



LATeco Progetto presentato nell'ambito della Sottomisura 10.2
PSRN-Biodiversità 2014-2020 ANAFI



“Fondo europeo agricolo per lo sviluppo rurale:
L'Europa investe nelle zone rurali” Autorità di gestione:
MIPAAF Ministero delle Politiche Agricole Alimentari e Forestali



UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI SCIENZE VETERINARIE
PER LA SALUTE, LA PRODUZIONE ANIMALE
E LA SICUREZZA ALIMENTARE



UNIVERSITÀ
DEGLI STUDI
DI PADOVA

COMPARING FEED EFFICIENCY IN ITALIAN HOLSTEIN FRIESIAN HEIFERS, LACTATING COWS AND BULLS

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Feed Efficiency: why is important?

Feed efficiency: Amount of milk produced per quantity of dry matter ingestion

- **Feeding animals:** 40-60% animal production costs
(Pomar *et al.*, 2011; Bethard, 2013)
- International interest
- One of the promises enabled by the introduction of Genomic Selection
- **Still big challenges**



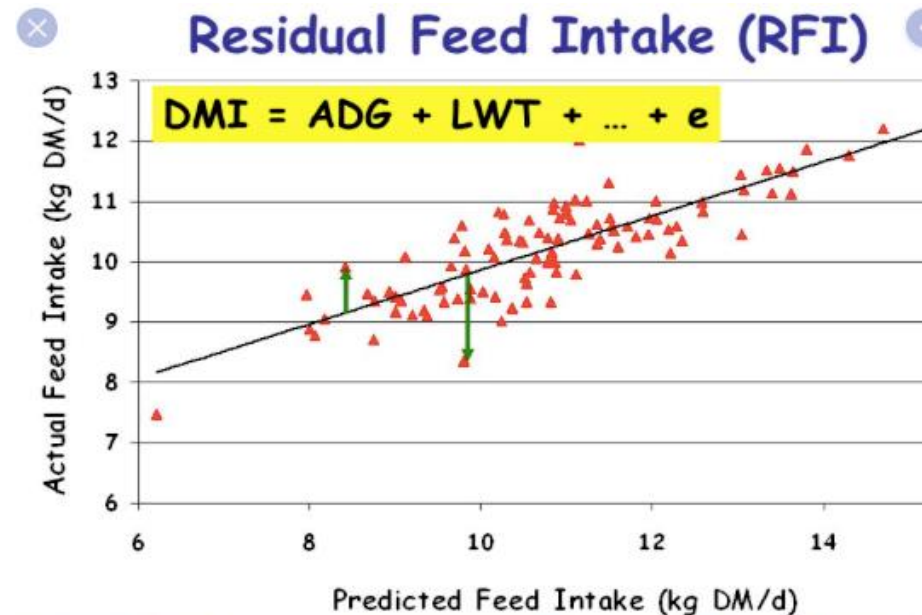
Feed Efficiency Phenotypes

Ratio traits

- DMI/ADG (Feed Conversion Ratio)
- ADG/DMI
- Milk/DMI

Residual Feed Intake (RFI)

- Observed Feed intake – Expected feed intake (productive parameters)





AIM

Direct phenotype collection for different traits related to feed efficiency



Comparison of different traits and physiological status

Create an Italian data base for these traits

Genotyping

This presentation

Longer process



Set up a genetic evaluation



Italian Holstein Efficiency project

- Important to establish «standardized» data collection and to know the phenotype

Ongoing experiments for Individual Feed Intake and Methane emission

- **Cows and Heifers** feed intake (RIC system) and CH₄ (LMD)
- **Young bulls** feed intake (RIC system) and GHG (GF + LMD)
- **Feces collection (all animals)** → Chemical analysis through the use of NIRS FOSS DS-2500 technology (weekly collection)





Italian Holstein Efficiency project

Livestock Production Science, 32 (1992) 189–202
Elsevier Science Publishers B.V., Amsterdam

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Genetic relationships between feed intake, efficiency and production traits in growing bulls, growing heifers and lactating heifers

G.J. Nieuwhof, J.A.M. van Arendonk, H. Vos and S. Korver
Department of Animal Breeding, Wageningen Agricultural University, Wageningen, Netherlands
(Accepted 27 January 1992)





Material and Methods growing animals (Heifers and Bulls)

- 32 Holstein-Friesian **heifers** (trial length: 35 - 60 days)
 - Tie-stall barn: Individual bins with electronic scales. Diet ad libitum
 - Feed intake, Live Body Weight, BCS, Wither Height and Heart Girth

- 58 Holstein-Friesian **young bulls** (trial length: 20 days)
 - Free stall barn (RIC system). Diet ad libitum
 - Traits recorded: Feed intake, Live Body Weight, BCS, Wither Height and Heart Girth

 - RFI and FCR





Material and Methods

Lactating cows

- 30 Holstein-Friesian **dairy cows** (trial length: 57 days)
(mean DIM = 153.33 ± 53.65)
 - Free stall barn (RIC system). Diet ad libitum
 - Feed intake, Live Body Weight, BCS, ECM, fat and protein content, MilkE, and Δ BodyE

