose rate of C32 (modified from Boloventa et al. 1994; Moshtaghi-Nia and Wittenberg, 2002)

Feed intake of high and low RFI_{fat} heifers during summer grazing (n=20)



Feed intake (dry matter)
% OF BODY WEIGHT
High 2.0±0.03
Low 1.9±0.03

Growth & backfat (0-46 days)

Traits	High RFI	Low RFI
Gain, kg	32.7	44.9
ADG, kg/d	0.71	0.98
BF gain, mm	0.5	0.9
RF gain, mm	0.7	1.3

Correlations: RFI to other traits

Traits	Direction in low RFI	phenotypic correlation	genetic correlation
DMI	lower intake	0.60 to 0.72	0.69 to 0.79
FCR	improved	0.53 to 0.70	0.66 to 0.88
Linear measurements	no affect	-0.08 to 0.15	-------
Feeding behaviours	lower	0.18 to 0.50	0.33 to 0.57
Docility /temperament	no affect	-0.01 to 0.09	0.07
DM & CP digestibility	2-5% improv.	-0.33 to -0.34	--------
Enteric methane	lower	0.35 to 0.44	-------
N & P excretion	lower	0.67 to 0.80	0.38 to 86

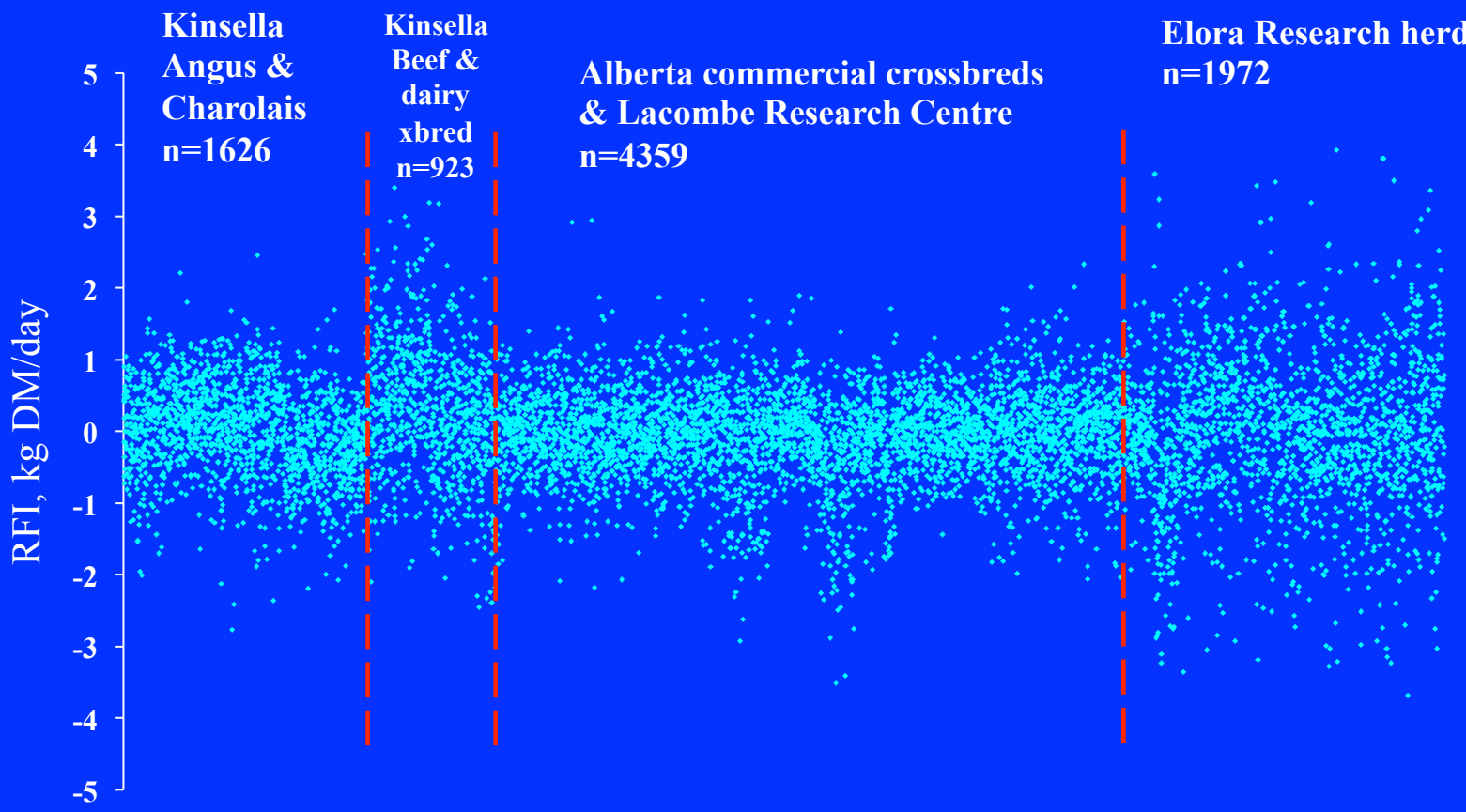
Summary of studies from Australia, Canada, Ireland and USA

