Relationship between milk production traits and fertility in Austrian Simmental cattle

Birgit Gredler[1], Christian Fuerst[2], Johann Sölkner[1]

[1] BOKU – University of Natural Resources and Applied Life Sciences – Dept. of Sustainable Agricultural Systems, Vienna

[2] ZuchtData – EDV- Dienstleistungen GmbH, Vienna

Contents

- Introduction
- Objectives
- Material
- Methods
- Results
- Conclusions

Introduction

- Decreased fertility main reason for involuntary culling in dairy cows (23.5% culled due to reproductive disorders in 2006 in Simmental cattle)
- Many different reasons for reproductive disorders
- In early lactation negative energy balance is the main reason for poor reproductive performance
- Negative energy balance is a major problem in early lactation – high milk energy output and low energy input (relatively low feed intake)

Introduction

- Monitoring energy balance:
  - Analysis of blood metabolites
  - Dietary evaluation
  - Body Condition Score
  - **Data from routine milk recording**

Milk recording data

- **Milk urea nitrogen (MUN)**
  - Higher levels of MUN were negatively related to reproductive performance of dairy cows (Hojmann et al., 2004).
- **Fat-Protein-ratio (F:P)**
  - Useful predictor of dairy cows at high risk of negative energy balance, ovarian cysts, ketosis, lameness, … (Mulligan et al., 2006).
- **Milk lactose percentage**
  - Higher milk lactose content in the first weeks postpartum was associated with resumption of luteal function (Reksen et al., 2002).
  - Higher milk lactose percentage was correlated to higher pregnancy rates early after calving (Buckley et al., 2003).

Objectives

- Identify possible predictors of fertility for use in the genetic evaluation for fertility
  – estimation of genetic parameters of these traits
- Fertility traits: days to first service (DFS)
  days open (DO)
- Auxiliary traits analysed as measures of energy balance and metabolic status of cows:
  - Milk urea nitrogen (MUN)
  - Fat:Protein-ratio (F:P)
  - Milk lactose percentage (MLP)

Material

- In total 12,828 dual purpose Simmental cows
- 7 lactations
- 1,505 herds in Lower Austria
- Days to first service (DFS) = number of days between calving and first insemination
- Days open (DO) = number of days between calving and last insemination
- Milk yield (Mkg), MUN, MLP were routinely assessed during milk recording

