Implementing selection indexes for nitrogen efficiency in Italian Holstein population

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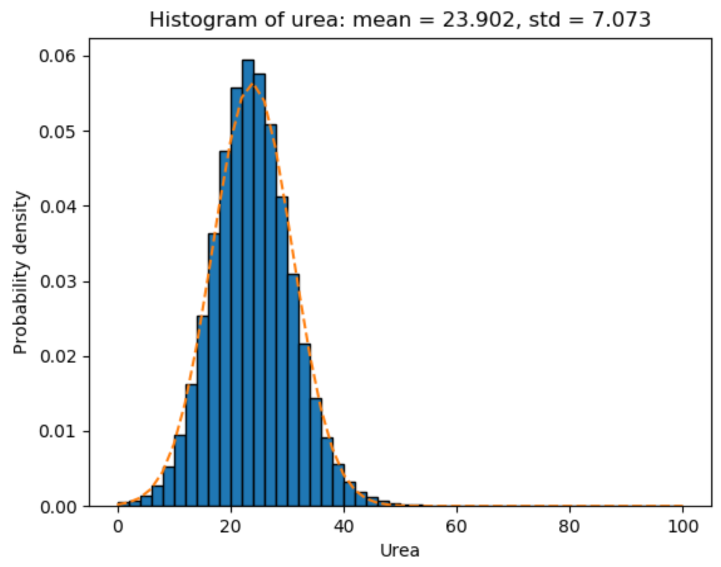
Introduction

- Urea collected during milk testdays
- Link between urea in milk and protein in diet

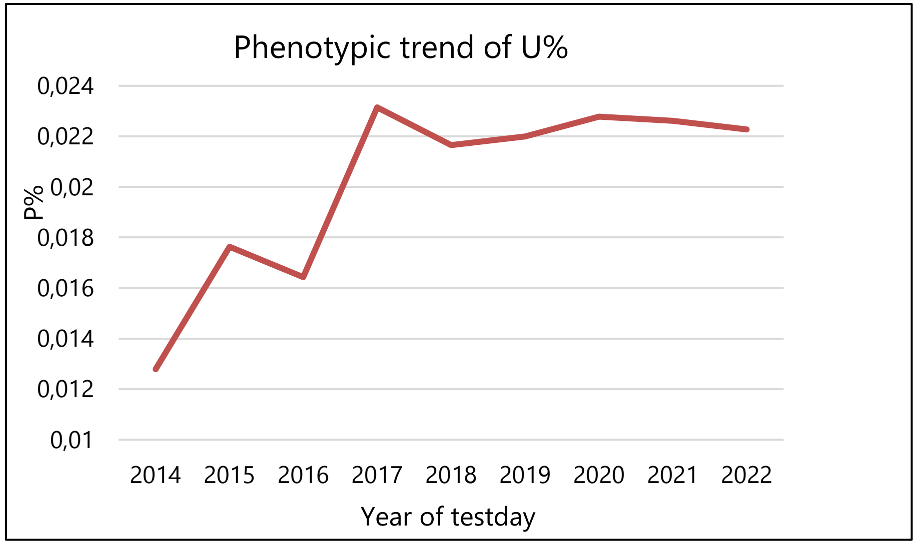
- Negative association between high urea in milk and fertility or other diseases

- Urea: content mean 20 mg/dL (from 10 to 30); h^2 0.14 – 0.40
- Correlation: positive with fat an protein %, negative with milk



Introduction

- Italian situation: constant phenotypic trend in urea in milk since 2017
- Urea % phenotypic mean 0.024% ± 0.007
- The majority of data comes from Lombardia and Emilia-Romagna regions



Region of analysis	data %
LOMBARDY	42.21
EMILIA-ROMAGNA	20.93
VENETO	6.77
SARDEGNA	6.26
SICILY	4.65
TUSCANY	4.18
OTHERS	15

Aim

- Implement a selection index in Italian Holstein dairy cattle for nitrogen efficiency

- Breeding goal is to improve the **Protein % / Urea % ratio** through a multiple-trait model (P%, U% and P%/U%)

↑ protein production in milk ↓ urea excretion in milk

- Define weights (selection index theory) for Protein and Urea to estimate the breeding values

Materials and Methods

Data

- 1,908,431 Holstein cows
- 9,324 herds
- 20,824,821 P%/U% records
- data from 2017 to 2022
- Up to 3 lactations per cow
- At least 4 testdays per cow

Softwares:

- THRGIBBS1F90, POSTGIBBSF90 → variances and covariances
- MiX99 → EBV

Method:

