Somatic cell count-based selection reduces susceptibility to negative energy balance during early lactation in dairy sheep

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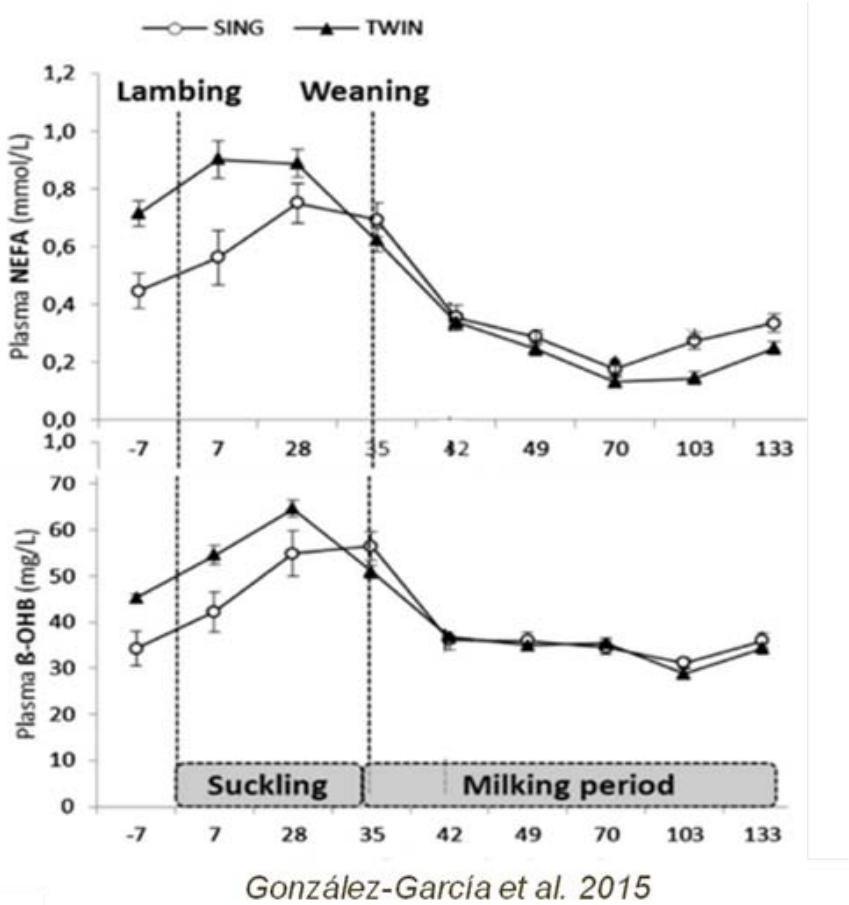
Negative Energy Balance around parturition

NEFA

Non Esterified Fatty Acids

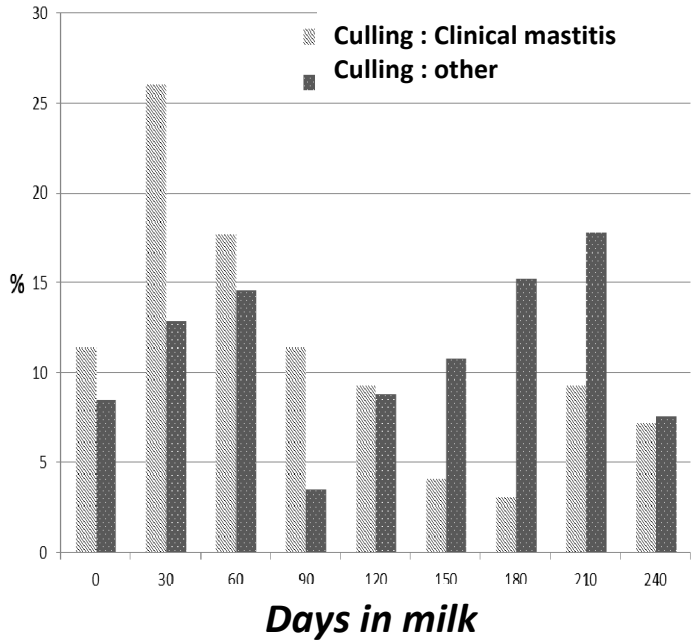
BHB

Beta-hydroxybutyrate



González-García et al. 2015

Higher risk of mastitis around parturition



INRA La Fage, personnal data

Genetic correlations

- $Rg_{BHB\text{-}mastitis} = 0.48$
  Koeck et al., (2014)
- $Rg_{ketosis\text{-}mastitis} = 0.17$
  Zwald et al., (2004)
- $Rg_{ketosis\text{-}mastitis} = 0.26$
  Heringstad et al., (2015)

