

Role of daily feeding rhythms in the genetics of feed efficiency in growing pigs



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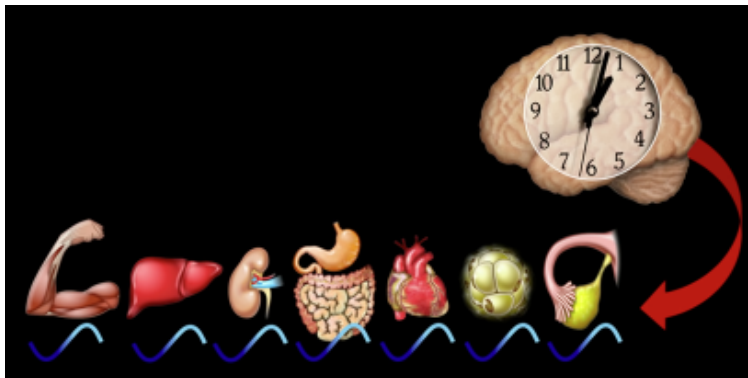
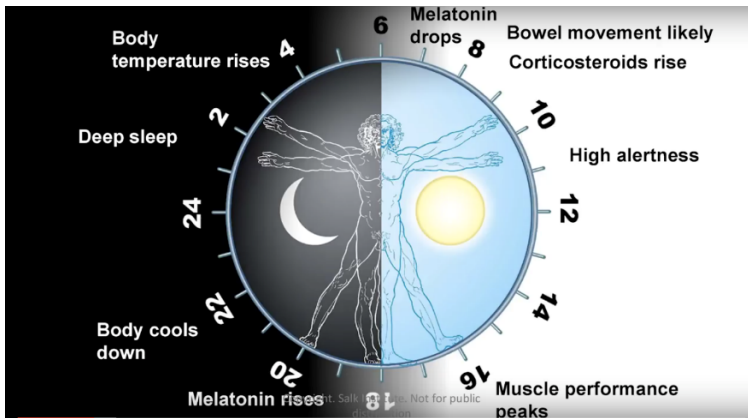
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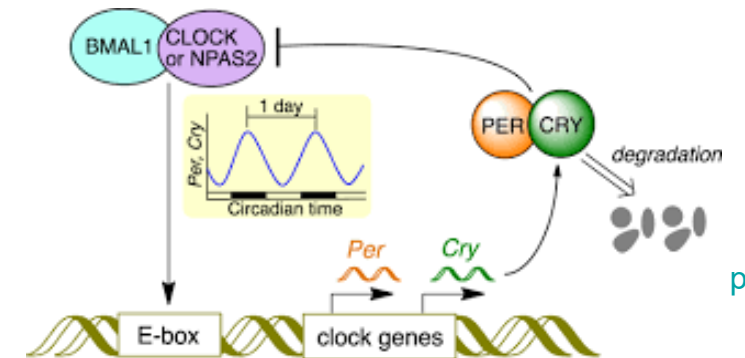
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➤ Circadian rhythm, feed intake and metabolism?



- **Circadian rhythms** are the bases of physiological regulation
 - *Energy metabolism* is optimal when feed intake is aligned with circadian rhythm
 - In diurnal animals, the energy metabolism is more efficient in the morning than in the afternoon
- Circadian rhythms are regulated by **biological clocks**, the main one being in the suprachiasmatic nuclei of the brain, synchronized by day light
 - This main clock regulates all organ clocks
 - They depend on automotive molecular oscillations, based on specific genes called core-clock genes



➤ Do pigs differing for feed efficiency vary for their feeding rhythms?

RFI = residual feed intake



LW F0

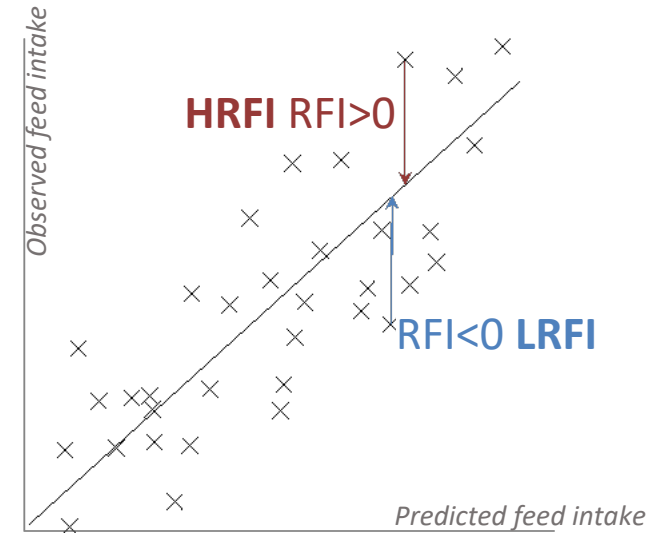
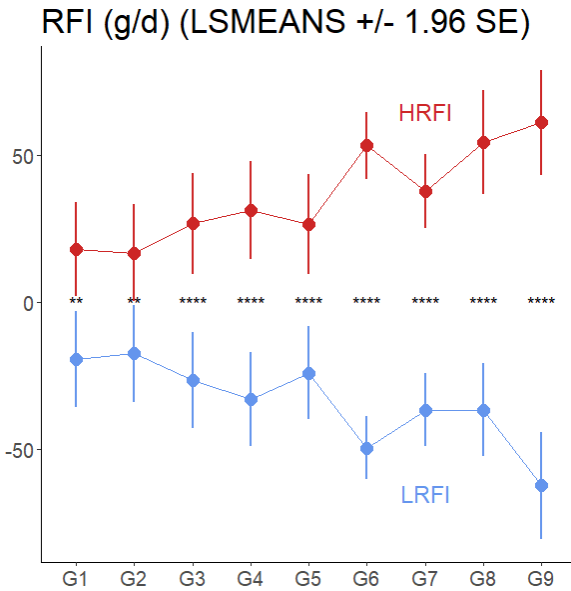
LRFI G0