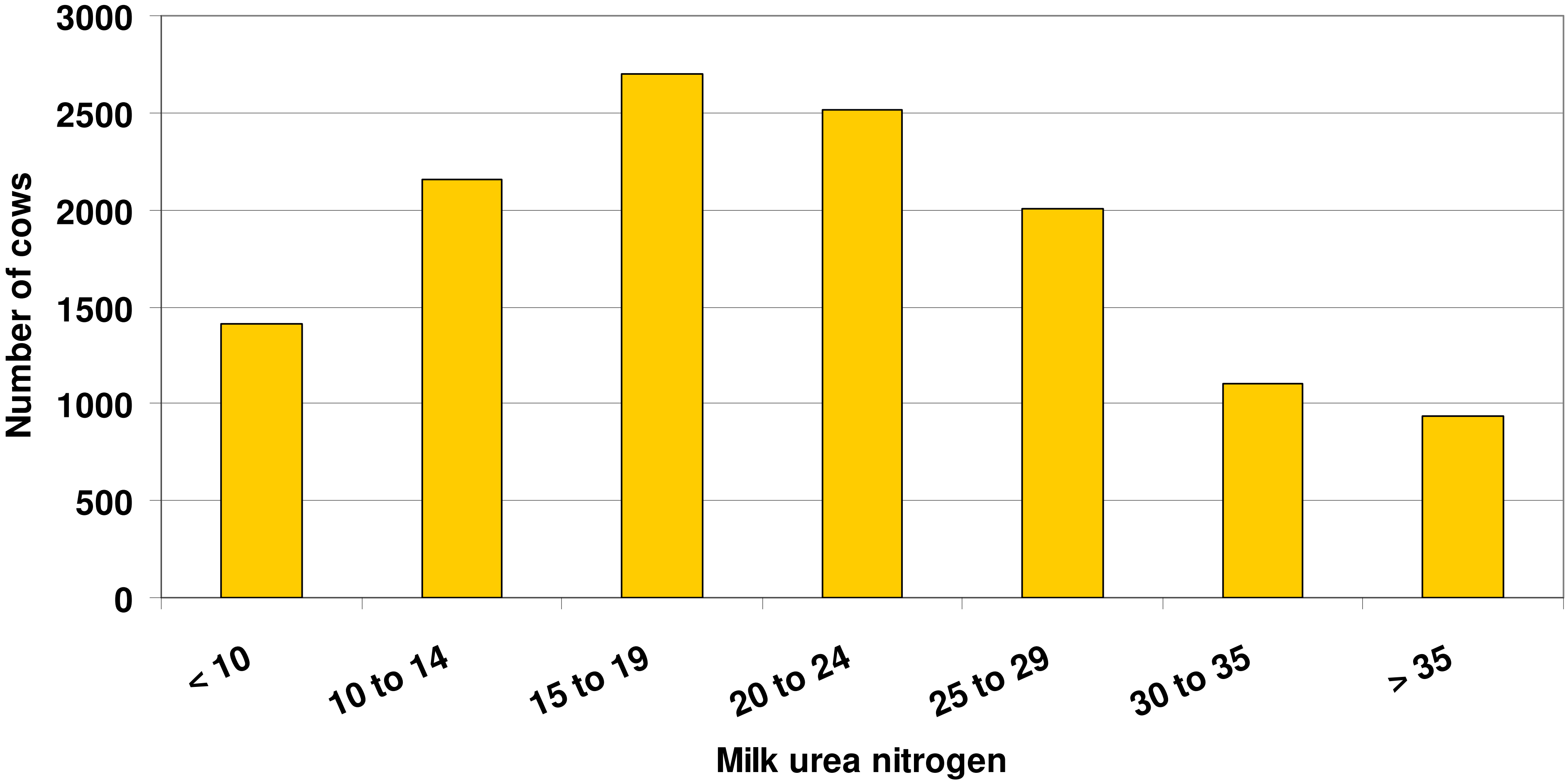
Material

- Fat-protein-ratio (F:P) was computed from milk fat and protein percentages of each record
- Closest milk record to the date of first insemination was used
- Data restrictions:
  - DFS: 20 – 200 days
  - DO: 20 – 365 days
  - MUN: 1 – 70 mg/100ml
  - F:P: 0.5 – 2.5
  - MLP: 3 – 6%

