Options for incorporating feed intake data into national selection indexes

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Filippo Miglior, Christine Baes, Caeli Richardson – CDN/University of Guelph

Mike Coffey, Eileen Wall - SRUC

Interbull Tallin 2017

Efficient Dairy Genome Project

- Genome Canada Large Scale Applied Research Project
  - Led by Filippo Miglior (Guelph) and Paul Stothard (Alberta)
- **Improve feed efficiency (FE) and reduce methane emissions (ME) in dairy cattle using genomics**
- Build a Canadian female reference population for FE and ME and link with international partners
- **Measure farm level and societal cost benefits from incorporating the new traits into breeding programs**

A Fully Integrated Partnership

University of Guelph

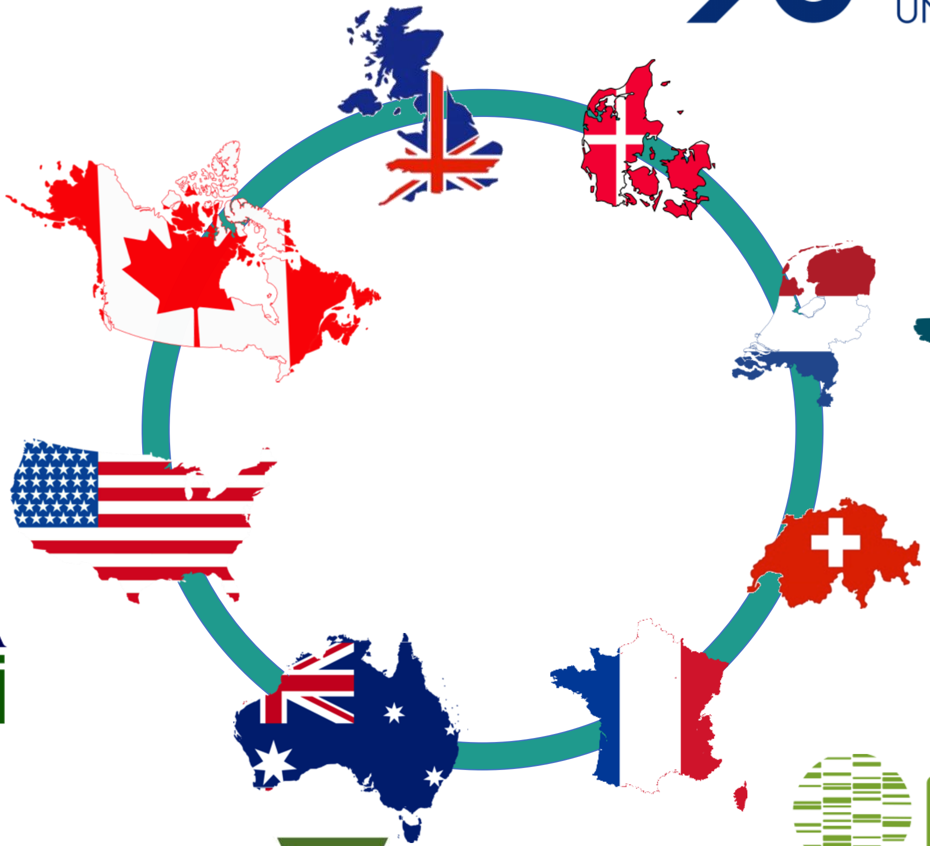
University of Alberta

Réseau laitier canadien
CDN
Canadian Dairy Network

GrowSafe SYSTEMS®

USDA

SRUC



Aarhus University

WAGENINGEN UR
For quality of life

QUALITAS

INRA
SCIENCE & IMPACT

AGRICULTURE VICTORIA

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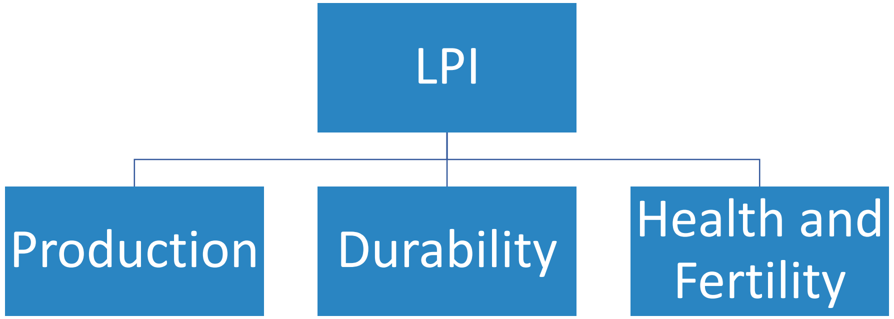
DAIRY at GUELPH
CANADA'S DAIRY UNIVERSITY

THE Efficient Dairy GENOME PROJECT

#1 – DE-SU PHOENIX 588



Sire:	HOUSAM60597003	ENSENADA TABOO PLANET-ET	03-MAR-03	7.21%	12%
Dam:	HOUSAF62721460	DE-SU 7902-ET	15-AUG-07	7.49%	11%
MGS:	HOUSAM131823833	SANDY-VALLEY BOLTON-ET	11-SEP-01	6.05%	11%

PRODUCTION GPA 12*APR

Herds			Kg	%RK	%Dev
Daughters		Milk	2884	99%	
Lactations		Fat	118	99%	+0.12
Reliability	73%	Protein	98	99%	+0.04

