FEED EFFICIENCY IN THE ITALIAN HOLSTEIN: WORK IN PROGRESS

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INTRODUCTION

- **Feed Efficiency**: Quantity of milk produced per quantity of **dry matter intake**

  - **Feed cost**→ Half of the total costs of dairy production

    - **Increase profitability of dairy production?**

      - Reduce feed costs by **improving feed efficiency**

  - **Feed trait** → Dry Matter Intake (DMI):
    - **Direct phenotypes** are scarce → difficult to collect (expensive & labor-intensive)

    - **Indirect phenotypes**: milk yield & content; maintenance of the cow (body weight and/or conformation traits)

DMI & different approaches

- Heritable trait & varies across lactation stages and it is highly correlated with production and maintenance traits.

  - **How to obtain this trait?**

  - **One way** to obtain breeding values → **genomic selection**

    - phenotypes are measured in a subset of the population, and genomic predictions are calculated for other animals that have genotypes but not phenotypes.

  - **Another way:** Prediction formulas based on routine data-collection

    → **Indirect measures:** for the «trait» can be used to asses genetic variation.

    → **Prediction trait:** a) Easy recordable; b) Routinely recorded; c) Inexpensive to measure; d) Heritable; e) Genetically correlated with the trait of interest

Italian Holstein state of the art

- Prediction equations for Live Weight (Finocchiaro *et al.*, 2017 – ICAR Edinburgh June 2017), developed algorithm to predict live weight (based on real weight and type traits)

- Currently setting up breeding value estimation for Feed Efficiency by means of indirect traits.

- Since September 2015 Member of the ICAR Feed&Gas WG and gDMI II (international cooperation)
  - Analyzing a pilot data set on individual cow and heifers feed intake together with the Universities of Milan and Padua.

  - Individual bull feed intake experiment will be set up at the ANAFI genetic center will be set up soon.

Experimental farm in Lodi – University of Milan

Live weight

- Tool for herd management and monitoring animals
- Used for calculating energy balance for a feeding ration
- Size of animals is related to animal maintenance costs, **feed efficiency and gas emission**

- **Live weight data**
  - Routine availability required → NO ROUTINE COLLECTION

  - **Solution**: Estimate live weight from existing routine data
    - Age at type scoring
    - Type scores
  - ANAFI → developed algorithm to predict live weight

Work in progress

- Set-up phenotypic and genetic prediction equations for live weight using type traits
  - Estimate genetic parameters for live weight
  - Estimate selection indices for live weight

- Use of live weight for other purposes:
  1. **Functional index** → IES (Economical & Functional index) → New Anafi EBV (August 2016)
  2. **Feed efficiency**
     - Predicted feed efficiency (**short term**)
     - Predicted feed efficiency including DGV estimates based on individual measurements (**long term**)

Live weight work

- 36 herds with in total 6,895 individual weights from 3,256 cows in different parities
  - Weighing through milking robots (2013-2015)
  - Average live weight: 624.37 ± 64.24 kg
- **Editing**
  - Only first parity cows retained → 862 cows in 30 herds
  - Stage of lactation max 12 months; Cow age 22-41 months
  - Max days between individual live weight and type scoring ± 30 d

Traits	Mean±SD	Range
Measured weight (kg)	588.99±50.12	500-700
Lactation stage (days)	141.57±78.35	10-365
Age at type scoring (months)	30.45±4.31	22-41

Phenotypic prediction of live weight

Setup model

1. Y = HYM + MC + SL + other predictors
2. Y – (HYM + MC + SL) = other predictors

Y: measured weight
HYM: herd-year-months of weighing
MC: month of calving
SL: stage of lactation
Other predictors:

- Age of cow at scoring ;
- Stature, chest width, body depth, rump width, BCS (when available)