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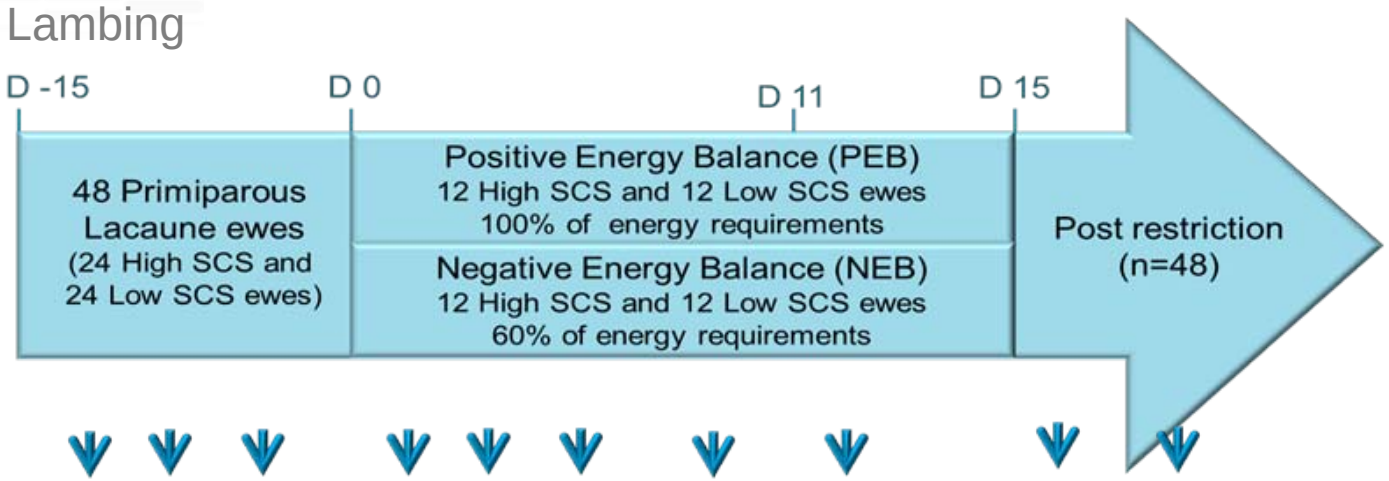
Link between energy deficit and mastitis in early lactation ?

What are the consequences of energy shortage in early lactation in dairy sheep selected for high and low mastitis resistance ?