HRFI G0



LRFI G9

HRFI G9



LRFI (more efficient) versus HRFI (less efficient) (Gilbert et al. 2017)

- ✓ better feed efficiency
- ✓ reduced daily feed intake
- ✓ leaner
- ✓ increased oxydative metabolism
- ✓ reduced feeding activity (Meunier-Salaün et al. 2014)

➔ What about the distribution of their feeding activity over 24h?

7 millions feeder visits recorded during 9 generations for the two lines, including 3824 pigs

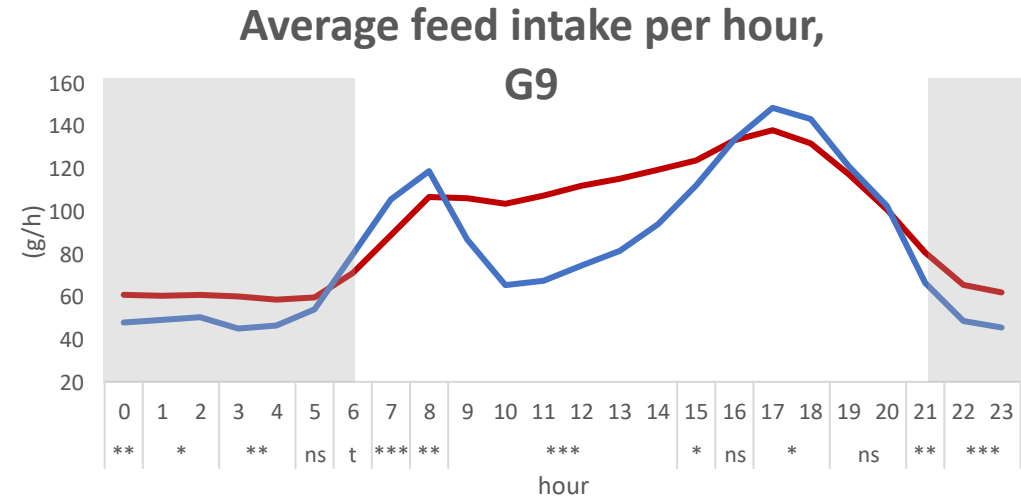
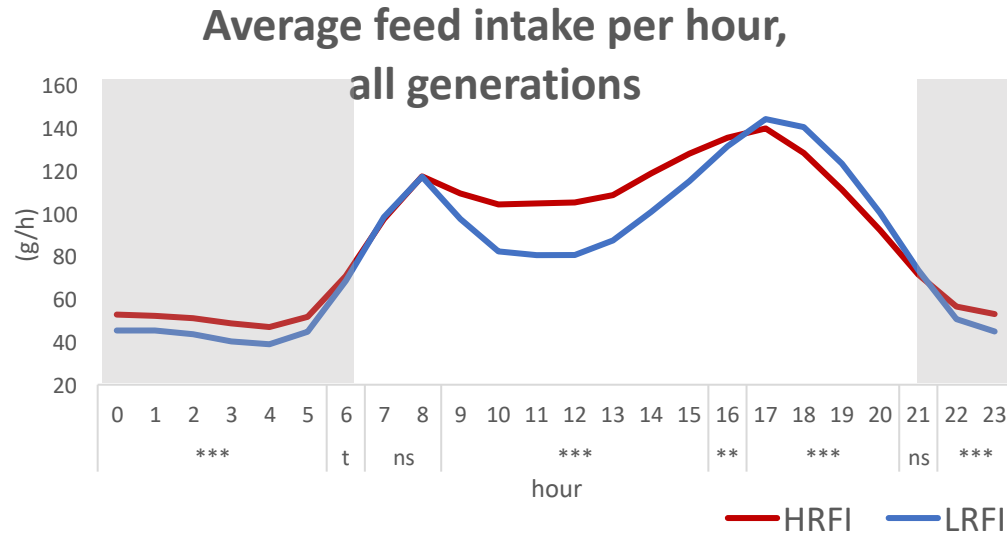


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➤ Does hourly feed intake differ between lines?