LIFETIME PROFIT INDEX

		Rel
GPA LPI	3594	69
PRODUCTION	2656	
DURABILITY	916	
HEALTH & FERTILITY	22	

CONFORMATION GPA 12*APR Herds: Daughters: Reliability: 68%

SCORECARD	Rating	%RK
Conformation	11	98%
Mammary System	12	99%
Feet & Legs	7	90%
Dairy Strength	5	81%
Rump	4	76%

DESCRIPTIVE	Rating		
Udder Depth	5S	Deep	Shallow
Udder Texture	7	Fleshy	Soft
Median Suspensory	8	Weak	Strong
Fore Attachment	8	Weak	Strong
Front Teat Placement	7C	Wide	Close
Rear Attachment Height	7	Low	High
Rear Attachment Width	11	Narrow	Wide
Rear Teat Placement	3C	Wide	Close
Teat Length	7S	Short	Long
Foot Angle	3	Low	Steep
Heel Depth	4	Shallow	Deep
Bone Quality	4	Coarse	Flat
Rear Legs Side View	5C	Straight	Curved
Set of Rear Legs	1	Undesirable	Desirable
Rear Legs Rear View	6	Hocked-in	Straight
Stature	0	Short	Tall
Height at Front End	-2	Low	High
Chest Width	2	Narrow	Wide
Body Depth	0	Shallow	Deep
Angularity	7	Non-Angular	Angular
Loin Strength	0	Weak	Strong
Rump Angle	1H	High	Low
Pin Setting	2	Undesirable	Desirable
Pin Width	6	Narrow	Wide

FUNCTIONAL Difference from Breed Average (SD)

	Rating	Rel			Breed Avg.
Herd Life	109GPA	63%	Short	Long	100
Somatic Cell Score	2.84GPA	70%	Undesirable	Desirable	3.00
Lactation Persistency	102GPA	57%	Poor	High	100
Daughter Fertility	99GPA	58%	Poor	High	100
Milking Speed	99GPA	55%	Slow	Fast	100
Milking Temperament	110GPA	54%	Nervous	Calm	100
Calving Ability	104G	84%	Difficult	Easy	100
Daughter Calving Ability	103GPA	57%	Difficult	Easy	100

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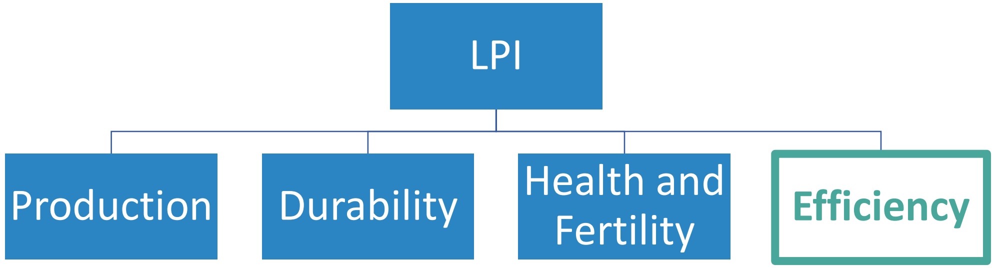

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Feed intake into UK dairy and beef indexes

Profitable Lifetime Index – £PLI

AHDB Breeding

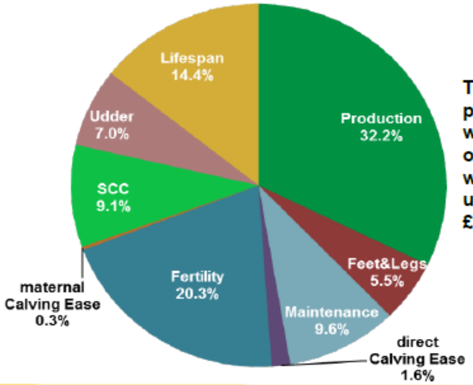
An economic breeding index for UK autumn block and all year round calving herds

What is the £PLI? Spring 2014

The national Profitable Lifetime Index (£PLI) is published by DairyCo Breeding+ as part of its genetic evaluation service. The £PLI is a within-breed genetic ranking index developed for UK dairying conditions in consultation with industry partners and is expressed as a financial value.

The £PLI will:

- ✓ **Promote yield while protecting milk quality**
- ✓ **Increase emphasis on fertility**
- ✓ **Improve functional type – feet & legs and udders**
- ✓ **Increase emphasis on longevity**
- ✓ **Reduce costs associated with maintenance**
- ✓ **Improve udder health**
- ✓ **Improve calving performance**