Correlations: RFI to other traits

Traits	Direction in low RFI	phenotypic correlation	genetic correlation
Cow productivity	no affect	0.03	------
Age at puberty	(-) to no affect	0.00 to -0.16	------
Bull fertility*	(-) to no affect	-0.04 to 0.21	------
5 Carcass traits	2-4% less fat	-0.07 to 0.27	-0.07 to 0.19
34 meat quality traits	no affect	-0.09 to 0.12	-----
WBSF**	little affect	-0.05 to -0.01	-----

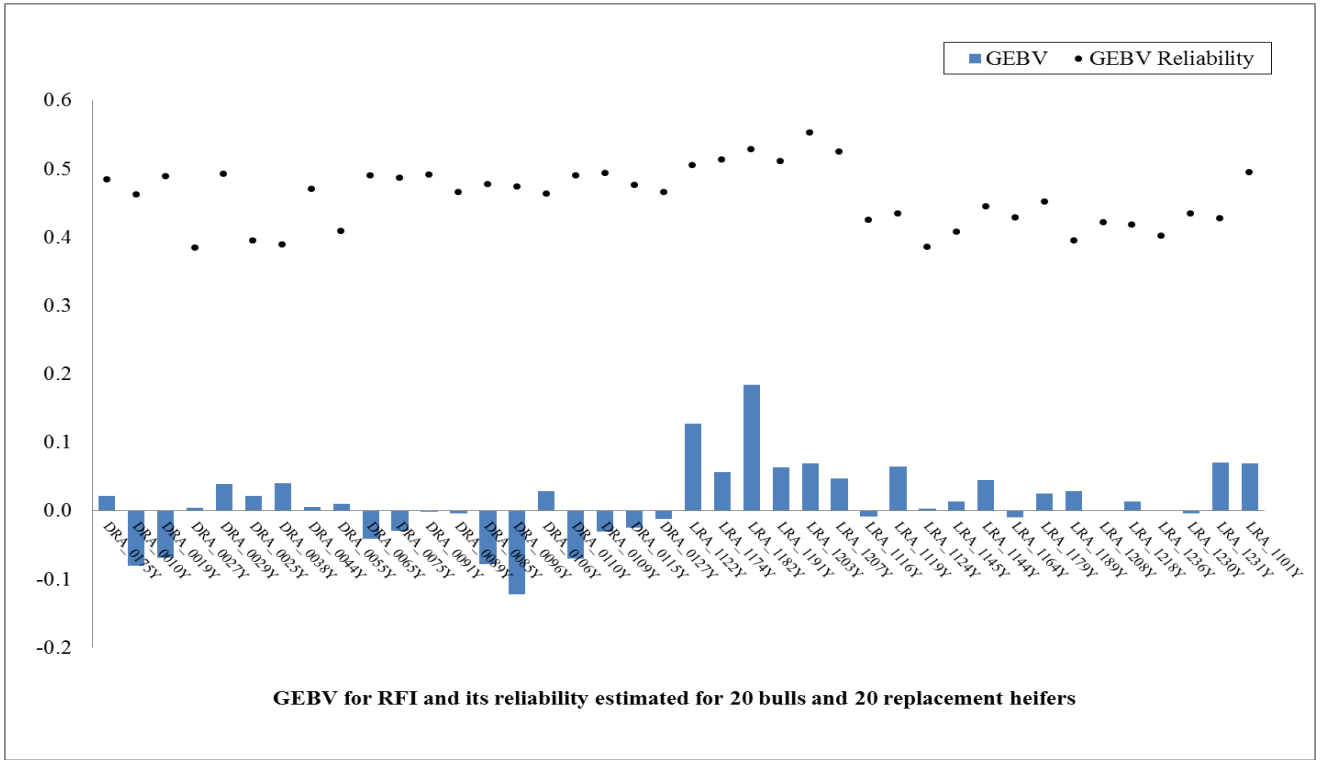
Summary of studies from Australia, Canada, Ireland and USA
* sperm morphology and motility;
** may affect tenderness and texture due to decreased lipid and postmortem protein degradation