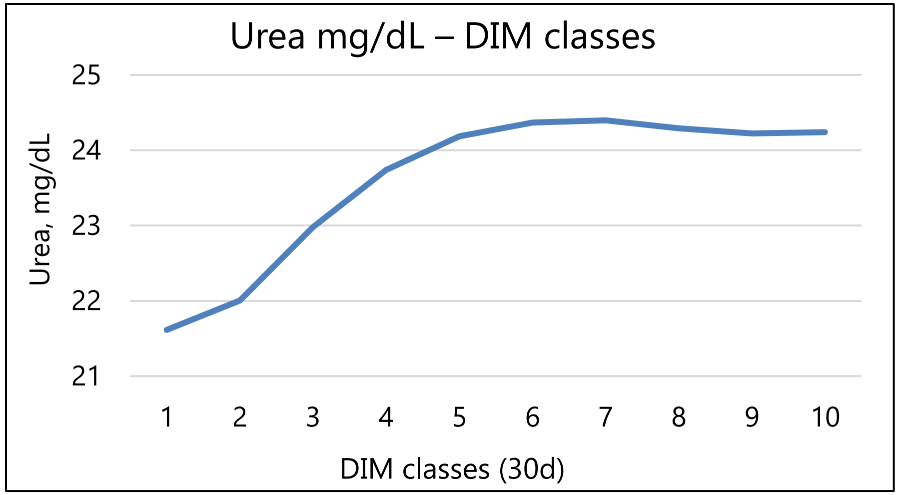
- selection index theory

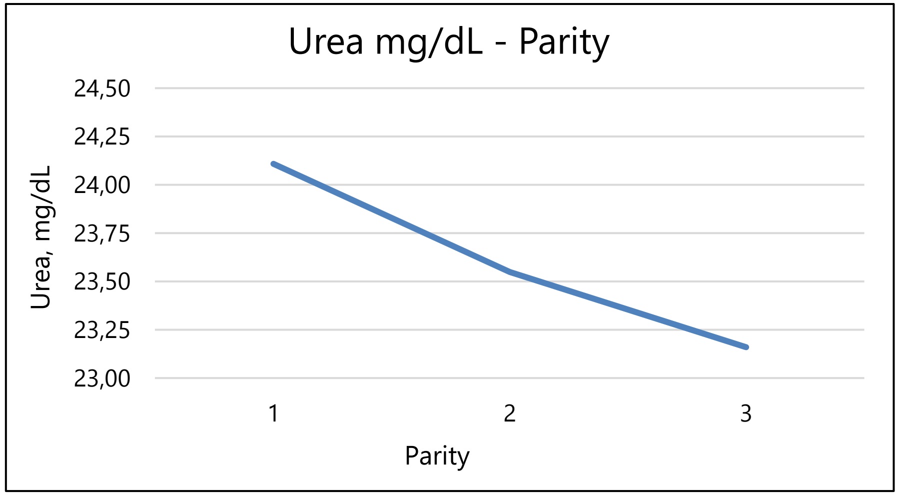
Materials and Methods

$$Y_{ijklmn} = htd_i + dim_j + parity_k + age_l * parity_k + dim_j * parity_k + a_m + pe_n + e_{ijklmn}$$

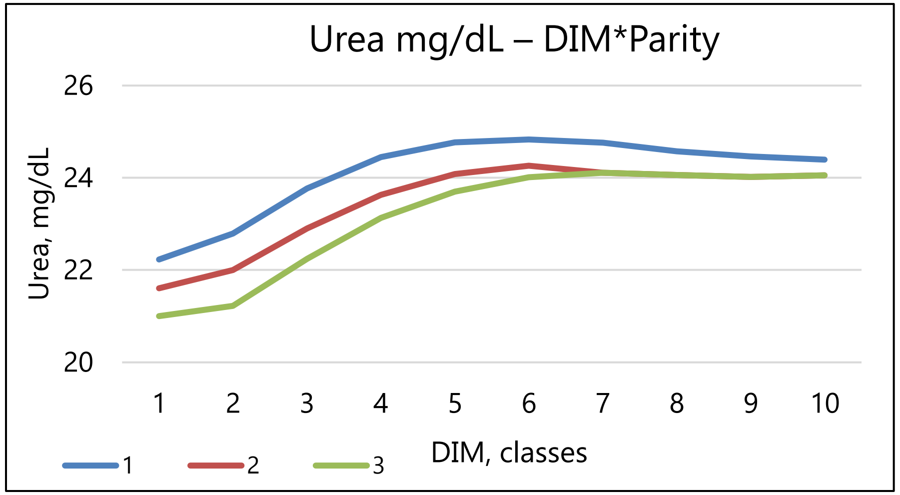
- Fixed effects:
  - htd_i: herd-test-day as contemporary group (328,654 levels)
  - dim_j: days in milk (10 levels, 30 days each)
  - $parity_k$: up to 3
  - $age_l * parity_k$:interaction age at calving and parity (9 levels within parity)
  - $dim_j * parity_k$: interaction between DIM and parity
- Random effects:
  - a_n: additive genetic effect of the animal
  - pe_p: permanent environment
  - e_{ijklmn}: residual