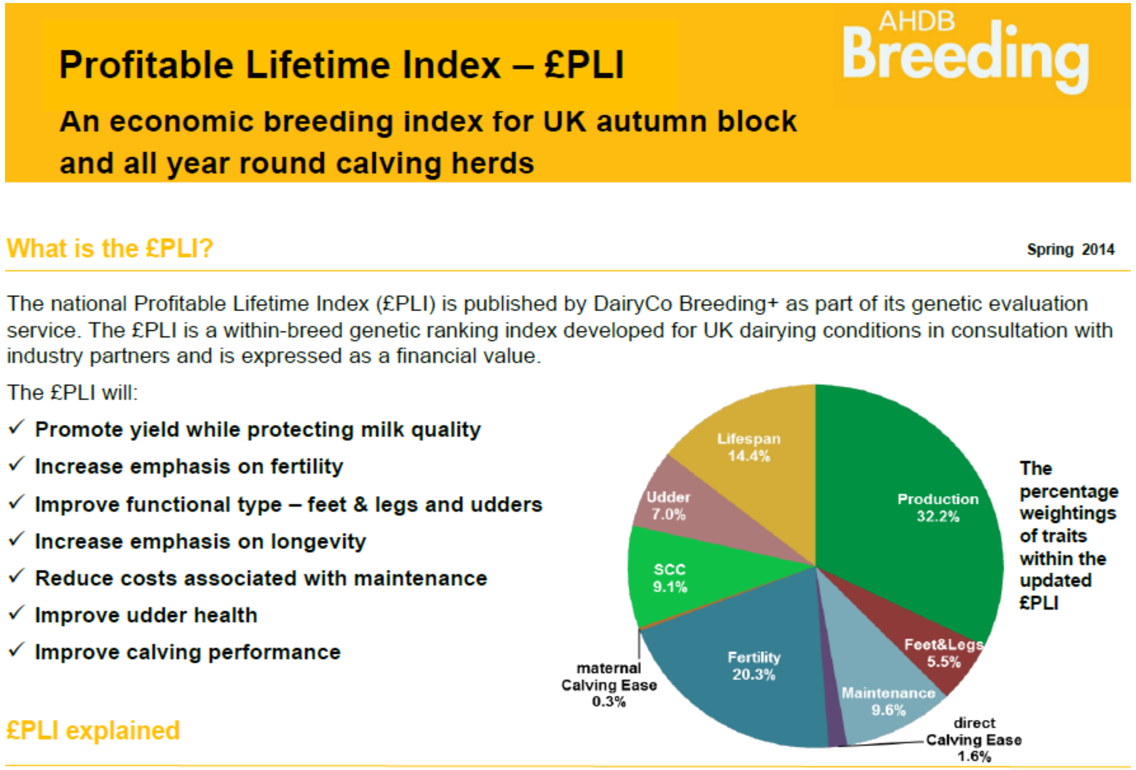
The percentage weightings of traits within the updated £PLI

£PLI explained

Feed intake into UK dairy and beef indexes

Genomic prediction of total feed intake

MIR prediction of total feed intake



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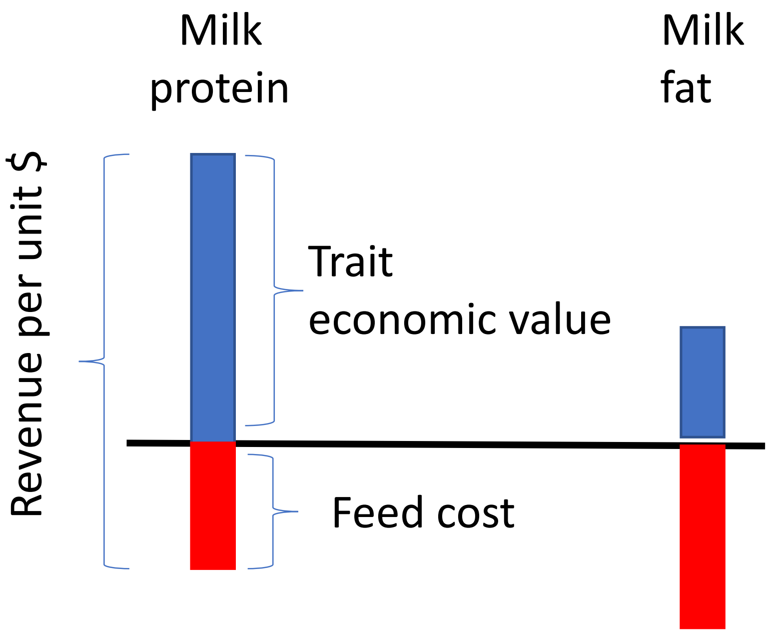
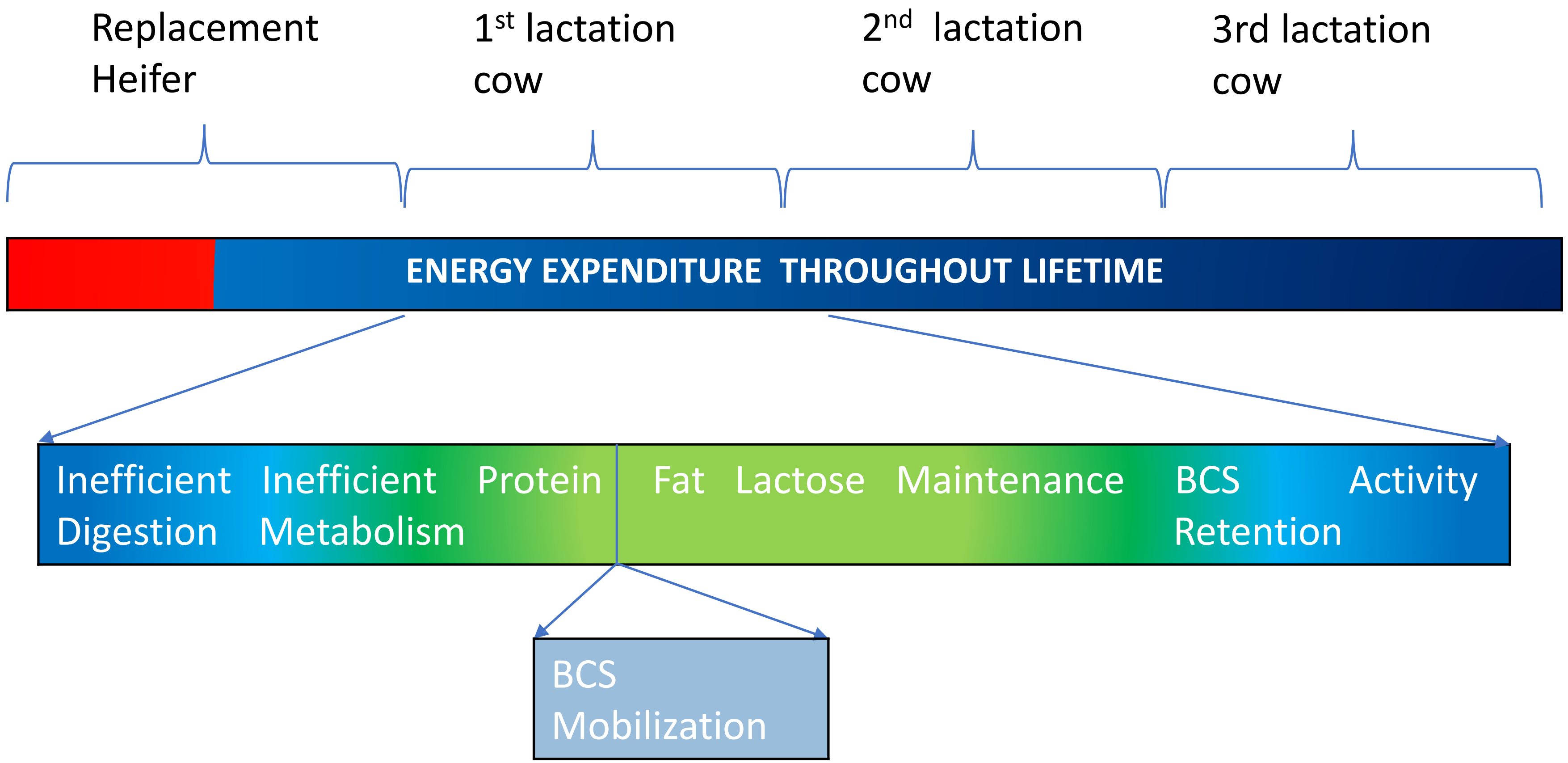
£PLI explained