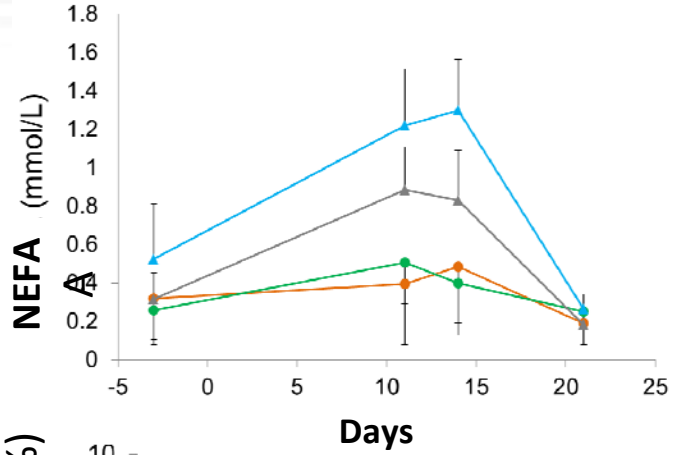
Experimental design

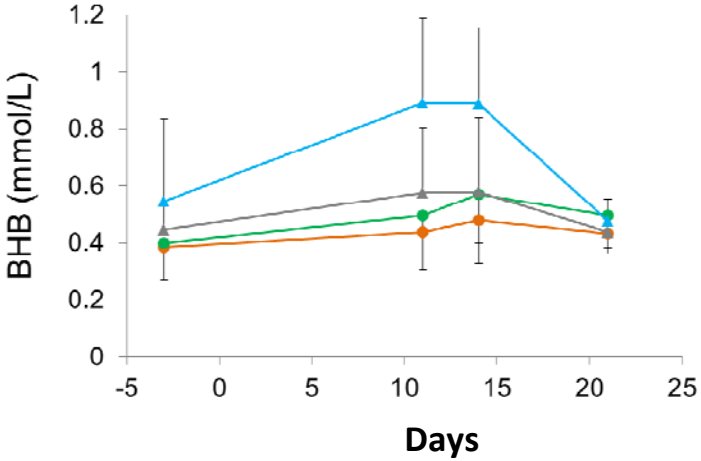


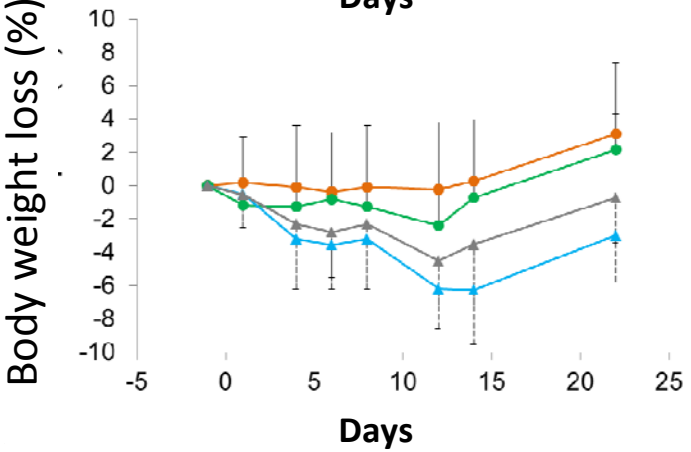
Daily feed intake, milk production traits, milk fatty acids, blood metabolites, live-weight, body condition score

RNA-seq blood samples (6 ewes per group)

Metabolic profiles in the four groups of sheep (genetic line X diet)







Interaction genetic line X diet