Phenotypic prediction of live weight: Model selection

	Linear terms	Quadratic terms	R^2
1	Age, Stature, Rump width	Chest width, BCS	0.78819
2	Stature, Rump width	Age, Chest width, BCS	0.78819
3	Age, Stature, Rump width	Age, Chest width, BCS	0.78825
4	Age, Stature, Body depth, Rump width	Chest width, BCS	0.79120
5	Age, Stature, Rump width	Chest width, Body depth, BCS	0.79155
6	Age, Stature, Body depth	Chest width, BCS	0.79025
7	Age, Stature	Chest width, Body depth, BCS	0.79057
8	Age, Stature, Chest width, Body depth, BCS	Stature, Chest width, Body depth, BCS	0.79354
9	**Age, Stature, Chest width, Body depth, Rump width, BCS**		**0.79141**
10	**Age, Stature, Chest width, Body depth, Rump width**		**0.74594**

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Validation method

- Final data-set randomly splitted
  - 70% reference set
  - 30% validation set
- Done twice
  - In validation sets correlations between measured weight and predicted weight have been estimated and ranged between 0.62-0.70.

Statistics & Genetic Parameter estimates

Trait	Mean±SD	Range	h^2±SE
Measured weight	595.03 ± 61.27	500 – 700	0.50±0.06
Predicted weight	598.29 ± 46.45	453 – 742	

Algorithm applied to National Dataset

Trait	Mean±SD	Range	h^2±SE
Predicted weight 1st parity cows	597.98 ± 41.24	500 – 700	0.21±0.01
Predicted weight ≥ 2nd parity cows	689.00 ± 50.82	550 – 800	

From live weight towards efficiency (1)

Feed efficiency = Milk/Dry matter intake (DMI)

- Several traits are considered in order to link those to feed efficiency:
  - Metabolic weight;
  - 4% fat corrected milk yield and fat yield (FCM);
  - Energy corrected milk (ECM).

- Based on these is possible to derive traits such as DMI or Feed efficiency
  - Metabolic weight (Live weight$^{0.75}$) is proportional to maintenance needs for animals (Kleiber, 1932);
  - ECM –energy used in order to produce milk (Sjaunja et al., 1991).
  - DMI (NRC,2001);

From live weight towards efficiency (2)

Phenotypic estimates of full data-set

Trait	Mean± SD	Range
Milk yield kg/d	31.65±8.12	3,40-60,60
Protein %	3,34±0,34	2,12-4,56
Fat %	3,67±0,70	1,93-6,21
FCM	29,89±7,60	4,42-59,51
ECM	29.97±7.35	4.53-58.60
Predicted BW	601.14±42.77	450-700
Metabolic BW	121.35±6.49	97.71-136.00
Predicted DMI	22.87±2.93	11.41-35.09
Predicted FE	1.37±0.22	0.23-2.34

From live weight towards efficiency (3)