We already “account for” feed intake in the existing indexes



Components of lifetime energy expenditure



What happens when select for total feed intake?

Replacement Heifer

1st lactation cow

2nd lactation cow

3rd lactation cow

ENERGY EXPENDITURE THROUGHOUT LIFETIME

Inefficient Digestion | **Inefficient Metabolism** | Protein | Fat | Lactose | **Maintenance** | **BCS Retention** | Activity

BCS Mobilization

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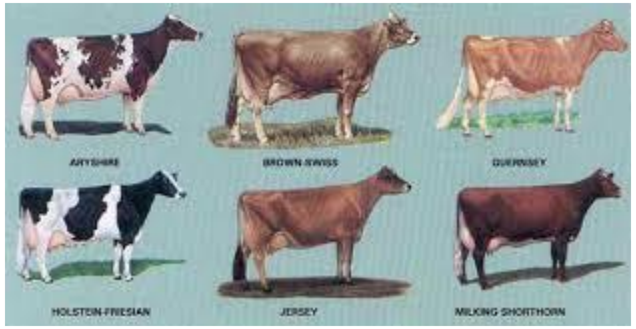
Variation in fatness

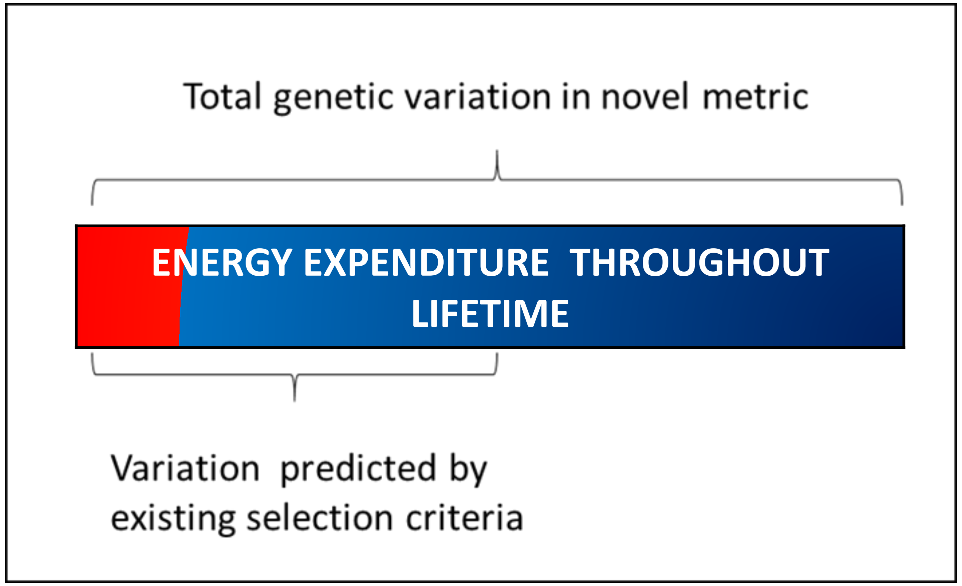


Unfavourable associations

- Feed intake and residual feed intake potentially unfavourably correlated with
  - Body reserves
  - Health
  - Fertility
  - Activity
  - Animal welfare
  - Foraging ability
  - Diet selectivity