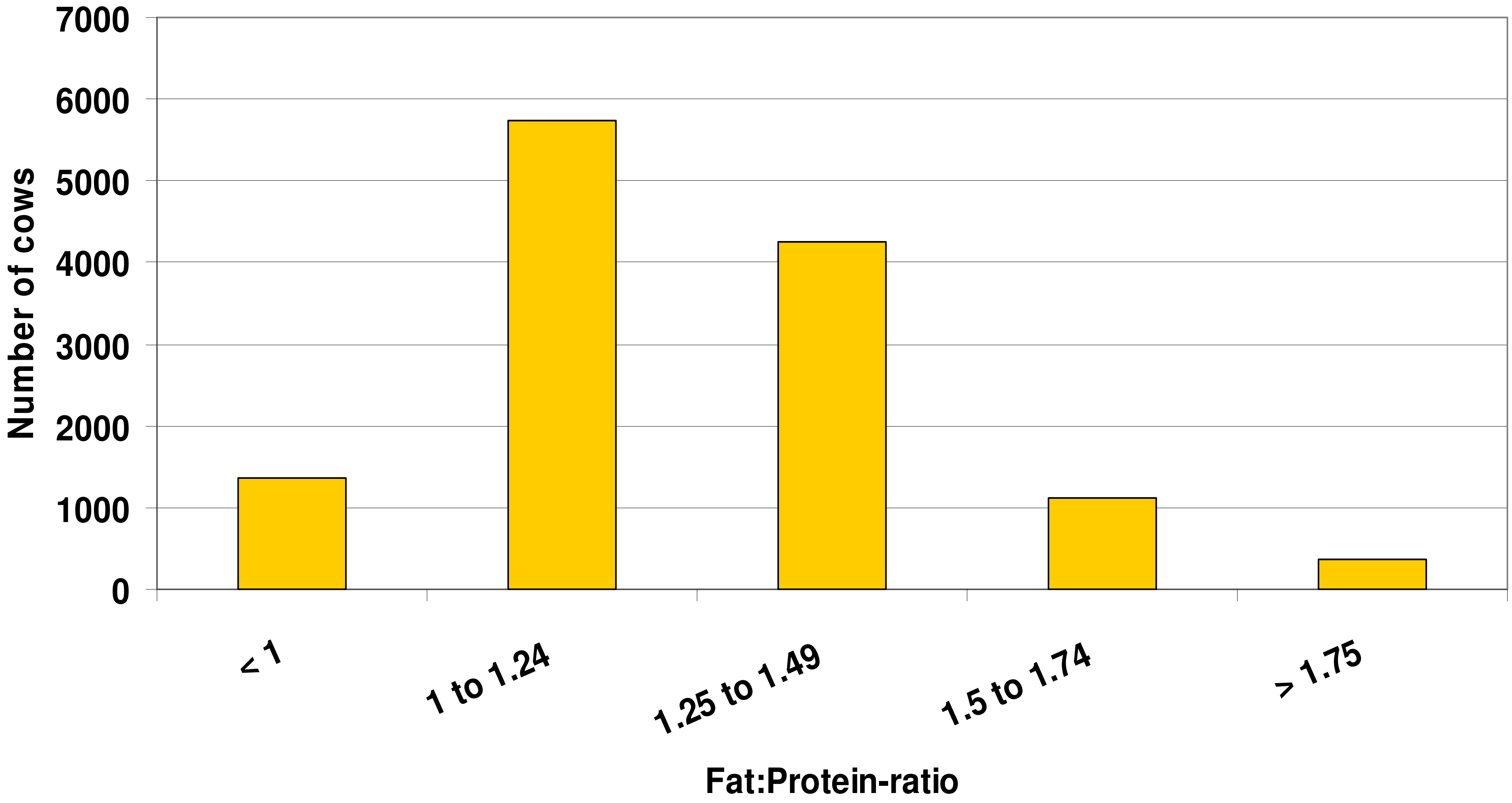
Descriptive Statistics

Trait	N	Mean	SD	MIN	MAX
DFS	12,828	64.7	22.6	20	199
DO	12,828	100.6	58.1	20	365
MKg	12,828	27.3	7.1	4.8	69
MUN	12,828	20.5	9.4	1	68
F:P	12,828	1.24	0.22	0.69	2.43
MLP	12,828	4.88	0.17	3.5	5.5