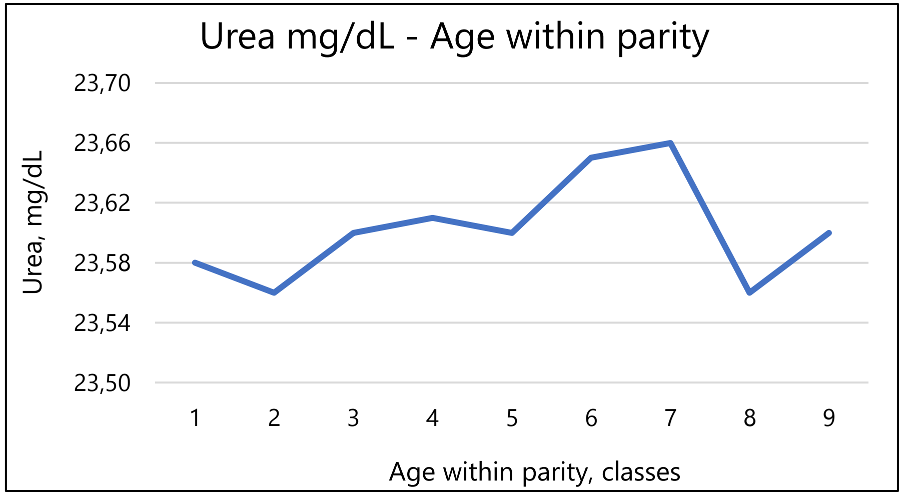
Results





Relationship between U mg/dL and model effects





Results

- Corr P%-U% 0.10
- h^2 U% 0.16
- h^2 P/U 0.18

Estimated weights of P% and U%
44% P + 56% U

	corr
p/u_pheno	0.45
protein %	0.16
urea %	-0.36

→ Correlations between EBV index of bulls (rel > 50, 20 daughters, 20 herds) and daughters' phenotypes

Results

EBVs of proven italian and foreign bulls

> 105	EBV	p/u_pheno	protein %	urea %	urea_mg/dL
count	420	420	420	420	420
mean	106.14	137.14	2.91	0.018	19.53
std	± 1.54	± 20.14	± 0.44	± 0.003	± 3.06
min	105	24.23	0.48	0.003	3.08
max	113	161	3.42	0.022	23.15

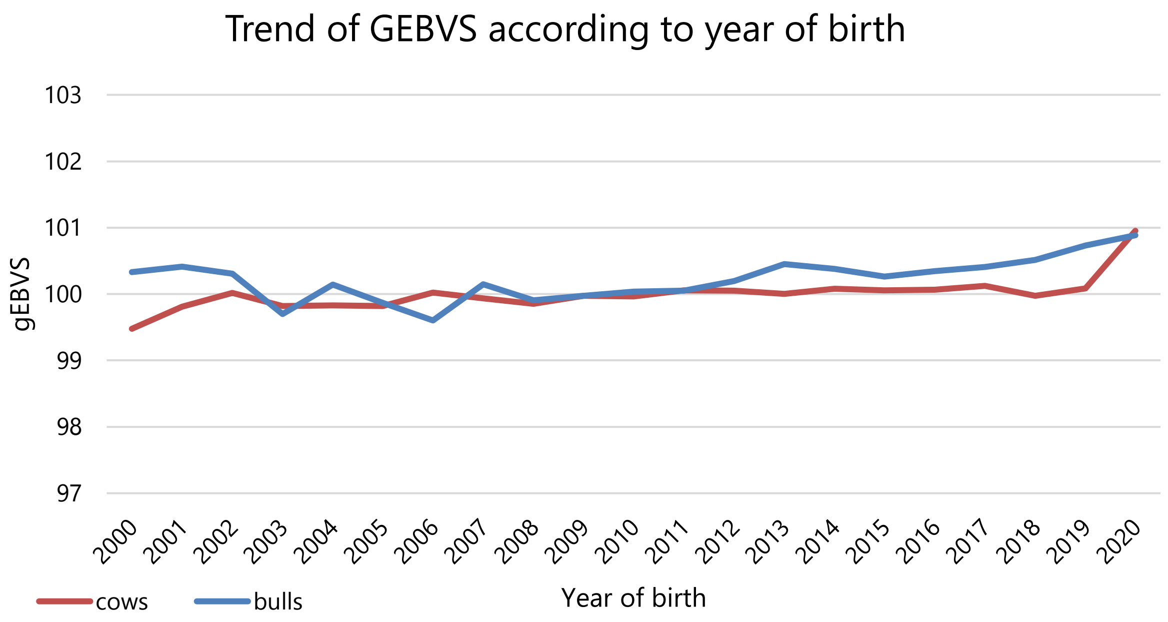
lower urea, higher proteins, high ratio
→ high EBV index

< 95	EBV	p/u_pheno	protein %	urea %	urea_mg/dL
count	325	325	325	325	325
mean	93.69	125.58	2.88	0.022	21.74
std	± 1.54	± 13.41	± 0.29	± 0.011	± 2.24
min	87	64.07	1.43	0.022	11
max	95	149.33	3.34	0.025	26.1

higher urea, lower proteins, low ratio
→ low EBV index

On average 2 mg/dL urea less with higher index!

Results



milk	-0.09
fat %	0.14
protein %	0.40

Conclusions

- Selecting for nitrogen efficiency is feasible
- Medium heritability
- High nitrogen efficiency index → better animal welfare and higher production of fat and protein
- Less urea excreted
  - lower environmental impact
  - better utilisation of dietary protein → less feeding costs

Thank you for your attention!

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