Preliminary phenotypic and genetic estimates

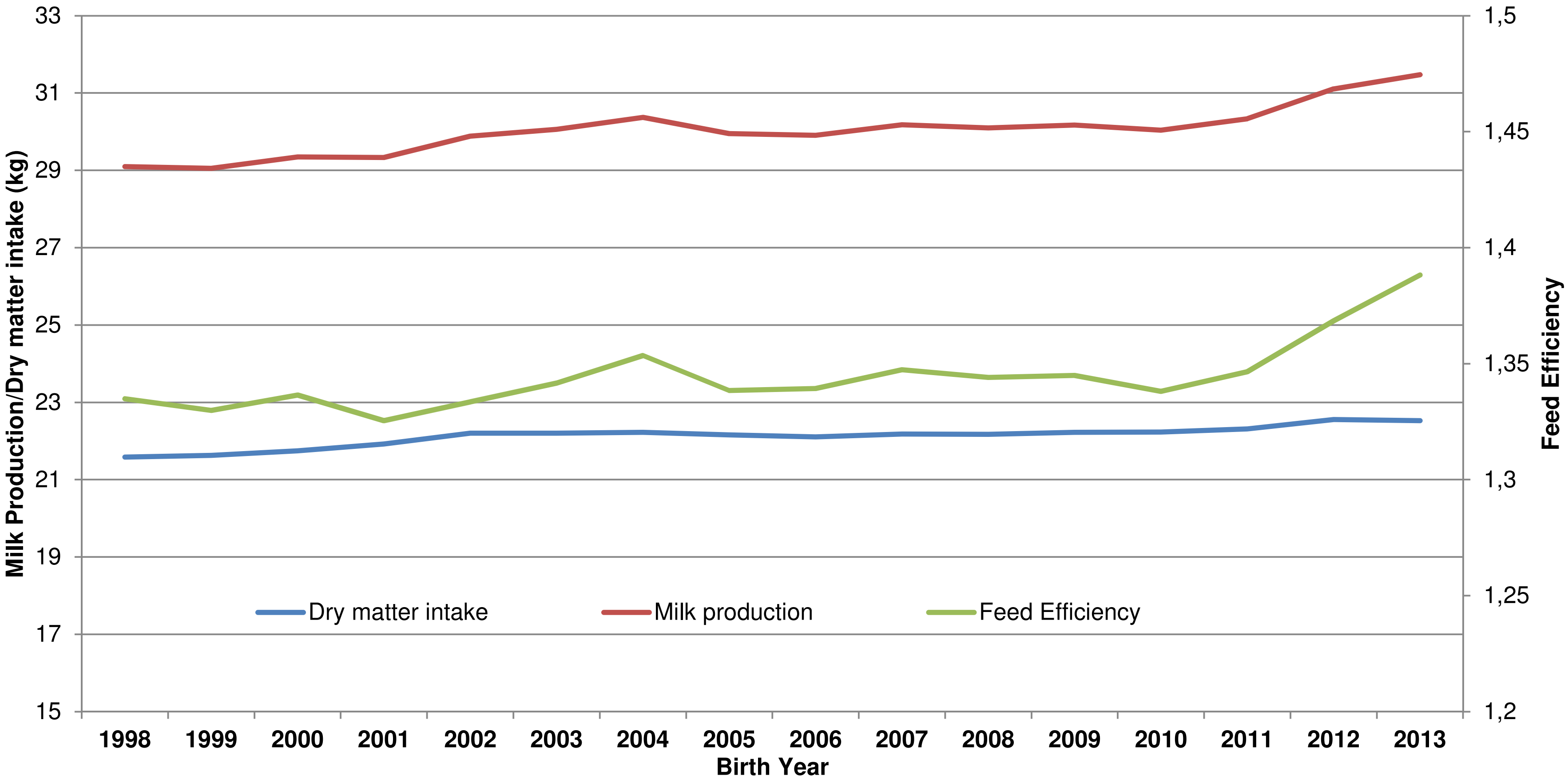
Phenotypic estimates of sample data-set

Trait	Mean± SD	Range
Predicted BW	598.15±39.86	450-700
Metabolic BW	120.90±6.05	97.78-136.00
ECM	31.18±6.70	6.97-57.56
Predicted DMI	23.33±2.73	12.86-34.63
Predicted FE	1.38±0.20	0.45-2.25