Distribution of residual feed intake across four Canadian beef cattle populations



Canadian Cattle Genome Project (CCGP) data base: Improved genetic panel & MBVs; - Quicker, cheaper and more accurate

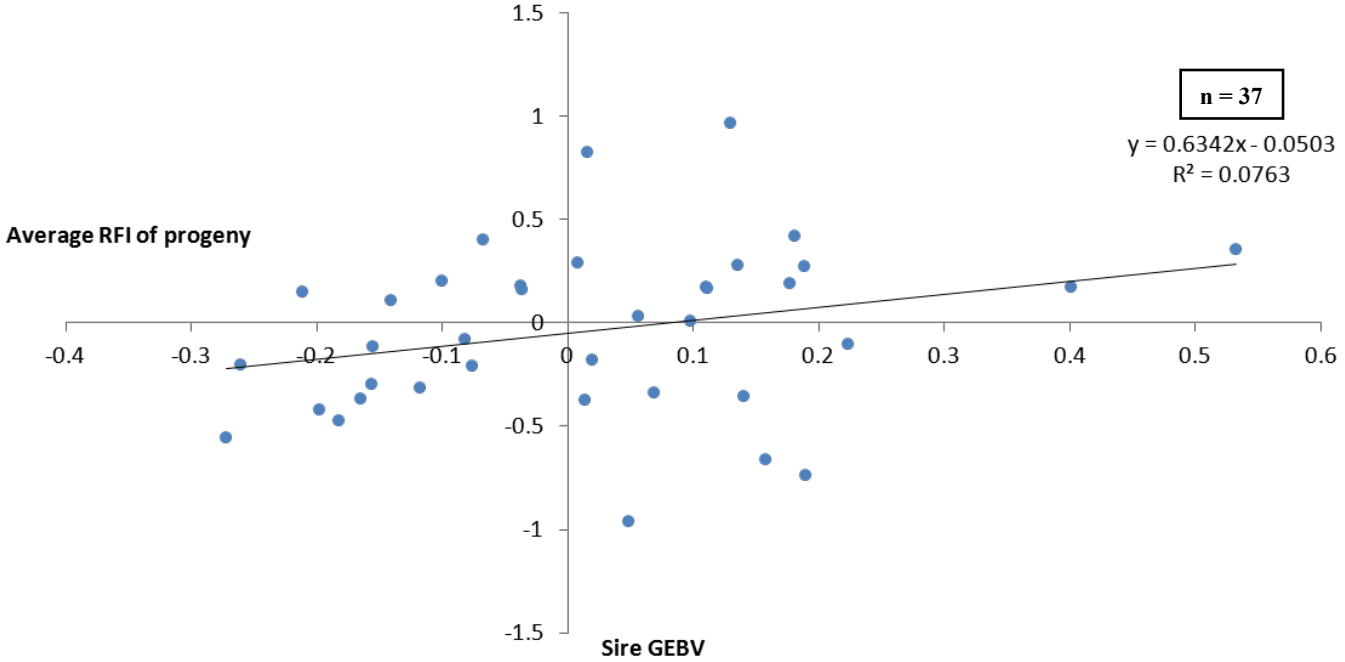
GEBV for RFI and its reliability for 20 youngest bulls and 20 youngest heifers



GEBV for RFI and its reliability estimated for 20 bulls and 20 replacement heifers

CANADIAN CATTLE GENOME PROJECT

Relationship between sire GEBV for RFI (kg DM/day) and average progeny performance for RFI (kg DM/day; 3 or more progeny per sire).



Sire GEBV vs Average RFI of Progeny

Each 0.1 unit improvement in sire GEBV for RFI resulted in a 0.0634 unit improvement in average progeny performance. If the price of feed is $0.30/kg DM, then 365 days of feeding would result in a feed savings of $6.94/animal in the first generation compared to sires with GEBVs for RFI of zero.

Genetic selection for RFI or its component traits

- improve feed efficiency, with no negative affects on cow productivity
- few antagonistic effects on carcass and meat quality
- small negative affects on age at puberty, but manageable
- reduce enteric methane and GHG emissions