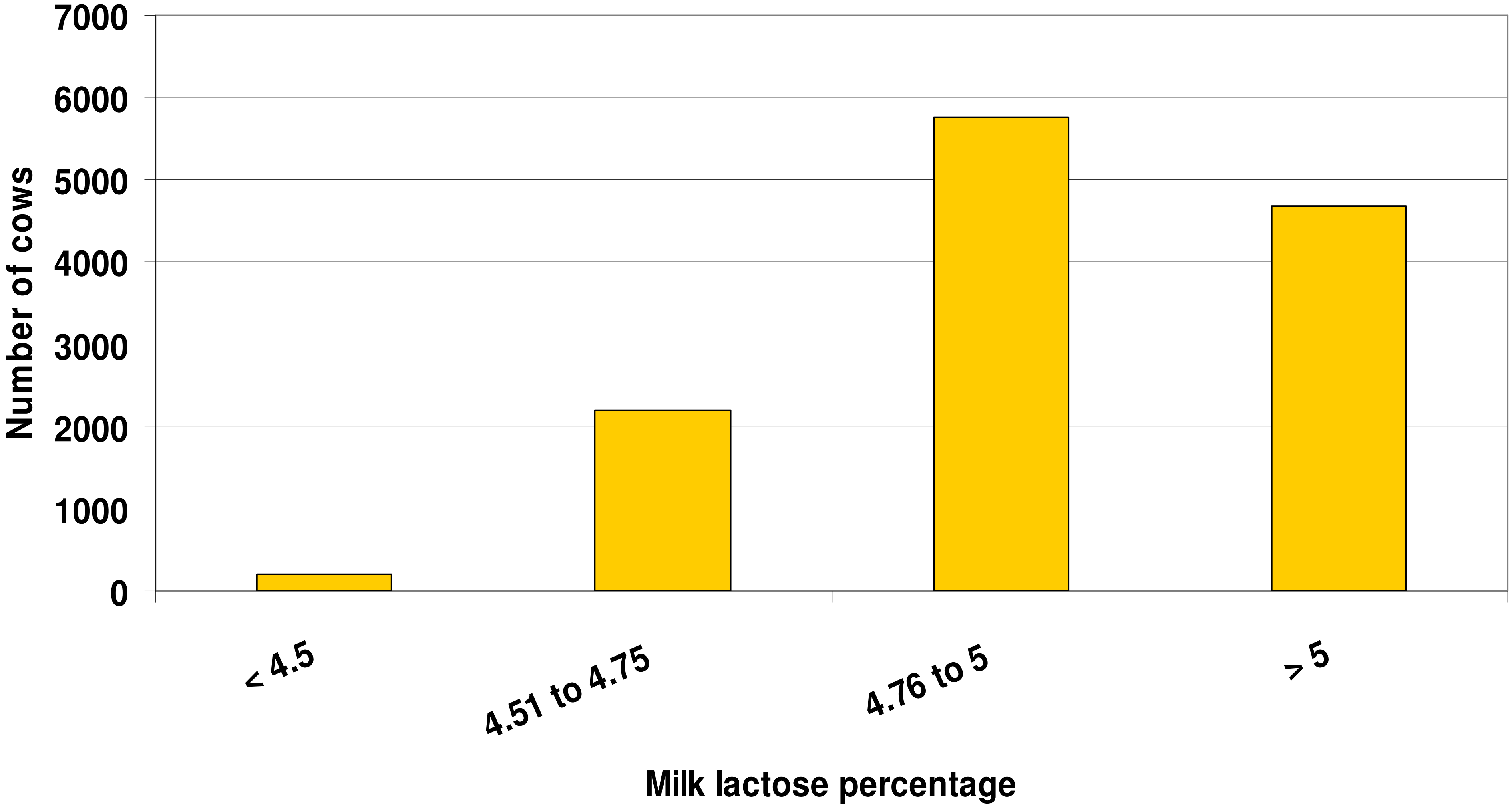
Distribution MUN



Distribution F:P



Distribution MLP



Statistical model

- Estimation by REML with VCE5.1, trivariate analyses, animal model

- **DFS and DO:**
  - Fixed effects:
  - Herd*year*season interaction of calving (n=3,447)
  - Calving age*lactation interaction (n=33)
  - Random additive genetic effect of animal

Statistical model

- **MKg, MUN, F:P, MLP:**
  - Fixed effects:
  - Herd*year*month interaction of test-day of milk recording (n=1,836)
  - Lactation (n=7)
  - AM/PM milking (n=2)
  - Continuous effect of days in milk after calving (linear and quadratic)
  - Random additive genetic effect of animal

Results

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	1.00 n.e.	0.65 ±0.13	-0.21 ±0.10	0.26 ±0.11	-0.12 ±0.07
DO	0.34 ***	**0.023 ±0.005**	0.75 ±0.089	-0.14 ±0.13	0.10 ±0.073	-0.20 ±0.12
Mkg	-0.14 ***	0.01 ns	**0.19 ±0.017**	0.05 ±0.055	0.33 ±0.08	-0.26 ±0.052
MUN	0.04 ***	0.00 ns	0.11 ***	**0.22 ±0.017**	0.06 ±0.048	0.12 ±0.058
F:P	-0.07 ***	0.00 ns	0.00 ns	0.11 ***	**0.10 ±0.014**	0.00 ±0.044
MLP	-0.12 ***	-0.02 ns	-0.04 ***	0.03 **	-0.06 ***	**0.39 ±0.018**

Results – Heritabilities

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	1.00 n.e.	0.65 ±0.13	-0.21 ±0.10	0.26 ±0.11	-0.12 ±0.07
DO	0.34 ***	**0.023 ±0.005**	0.75 ±0.089	-0.14 ±0.13	0.10 ±0.073	-0.20 ±0.12
Mkg	-0.14 ***	0.01 ns	**0.19 ±0.017**	0.05 ±0.055	0.33 ±0.08	-0.26 ±0.052
MUN	0.04 ***	0.00 ns	0.11 ***	**0.22 ±0.017**	0.06 ±0.048	0.12 ±0.058
F:P	-0.07 ***	0.00 ns	0.00 ns	0.11 ***	**0.10 ±0.014**	0.00 ±0.044
MLP	-0.12 ***	-0.02 ns	-0.04 ***	0.03 **	-0.06 ***	**0.39 ±0.018**

