2011 ADSA-ASAS JAM
July 10-14 New Orleans, Louisiana

Genetic relationships between fertility and content of major fatty acids in milk for first-parity Walloon Holstein cows

Catherine Bastin[1*], N. Gengler [1,2], and H. Soyeurt [1,2]

[1] Animal Science Unit, Gembloux Agro-Bio Tech, University of Liège (GxABT, ULg) Gembloux, Belgium
[2] National Fund for Scientific Research (FRS-FNRS) – Brussels, Belgium

ROBUSTMILK

www.robustmilk.eu

Context: indicator traits

Fertility traits

- are difficult to measure / not readily available
- have low heritabilities

⇨ **Indicator traits** (e.g. traits related to energy balance) are of interest to estimate EBV's

- Body condition score
- Milk **fatty acid** profile?

Context: fatty acids & fertility

Milk fatty acids and fertility?

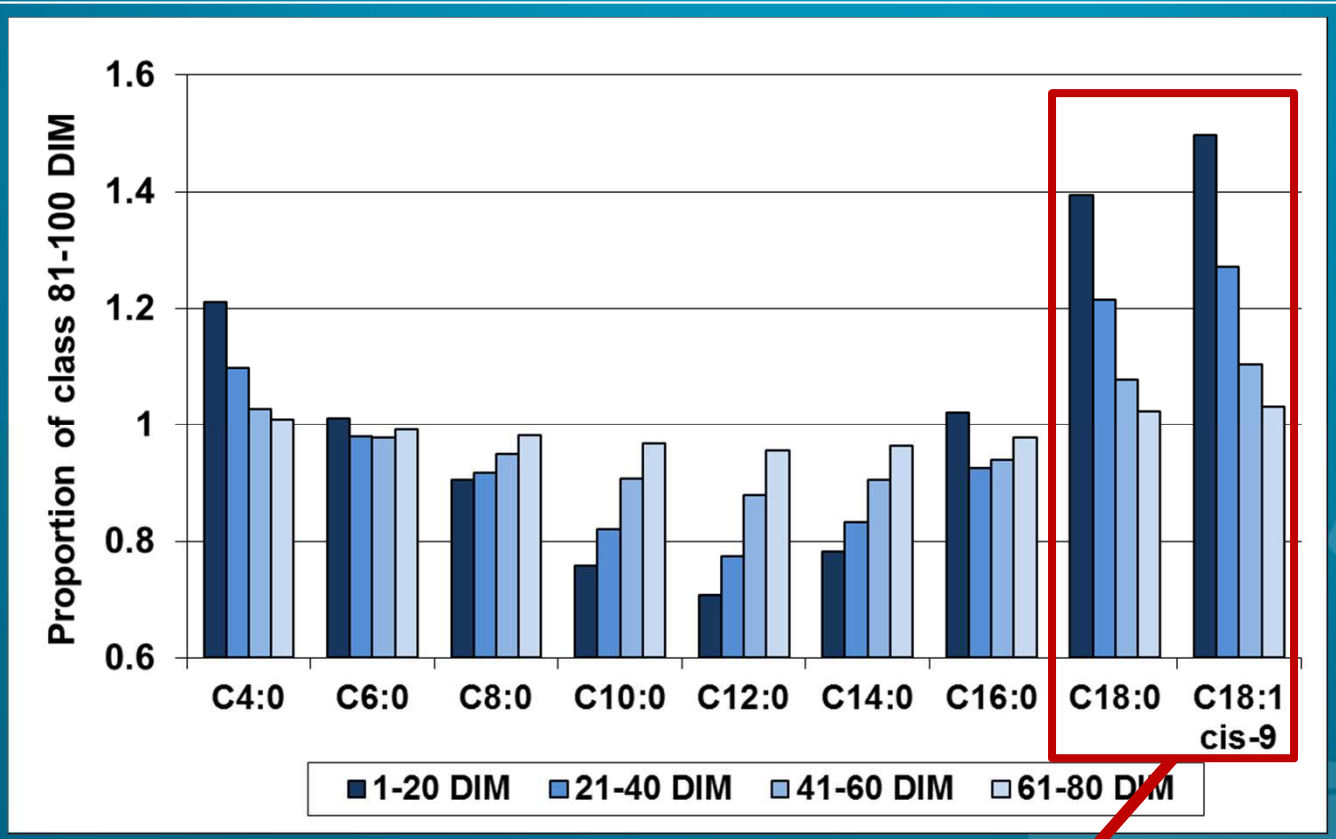
- **relationship between fertility and body fat mobilization in early lactation**
- **body fat mobilization**
  - **→ release of C18:0 and C18:1 cis-9 in milk**
  - **→ inhibition of *de novo* synthesis of fatty acids by mammary gland**