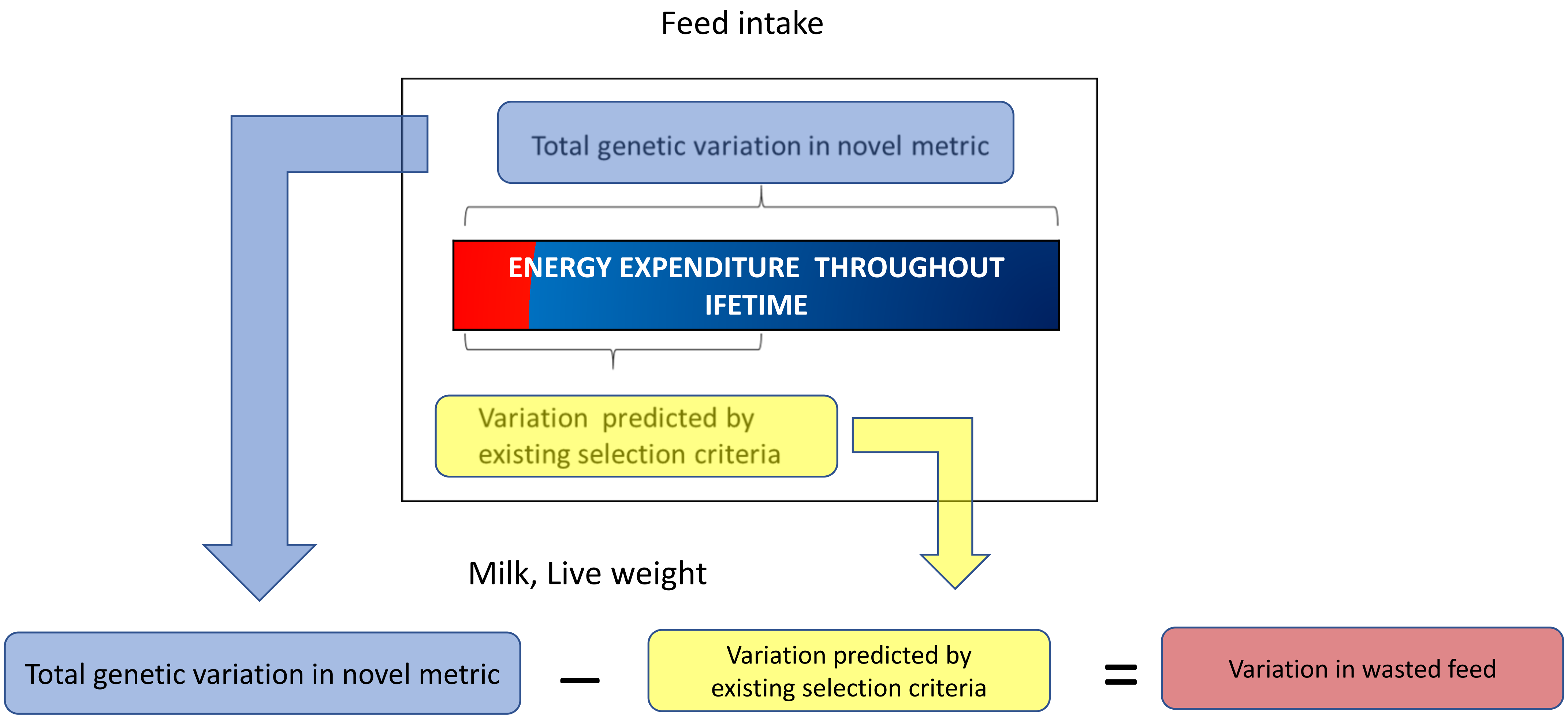
Prediction trade-off

Feed intake



Milk, Live weight

Prediction trade-off



The “Multi-trait Prediction” solution

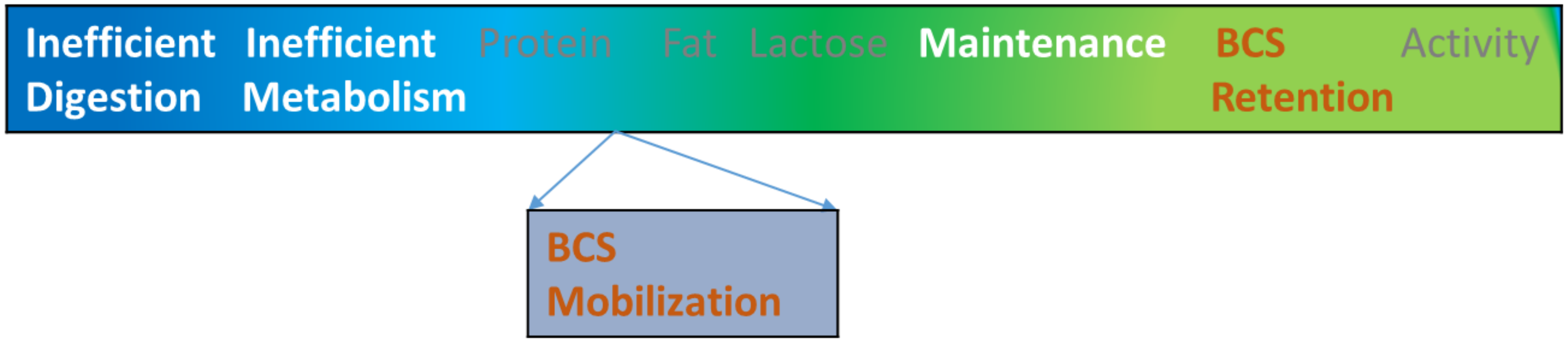
- Use growth/milk as correlated predictors of total feed intake

But…….