=> High SCS ewes (susceptible to mastitis) are more susceptible to energy shortage

Data integration
(sPLS – Discriminant Analysis)

BLOOD METABOLITES (n=48)
Glucose, Insulin
NEFA, BHB

PRODUCTION TRAITS (n=48)
Milk yields, Fat and Protein yields,
Fat and Protein contents
SCS
Body weight, body condition score

MILK FATTY ACIDS (n=48)

GENE EXPRESSION (n=24)
RNA-seq
(20,017 genes)

High SCS restricted (NEB)

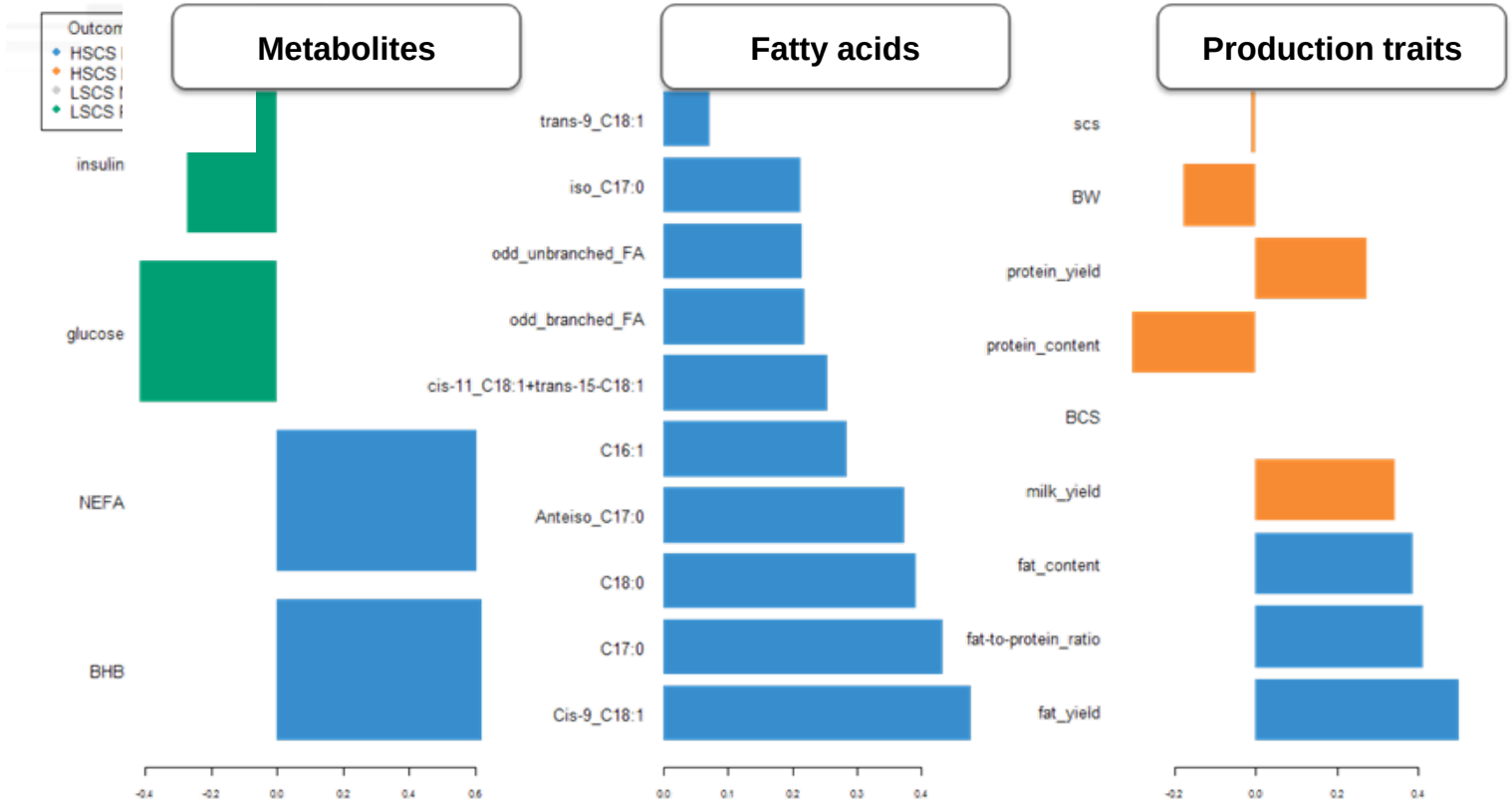
High SCS control (PEB)