Body fat mobilization:

- **increase of C18:0 and C18:1 *cis-9* contents in milk**
- **decrease of C8:0 to C14:0 contents in milk**

Context: fatty acids & fertility

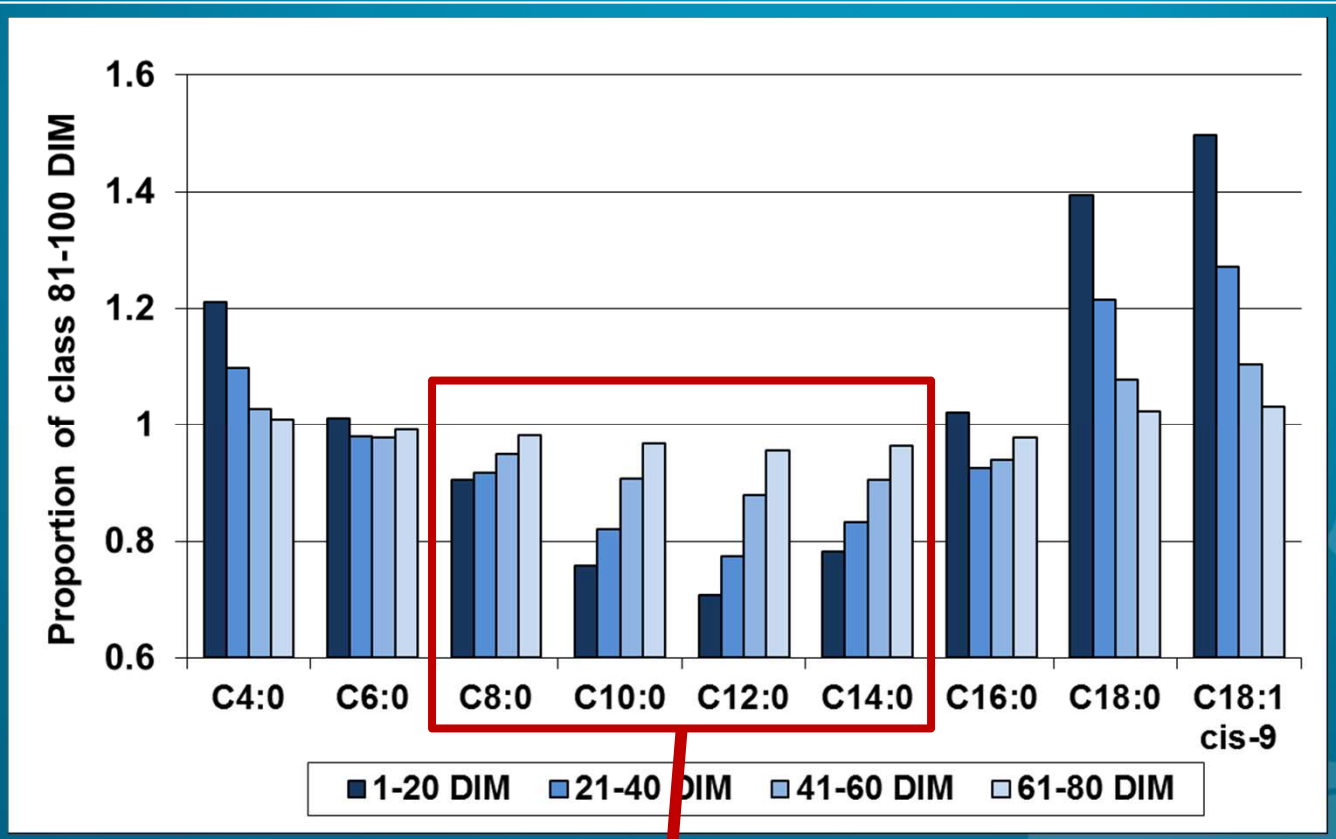
Concentrations of FA in milk at 1-20, 21-40, 41-60, 61-80 classes of DIM as a proportion of their concentration at class 81-100 DIM (1st parity Holstein)



Release of C18:0 and C18:1 cis-9

Context: fatty acids & fertility

Concentrations of FA in milk at 1-20, 21-40, 41-60, 61-80 classes of DIM as a proportion of their concentration at class 81-100 DIM (1st parity Holstein)



Inhibition of *de novo* synthesis

Objective

Estimate genetic correlations between fertility and content of major fatty acids in milk for 1st-parity Walloon Holstein cows

Use milk fatty acids profile to improve indirectly fertility?