- Major over-haul of the breeding objective
- Major over-haul of genetic evaluation to integrate new trait
- Feed intake recorded in animals where the correlation does not exist?
- Many genetic evaluation systems modular
- Becoming more modular as genomics included

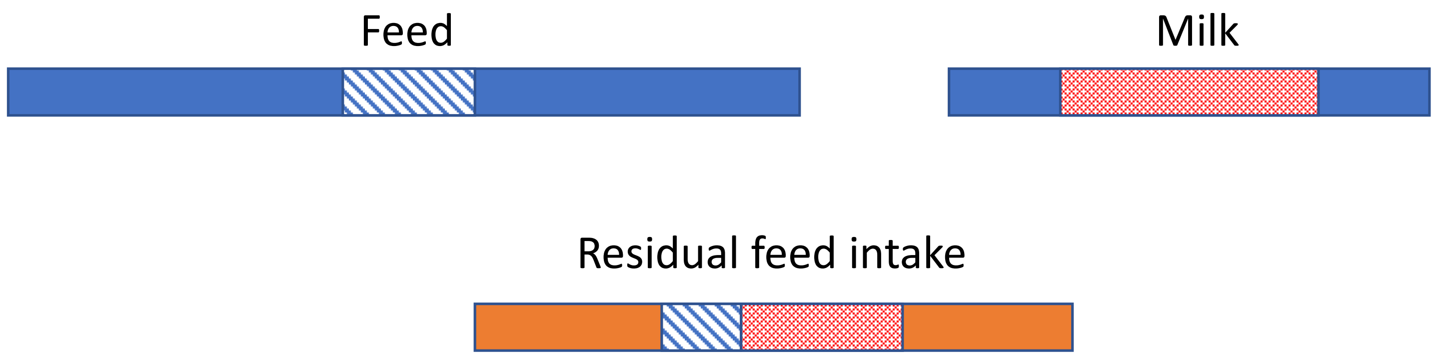
The "Residuals" solution

- Residual feed intake
  - Feed eaten after accounting for energy sinks linked to production (e.g. milk, growth, live weight) and viability (e.g. Body Condition Score, fatness)



Problems with "Residuals"

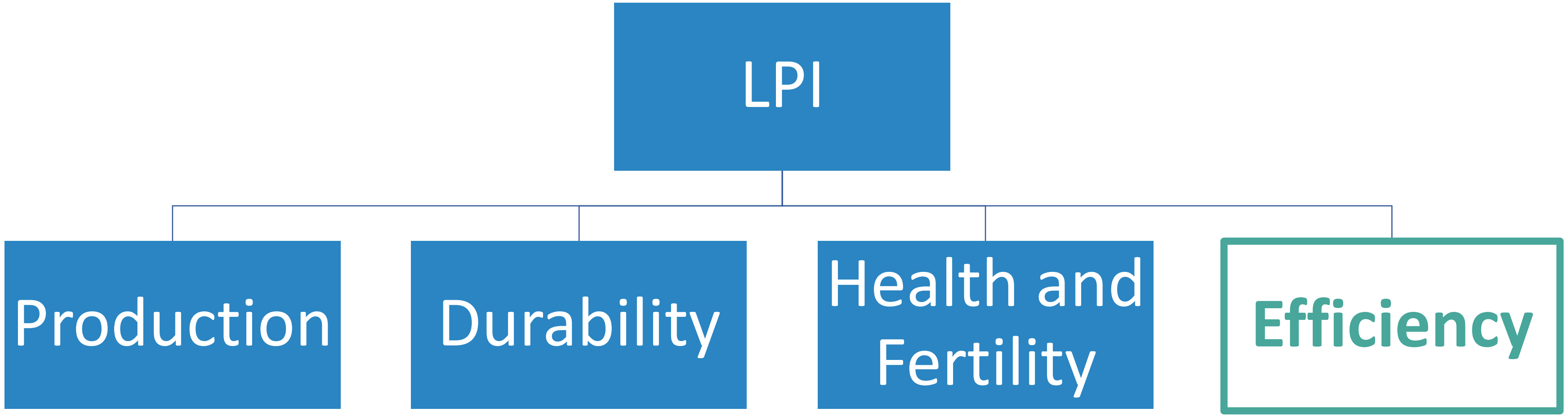
- Adjusting one genetic trait for another genetic trait can lead to false variation



- Not all energy sinks recorded accurately on all selection candidates (fatness!)
- Integrating information from multiple data capture systems
- Multi-collinearity in adjustment coefficients