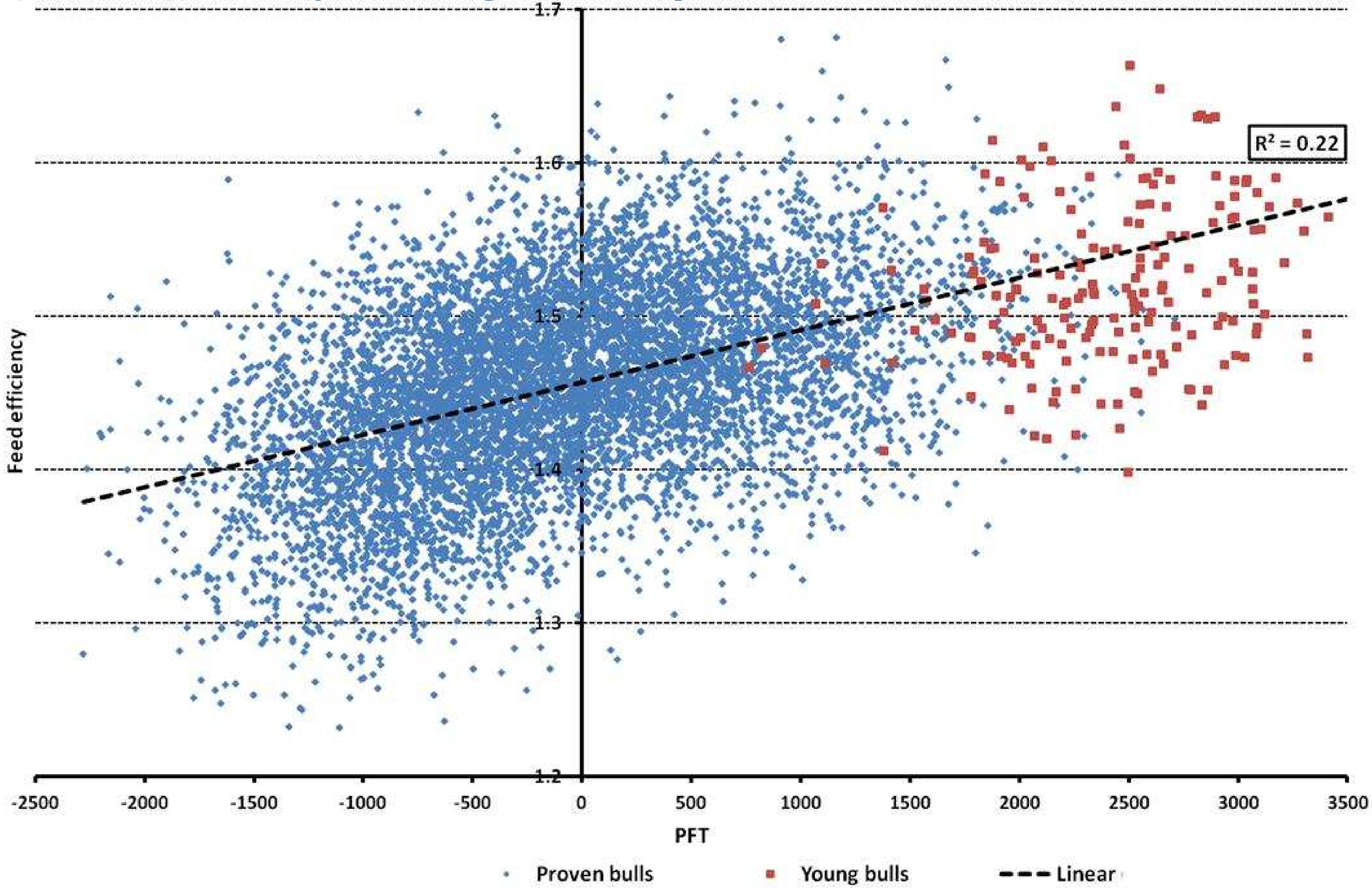
Genetic estimates of sample data-set

Trait	$h^2 \pm SE$
Predicted BW	0.21±0.01
ECM	0.36±0.003
Predicted DMI	0.41±0.003
Predicted FE	0.42±0.003