Low SCS restricted (NEB)

Low SCS control (PEB)

Data integration results :

High level of adipose tissue mobilisation in High SCS ewes

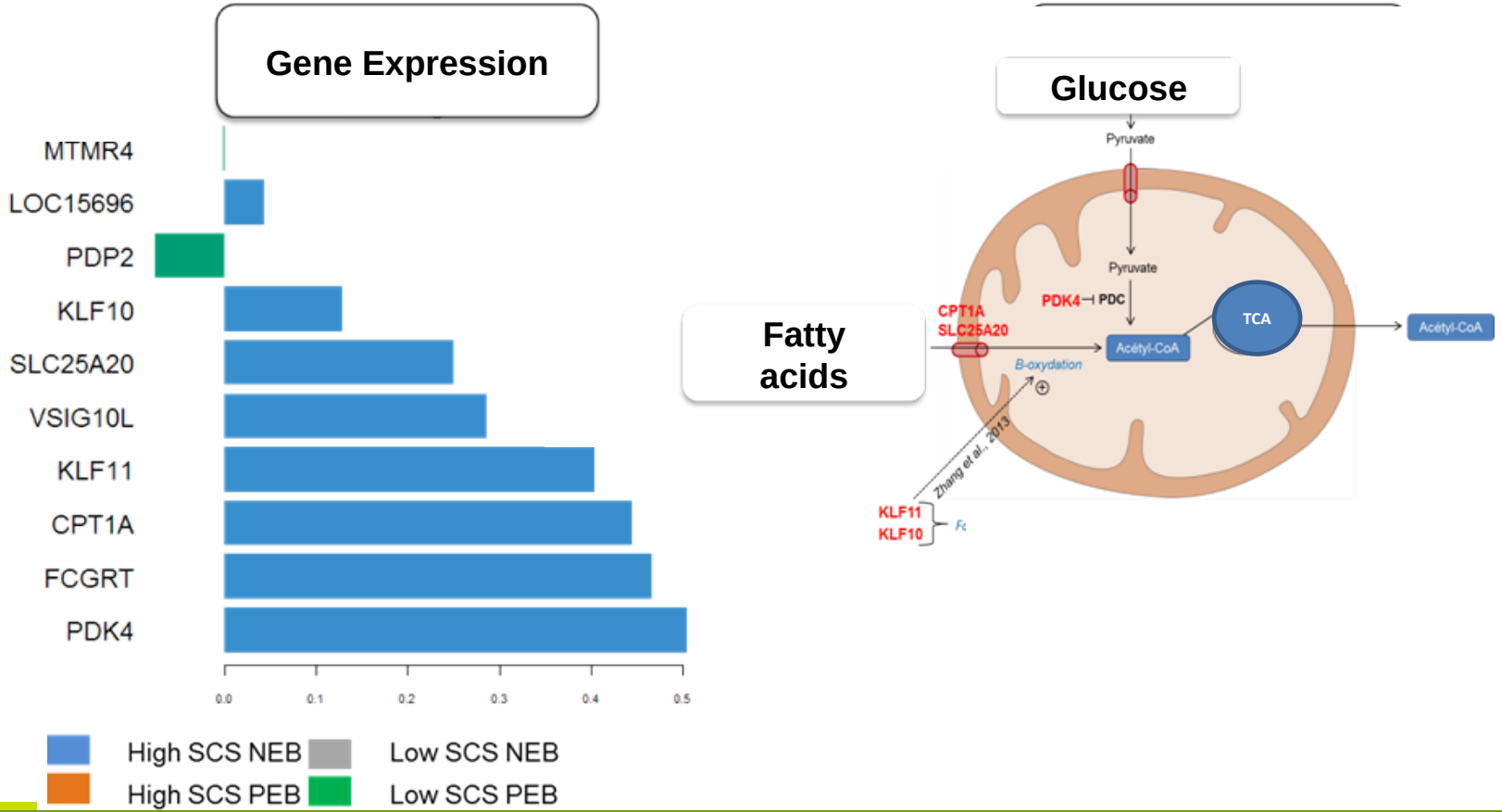


High SCS NEB Low SCS NEB

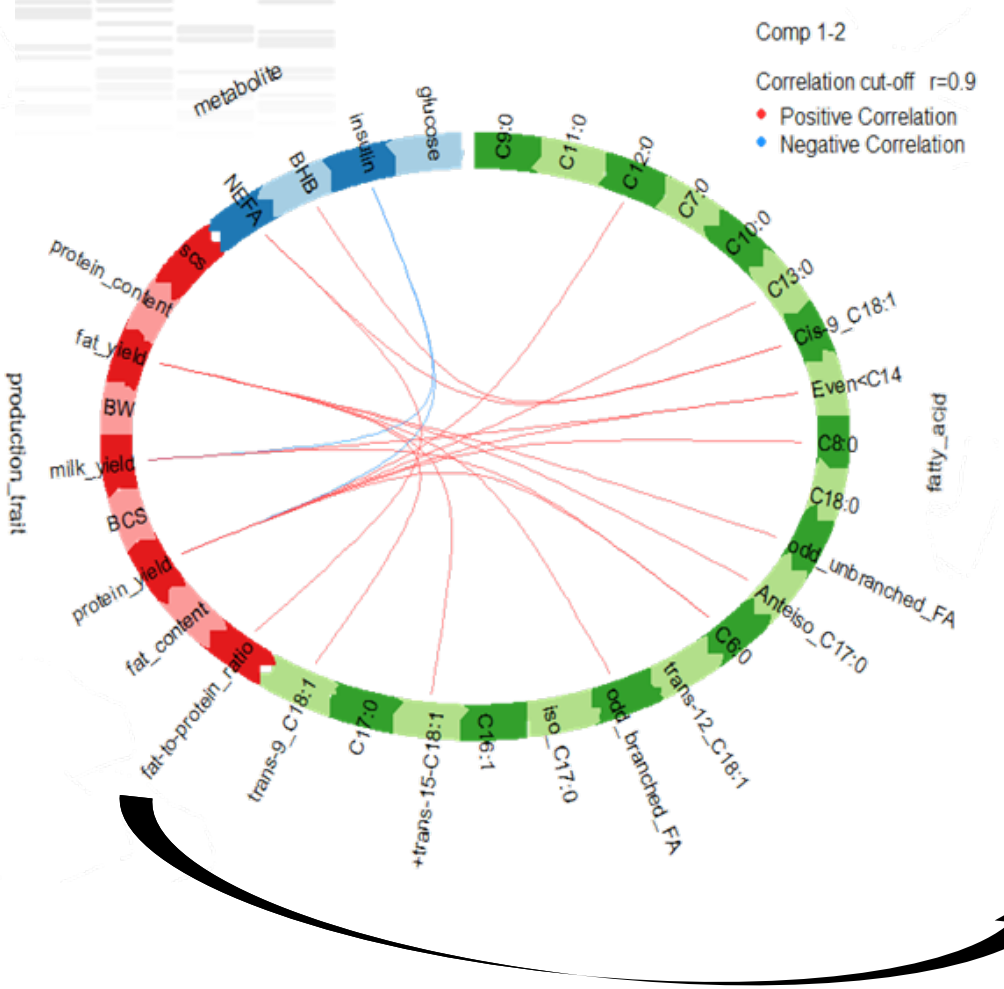
High SCS PEB Low SCS PEB

Data integration results :