Sub–index Feed efficiency

Future Lifetime Performance Index



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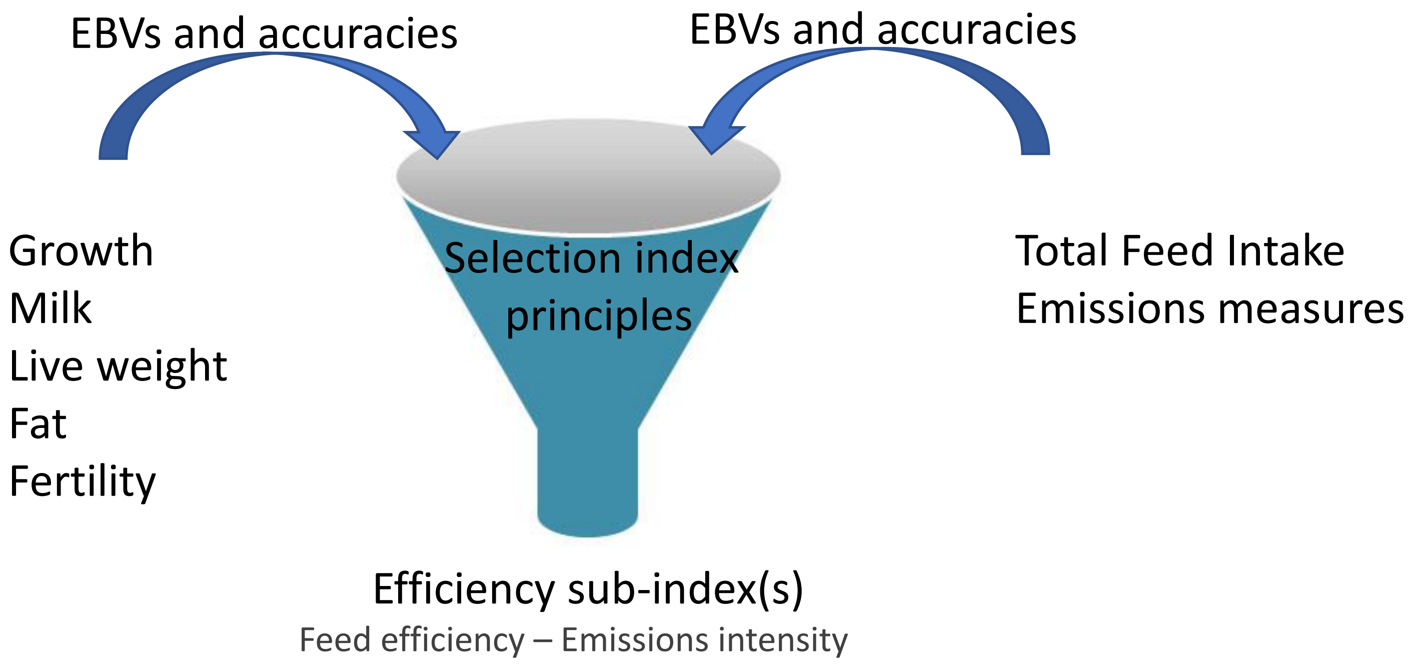
Sub–index Feed efficiency

- Current index stays as it is
- What added predictive value on feed intake relative to production do we have?



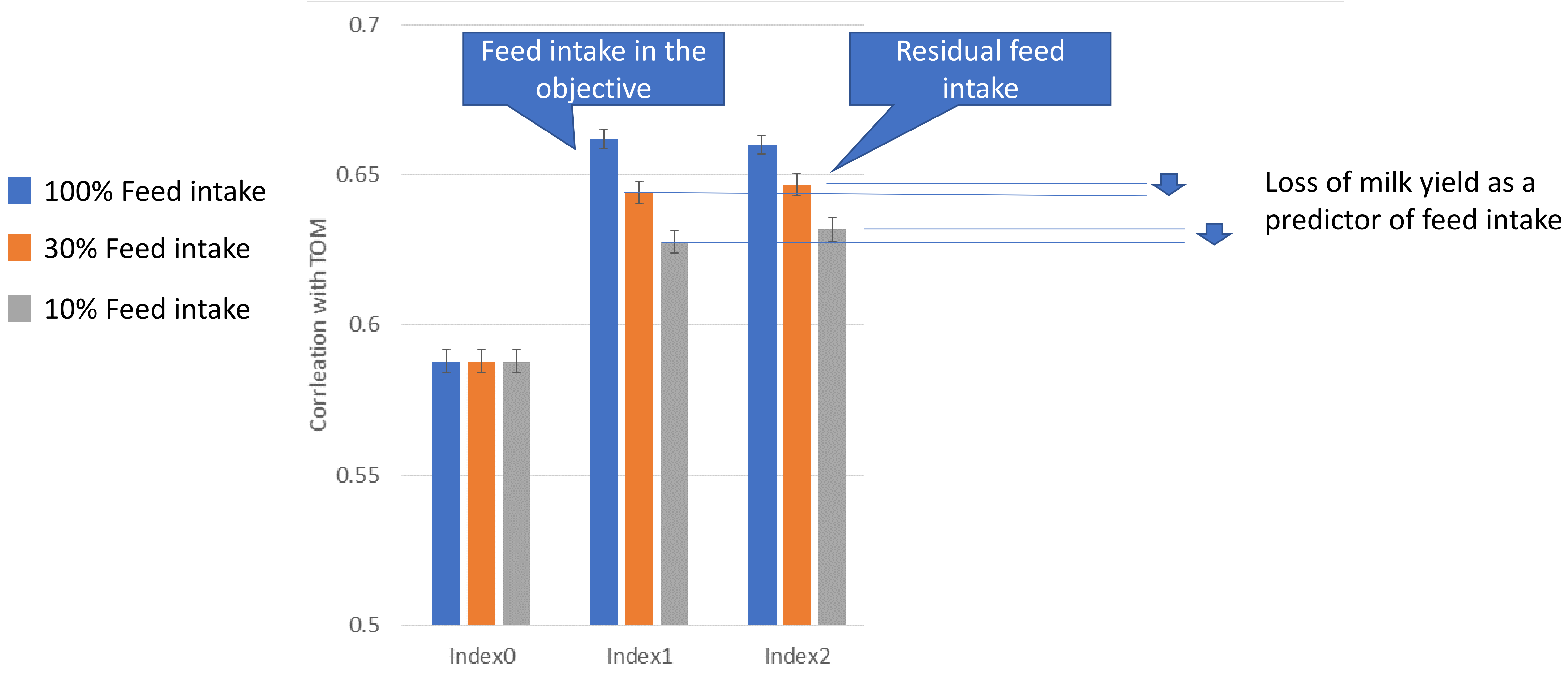
Simulation

- Sires with 80 daughters
- 100%, 30% or 10% of daughters recorded for feed intake
- Milk records, Live weight records