Phenotypic feed efficiency trend



Feed efficiency versus total merit index (PFT) for young and proven bulls

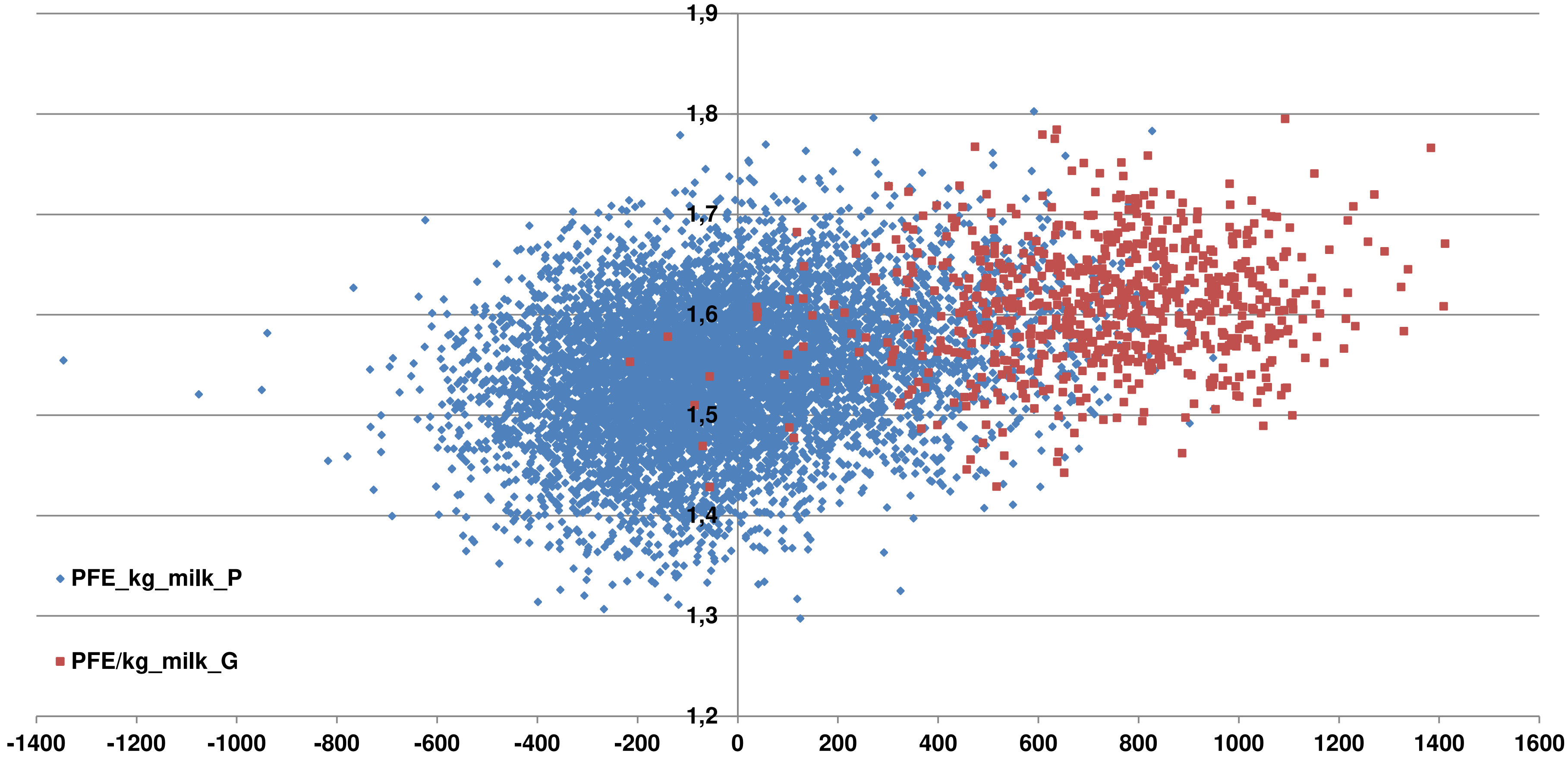


EBV pFE and IES of Italian HF bulls

IES → aim to maximize the genetic progress, both in the economic and for health and welfare traits.

IES → show **how many euros**, estimated in the entire productive lifetime, will contribute the use of a given bull with respect to the average population

EBV pFE and IES of Italian HF bulls



Final remarks

- We're on our way to establish routine evaluation for:
  - Feed efficiency

- We aim at EBV, DGV and GEBV

  - Direct individual measurements together with a genomic approach, of DMI are very helpful for more efficient selection strategies and for a better genetic control on daily feed intake.

- Current selection goal already improves feed efficiency, but extra attention can increase genetic gain

- Indices will be included in total merit index

- Questions?