Data & Model: traits

- Days open (DO) = no. of days from calving to conception
- Milk, fat, protein yields, fat and protein contents
- FA contents (g/dl of milk)
  - predicted by MIR (MIR spectrum are routinely collected through milk recording)
  - Saturated (SFA), Unsaturated (UFA), Monounsaturated (MUFA), Polyunsaturated (PUFA), Long Chain (LCFA), Medium Chain (MCFA), Short Chain (SCFA)
  - C4:0, C6:0, C8:0, C10:0, C12:0, C14:0, C16:0, C17:0, C18:0, C18:1 *cis-9*

Data & Model

- 29,792 first-parity Holstein cows with both DO and FA records and at least 2 FA records
- 143,332 FA records and 29,792 DO records

- Variance components estimated using Gibbs sampling
- 22 bivariate models

Data & Model: effects

Production and FA traits

- herd x test-day (F)
- gestation stage (F)
- lactation stage (F)
- age at calving x lactation stage x season of calving (F)
- herd x calving period (RR)
- permanent environment (RR)
- genetic (RR)

Regression curves modelled with 2nd order Legendre polynomials

DO

- herd (F)
- year x month of calving (F)
- age at calving x season of calving (F)
- herd x year of calving (R)
- environment (R)
- genetic (R)

Data & Model: effects

Production and FA traits	DO
• herd x test-day (F)	• herd (F)
• gestation stage (F)	• year x month of calving (F)
• lactation stage (F)	• age at calving x season of calving (F)
• age at calving x lactation stage x season of calving (F)	
• herd x calving period (RR)	• herd x year of calving (R)
• permanent environment (RR)	• environment (R)
• genetic (RR)	• genetic (R)