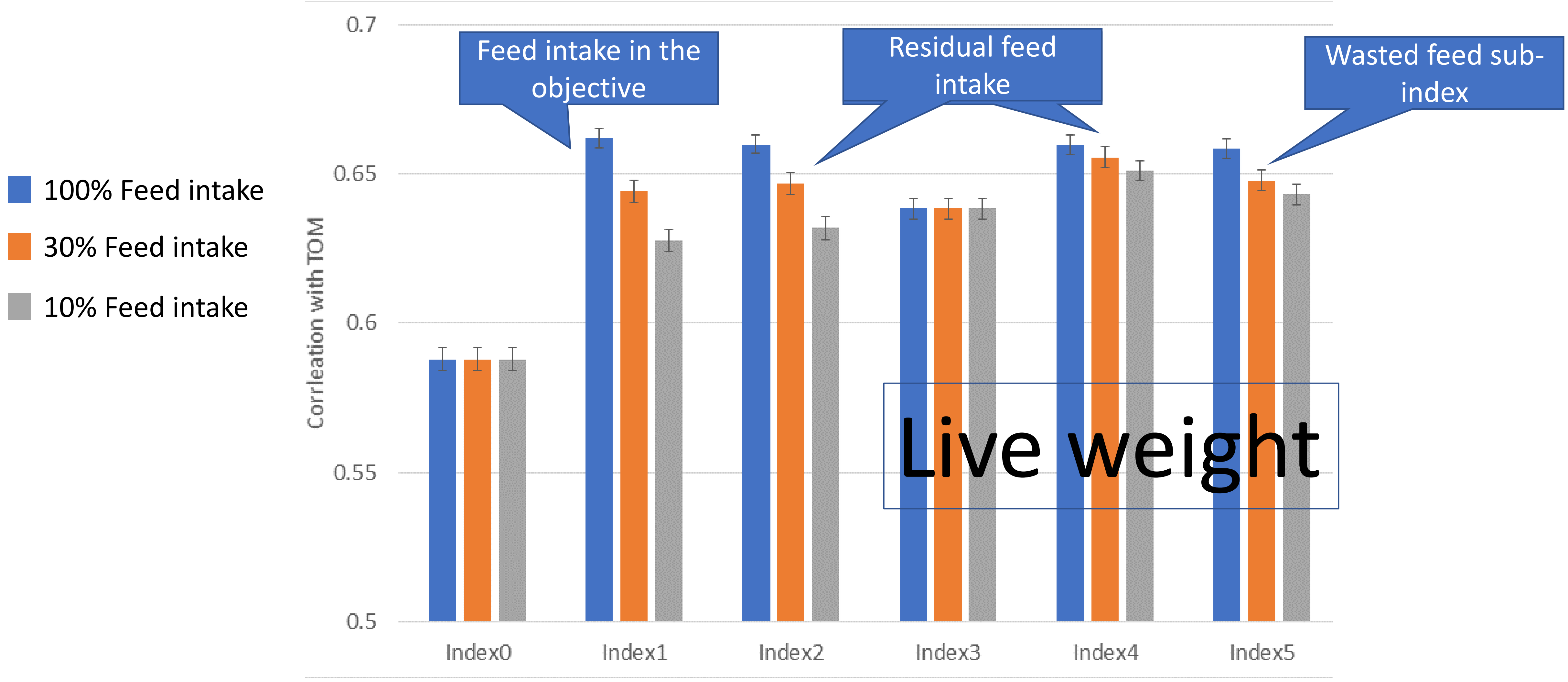
- Index correlations (of sires) with true (simulated) overall merit

Profit = Milk Revenue – Heifer feed costs – Cow feed costs + "Other" trait subindex

Simulation results – ignoring live weight



Simulation results

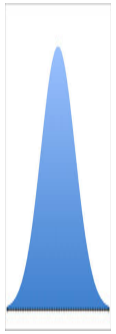


Wasted feed sub-index

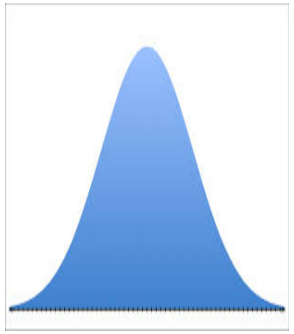
- Predicting

Total feed intake – feed milk – feed LW

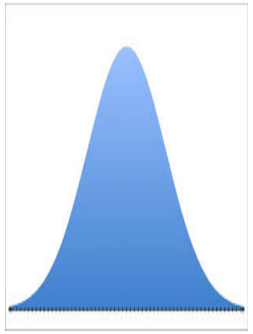
EBV(TFI) – α∘EBV(milk) - β∘EBV(LW)



Low reliability



High reliability



Moderate reliability

EBVs are not on correct scale to take a difference!

Wasted feed sub-index (with de-regressed EBV **d**EBV)

- Predicting

Total feed intake – feed milk – feed LW

$[\mathbf{d}\mathrm{EBV(TFI)} - \alpha \circ \mathbf{d}\mathrm{EBV(milk)} - \beta \circ \mathbf{d}\mathrm{EBV(LW)}] \times \boldsymbol{\lambda}$

λ accounts for the reliabilities (regresses back to the mean)

Take home messages

- Feed intake data likely doesn’t warrant a rebuild of genetic evaluation system and breeding objective
- Residual feed intake works, but does not work well with international sharing of data
- Sub-index approach is an appealing alternative
- Accounts for
  - Low and variable reliabilities of feed intake data
- Need to use information from live weight