- RFI and Milk/DMI



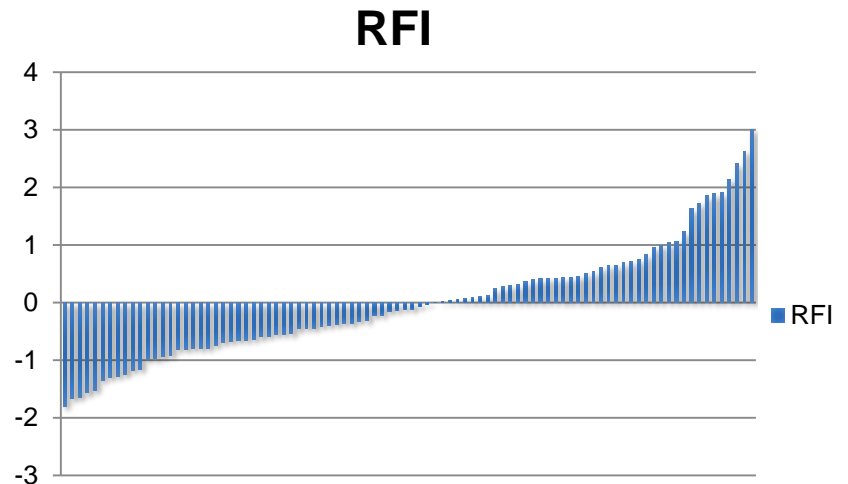


Material and Methods

- Animals have been divided into 2 groups on the basis of RFI FCR M:F values
- Several Mixed models within group type

Y= high and low groups (RFI / FCR /M:F)

Y= Age, MBW, initial weight, final weight, ADG, DMI, ECM, Parity....





Results: Descriptive Statistics

Traits	Heifers			Young Bulls		
	Mean± SD	MIN	MAX	Mean± SD	MIN	MAX
Age (month)	14,92±3,42	10,27	21,60	9,05±1,77	6,33	17,00
DMI (kg/d)	8,30±3,99	3,29	16,17	8,32±1,62	5,77	13,23
ADG (kg/d)	1,01±0,33	0,38	1,74	1,13±0,50	0,07	2,57
MBW (kg)	97,39±15,33	71,23	138,56	71,64±10,96	50,57	104,31
RFI (kg)	0.00±1,00	-1,80	2,14	0,00±1,00	-1,66	3,01
FCR	8,63±4,31	2,81	26,37	10,79±14,30	3,70	110,34
Initial weight (kg)	419,11±87,00	267,50	648,00	287,23±61,56	170,00	482,00
Final weight (kg)	468,42±101,65	310,00	745,50	311,57±61,56	194,00	500,00



Growing animals: Heifers

Traits	L-RFI	H-RFI	sign.	L-FCR	H-FCR	sign
Age (month)	13,89	16,06	*	12,70	17,42	**
Initial weight (kg)	407,0 9	432,73		377,94	465,77	**
Final weight (kg)	447,0 6	492,63		418,29	525,23	**
MBW (kg)	94,88	100,22		90,39	105,31	**
ADG (kg/d)	0,94	1,09		0,96	1,07	
DMI (kg/d)	5,97	10,94	**	5,69	11,27	**
RFI (kg)	-	-		-0,63	0,71	**
FCR	6,53	11,09	**	-	-	

** = P < 0.01

* = P < 0.05

† = 0.05 < P < 0.10



Growing animals: Young Bulls

Traits	L-RFI	H-RFI	sign.	L-FCR	H-FCR	sign.
Age (month)	9,02	9,09		8,71	9,50	†
Initial weight (kg)	285,37	289,36		279,69	295,86	
Final weight (kg)	310,50	312,79		310,13	313,21	
MBW (kg)	71,45	71,57		70,70	72,43	
ADG (kg/d)	1,12	1,15		1,47	0,74	**
DMI (kg)	7,78	8,92	**	8,13	8,53	
RFI (kg)	-	-		-0,13	0,15	
FCR	12,02	9,39		-	-	

** = P < 0.01

* = P < 0.05

† = 0.05 < P < 0.10



Lactating cows

** = $P < 0.01$;
 * = $P < 0.05$;
 † = $P < 0.10$

Traits	L-RFI	H-RFI	sig	L-M:F	H-M:F	sig
DIM (dd)	150,13	165,53		179,27	137,40	*
Parity	1,80	2,00		2	1,80	
ΔBCS (57d)	-0,12	-0,04		-0,22	-0,30	
DMI (kg)	18,62	21,07	**	19,87	19,83	
RFI (kg)	-	-		-0,27	0,27	
M:F ECM/DMI	1,45	1,36		-	-	
ECM (kg/d)	27,02	28,74		24,07	31,69	**
MilkE (Mcal/d)	20,23	21,35		18,31	23,27	**
ΔBodyE (Mcal/d)	2,86	2,82		2,71	2,96	



Conclusions

- RFI is constant in all different groups considered
- Selection for RFI allows to evaluate Feed Efficiency of “dairy” animals during both productive and non productive life
- RFI in lactating animals is unaffected by stage of lactation and production level
- Cows with higher M:F require more energy to produce milk, while consuming comparable amounts of feed
 - Biased by days in milk?
- Cows with lower RFI eat less while maintaining comparable levels of energy expenditure



Conclusions

RFI

Strengths

- Independent from age and production level
- **Can be used to evaluate both growing and lactating animals**

Weakness

- DMI and Body Weight measurements are required
- Does not take into account the effect of diet energy density

Simple indices (ratios)

Strengths

- Datasets for predictive indices already available
- Easier to calculate

Weakness

- Biased by production level and stage of lactation (M:F)
- **Cannot be used to evaluate both growing and lactating animals**