Correlated effects

Results: Heritabilities

Lactation heritabilities

Days open	0.05

Milk (kg)	0.31
Fat (kg)	0.29
Protein (kg)	0.29
Fat (%)	0.67
Protein (%)	0.67

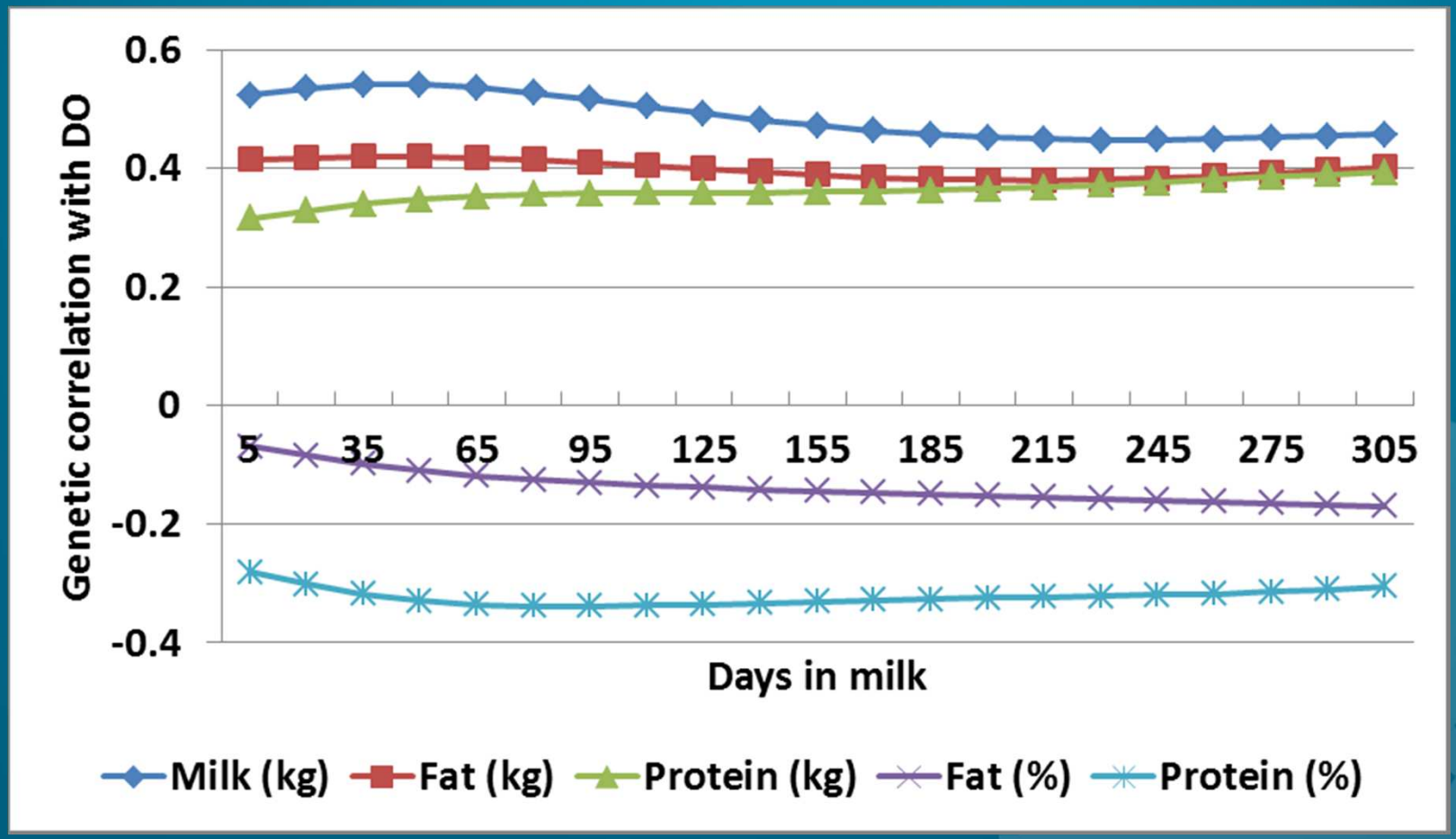
SFA	0.68
MUFA	0.58
PUFA	0.69
UFA	0.60
SCFA	0.68
MCFA	0.68
LCFA	0.56

C4:0	0.63
C6:0	0.67
C8:0	0.68
C10:0	0.68
C12:0	0.69
C14:0	0.68
C16:0	0.67
C17:0	0.70
C18:0	0.60
C18:1 *cis-9*	0.52

De novo **synthetized FA are more heritable than FA from the diet and from body fat mobilization**