Increased Fatty acid oxydation in High SCS ewes



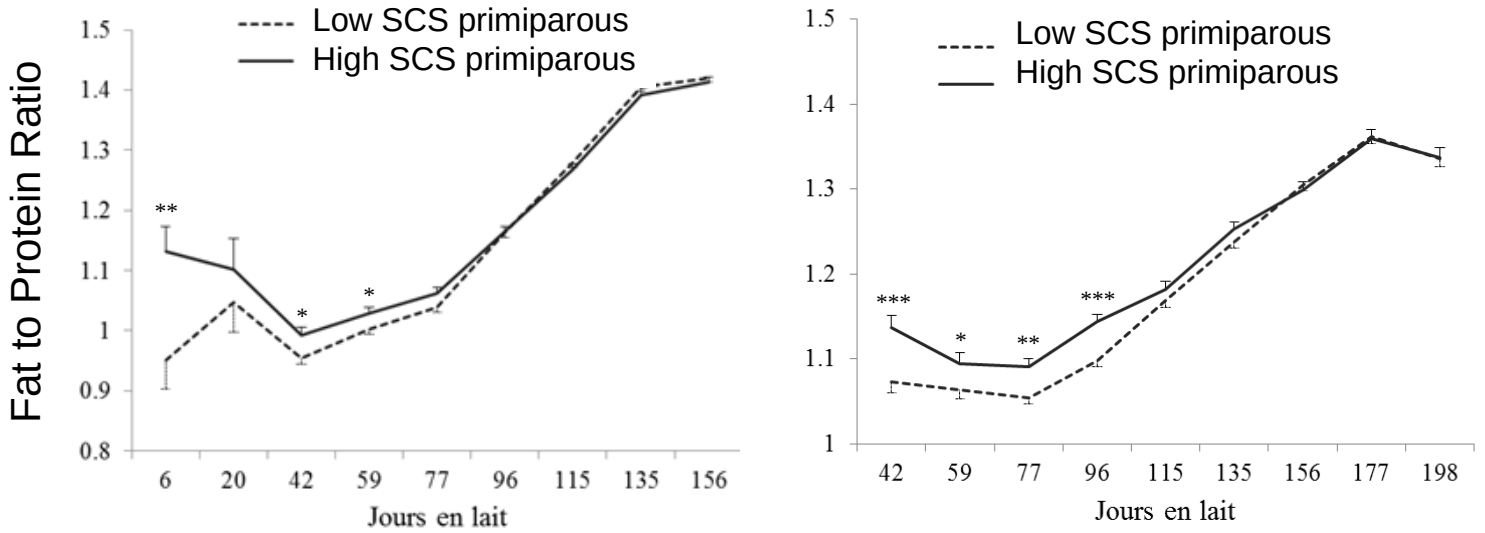
Fat-to-protein ratio: a good predictor of NEB



Traits and genes	Correlation with fat to protein ratio
PDK4	0.62
KLF11	0.76
SLC25A20	0.68
CPT1A	0.77
KLF10	0.67
C16:1	0.73
C17:0	0.80
anteiso C17:0	0.76
iso C17:0	0.79
C18:0	0.77
cis 9 C18:1	0.85
cis 11 C18:1_*trans* 15 C18:1	0.70
trans 9 C18:1	0.61
Fat content	0.87
BHB	0.79
NEFA	0.91

Field data confirms a different energy status in sheep divergently selected for mastitis

16,412 milk records (1025 ewes born between 2005 and 2016)



Conclusion and perspectives

- High SCS sheep were more susceptible to NEB than Low SCS sheep in early lactation
- SCS-based selection most probably limits metabolic troubles during this period
- Fatty acid oxidation and glucose utilization in mitochondria are key mechanisms =>Functional studies needed
- Pave the way for genetic studies on adaptation to energy shortage after lambing in dairy sheep (fat-to-protein ratio)

Thank you for your attention

Source : Rachel Rupp

Bouvier-Muller et al. JDS 99:480, 2016

Bouvier-Muller et al. Sci. Reports 7:2379, 2017

Bouvier-Muller et al. JDS 101:1, 2018