Results - genetic correlations

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	**1.00 n.e.**	**0.65 ±0.13**	**-0.21 ±0.10**	**0.26 ±0.11**	**-0.12 ±0.07**
DO	0.34 ***	**0.023 ±0.005**	0.75 ±0.089	-0.14 ±0.13	0.10 ±0.073	-0.20 ±0.12
Mkg	-0.14 ***	0.01 ns	**0.19 ±0.017**	0.05 ±0.055	0.33 ±0.08	-0.26 ±0.052
MUN	0.04 ***	0.00 ns	0.11 ***	**0.22 ±0.017**	0.06 ±0.048	0.12 ±0.058
F:P	-0.07 ***	0.00 ns	0.00 ns	0.11 ***	**0.10 ±0.014**	0.00 ±0.044
MLP	-0.12 ***	-0.02 ns	-0.04 ***	0.03 **	-0.06 ***	**0.39 ±0.018**

Results – genetic correlations

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	1.00 n.e.	0.65 ±0.13	-0.21 ±0.10	0.26 ±0.11	-0.12 ±0.07
DO	0.34 ***	**0.023 ±0.005**	**0.75 ±0.089**	**-0.14 ±0.13**	**0.10 ±0.073**	**-0.20 ±0.12**
Mkg	-0.14 ***	0.01 ns	**0.19 ±0.017**	0.05 ±0.055	0.33 ±0.08	-0.26 ±0.052
MUN	0.04 ***	0.00 ns	0.11 ***	**0.22 ±0.017**	0.06 ±0.048	0.12 ±0.058
F:P	-0.07 ***	0.00 ns	0.00 ns	0.11 ***	**0.10 ±0.014**	0.00 ±0.044
MLP	-0.12 ***	-0.02 ns	-0.04 ***	0.03 **	-0.06 ***	**0.39 ±0.018**

Results – genetic correlations

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	1.00 n.e.	0.65 ±0.13	-0.21 ±0.10	0.26 ±0.11	-0.12 ±0.07
DO	0.34 ***	**0.023 ±0.005**	0.75 ±0.089	-0.14 ±0.13	0.10 ±0.073	-0.20 ±0.12
Mkg	-0.14 ***	0.01 ns	**0.19 ±0.017**	**0.05 ±0.055**	**0.33 ±0.08**	**-0.26 ±0.052**
MUN	0.04 ***	0.00 ns	0.11 ***	**0.22 ±0.017**	**0.06 ±0.048**	**0.12 ±0.058**
F:P	-0.07 ***	0.00 ns	0.00 ns	0.11 ***	**0.10 ±0.014**	**0.00 ±0.044**
MLP	-0.12 ***	-0.02 ns	-0.04 ***	0.03 **	-0.06 ***	**0.39 ±0.018**

Results – phenotypic correlations

Trait	DFS	DO	Mkg	MUN	F:P	MLP
DFS	**0.022 ±0.006**	1.00 n.e.	0.65 ±0.13	-0.21 ±0.10	0.26 ±0.11	-0.12 ±0.07
DO	**0.34 *****	**0.023 ±0.005**	0.75 ±0.089	-0.14 ±0.13	0.10 ±0.073	-0.20 ±0.12
Mkg	**-0.14 *****	**0.01** ns	**0.19 ±0.017**	0.05 ±0.055	0.33 ±0.08	-0.26 ±0.052
MUN	**0.04 *****	**0.00** ns	**0.11 *****	**0.22 ±0.017**	0.06 ±0.048	0.12 ±0.058
F:P	**-0.07 *****	**0.00** ns	**0.00** ns	**0.11 *****	**0.10 ±0.014**	0.00 ±0.044
MLP	**-0.12 *****	**-0.02** ns	**-0.04 *****	**0.03 ****	**-0.06 *****	**0.39 ±0.018**

Conclusions

- Substantial genetic variance exists for MUN, F:P and MLP
- Genetic correlations indicate that these traits can be used as predictors of fertility
- Further studies:
  - To confirm results - consideration of a higher number of cows and additional fertility traits (NR56, number of inseminations, …)
  - Analysis of a combination of MUN and milk protein-percentage

Thank you for your attention!