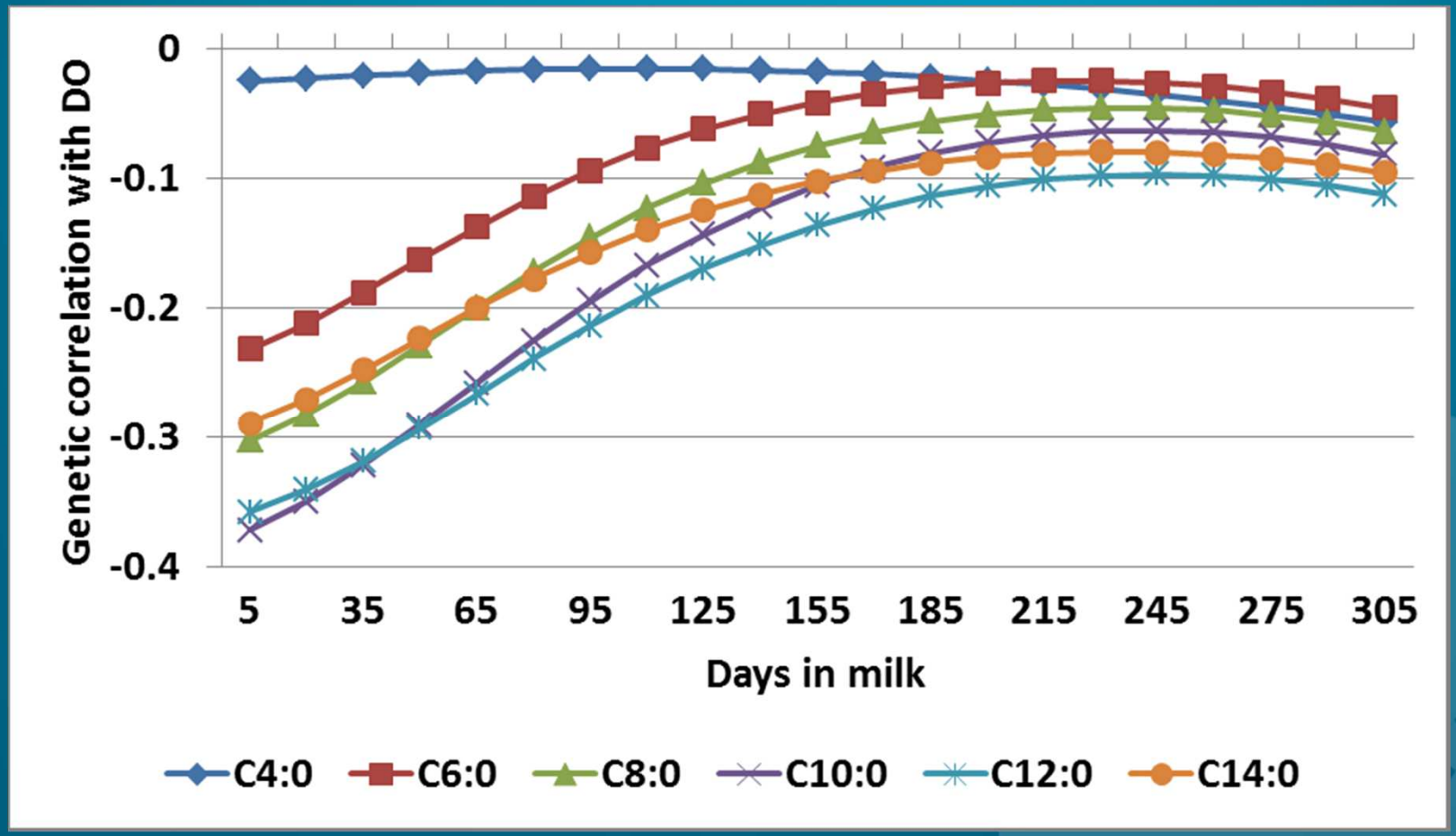
Results: Correlations

Daily genetic correlations with DO



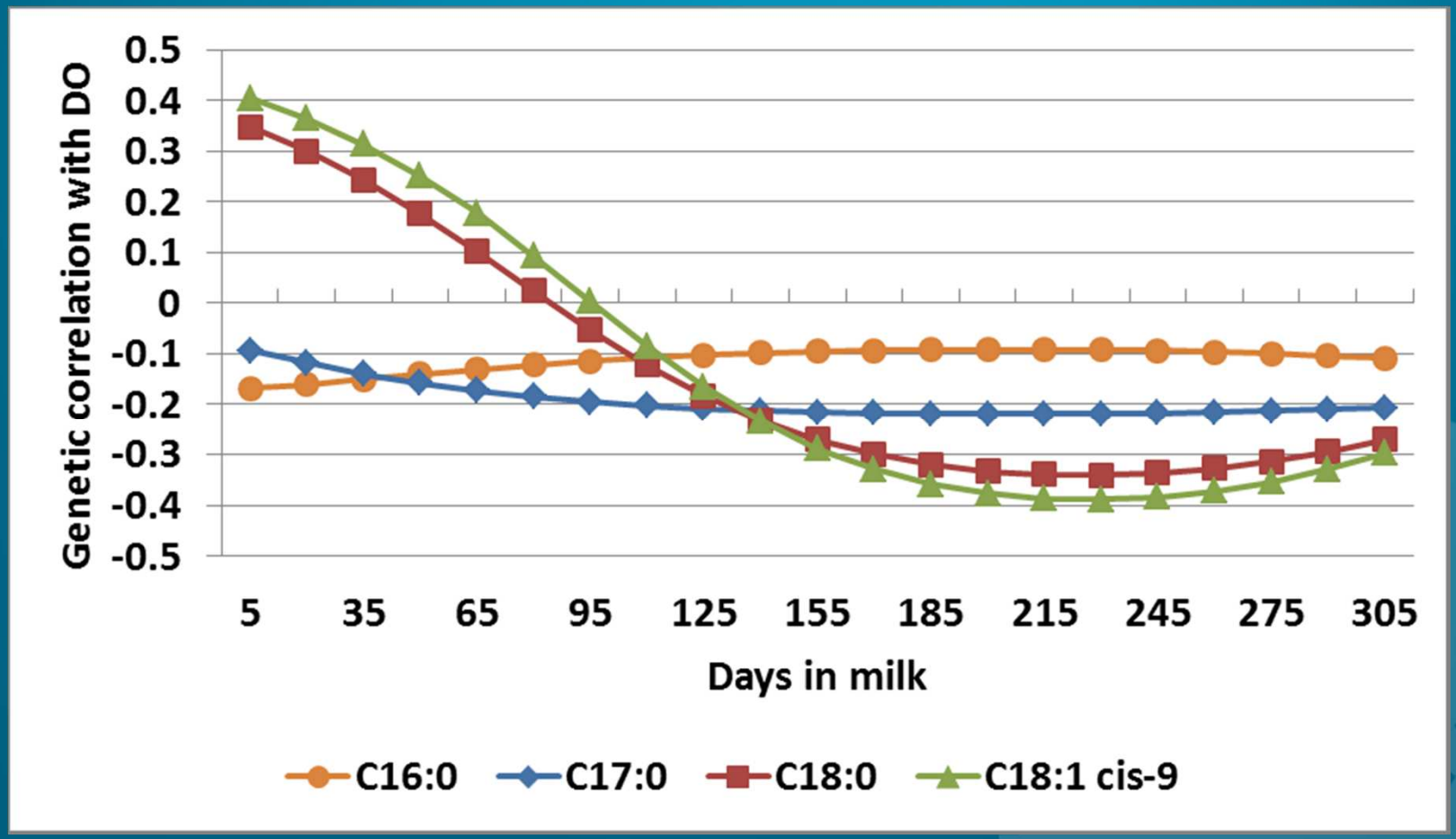
Results: Correlations

Daily genetic correlations with DO



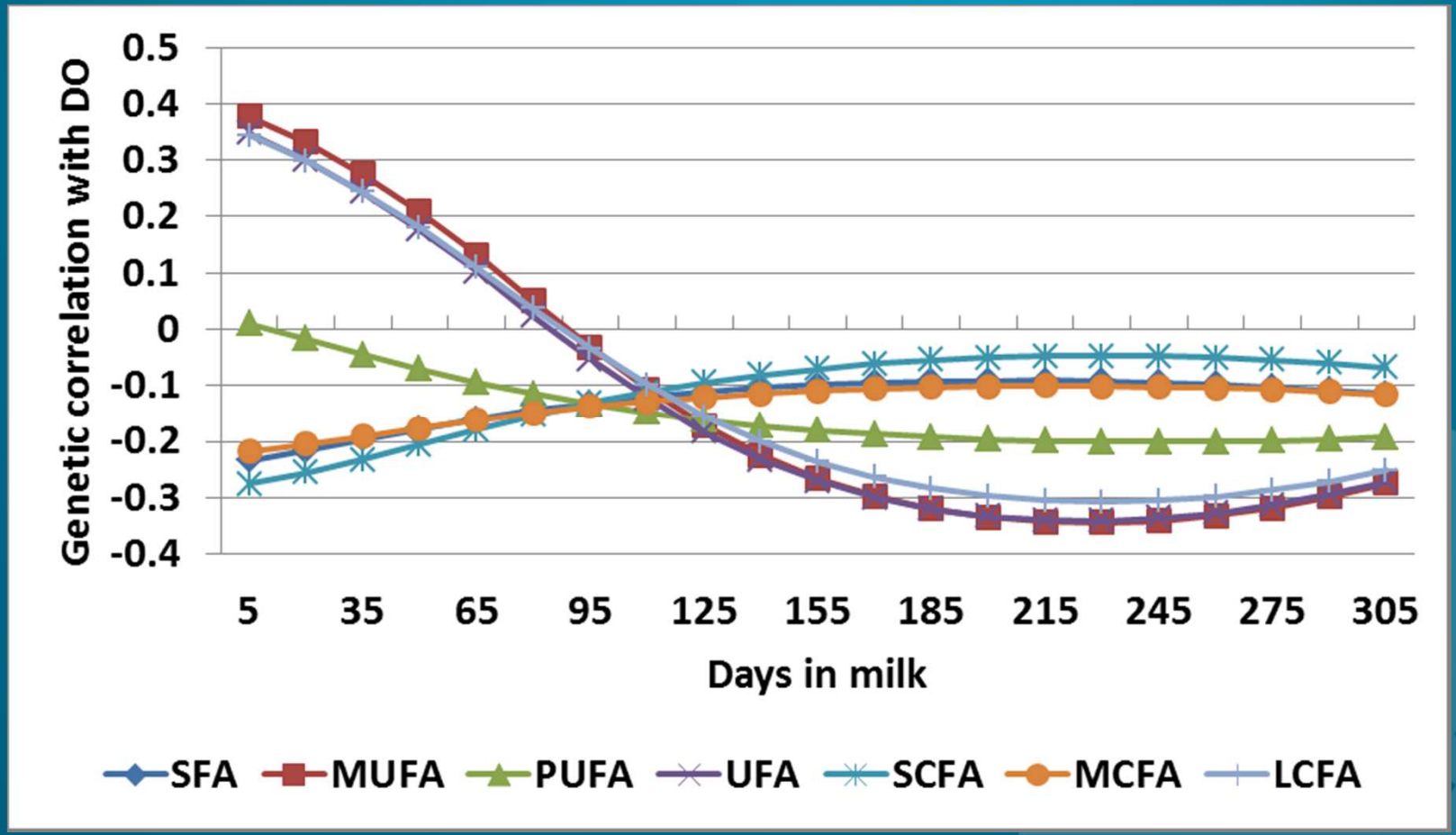
Results: Correlations

Daily genetic correlations with DO



Results: Correlations

Daily genetic correlations with DO



Results: Correlations

- In early lactation (< 30 DIM)
  - higher content of C18:1 *cis-9* in milk
    - → poorer fertility (r=0.40 at 5 DIM)
    - ➡ **Selection for lower content of C18:1 *cis-9* in early lactation would improve fertility**
  - higher content of C6:0 to C16:0 in milk
    - → better fertility
- In mid to late lactation
  - higher content of all FA in milk → better fertility

Response to selection

- Expected response to selection for days open = 3.3 days
- Correlated response on days open as a result of selection for lower content of C18:1 *cis-9* in milk at 5 DIM = 2.3 days

= selection against body fat mobilization in early lactation

Response to selection

- Expected response to selection for days open = 3.3 days
- Correlated response on days open as a result of selection for lower content of C18:1 *cis-9* in milk at 5 DIM = 2.3 days
- Correlated response on days open as a result of selection for higher content of C18:1 *cis-9* in milk at 230 DIM = 2.5 days

= higher correlated response to selection and desirable selection for nutritional quality of milk (i.e. increasing content of monounsaturated FA)

Response to selection

- Expected response to selection for days open = 3.3 days
- Correlated response on days open as a result of selection for lower content of C18:1 *cis-9* in milk at 5 DIM = 2.3 days
- Correlated response on days open as a result of selection for higher content of C18:1 *cis-9* in milk at 230 DIM = 2.5 days

Considering:

- $h^2_{DO} = 0.05$; $h^2_{\text{C18:1 } cis\text{-}9 \text{ at 5 DIM}} = 0.13$; $h^2_{\text{C18:1 } cis\text{-}9 \text{ at 230 DIM}} = 0.20$
- $r_{\text{DO-C18:1 } cis\text{-}9 \text{ at 5 DIM}} = 0.41$; $r_{\text{DO-C18:1 } cis\text{-}9 \text{ at 230 DIM}} = -0.39$
- phenotypic SD of DO = 65.2 days; selection intensity = 1

Conclusions

- Fatty acids contents in milk are correlated to fertility
  - correlations change throughout the lactation
  - it emphasizes relationship between body fat mobilization and fertility
- Interest of using FA contents in milk in indirect selection for better fertility in dairy cows
  - but all features of FA should be considered

    e.g. nutritional, sensory, and technological qualities of milk fat, relationships with methane emissions, etc.

Corresponding author's email:
catherine.bastin@ulg.ac.be

www.robustmilk.eu

Study supported by:

- Ministry of Agriculture of the Walloon Region of Belgium (SPW-DGARNE; projects D31-1207 & D31-1224)
- European Commission, Directorate-General for Agriculture and Rural Development, under Grant Agreement 211708 (project Robustmilk)

This study has been carried out with financial support from the Commission of the European Communities, FP7, KBBE-2007-1. It does not necessarily reflect its view and in no way anticipates the Commission's future policy in this area.