Line differences

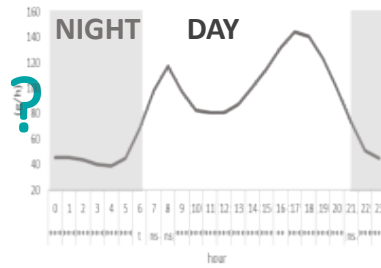
(p line < 0.0001, line x generation < 0.0001)

- During night hours
- Between peak hours
- During the second peak hours

Accentuated in G9 (p line < 0.0001)

➔ In HRFI, peaks seem to disappear

➤ Does day/night feed intake differ between lines (6h to 21h) ?



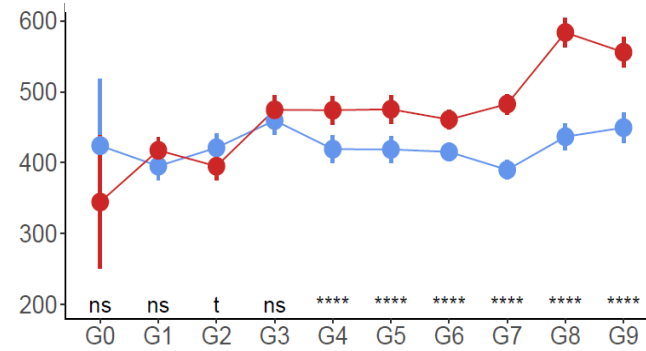
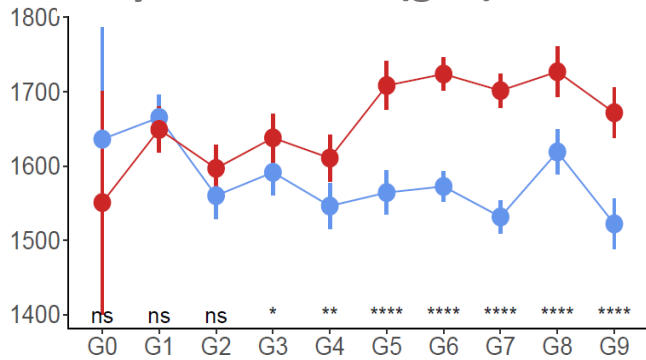
— HRFI — LRFI

DAY

NIGHT

Day feed intake (g/d)

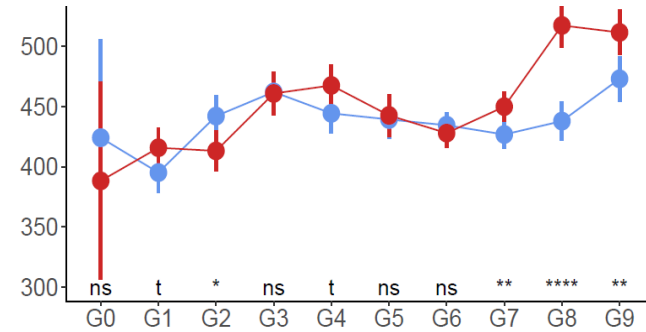
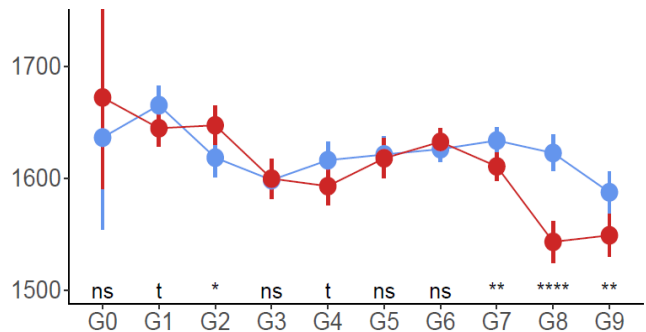
Night feed intake (g/d)



➔ Day and night feed intake diverged with selection

Day feed intake, adj for total intake (g/d)

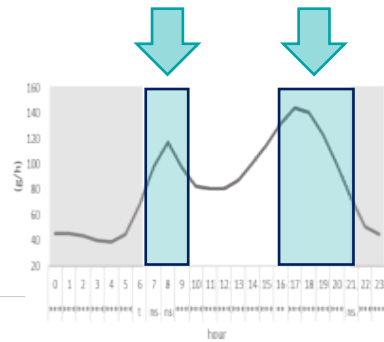
Night feed intake, adj for total intake (g/d)



➔ Mainly due to divergence in total feed intake



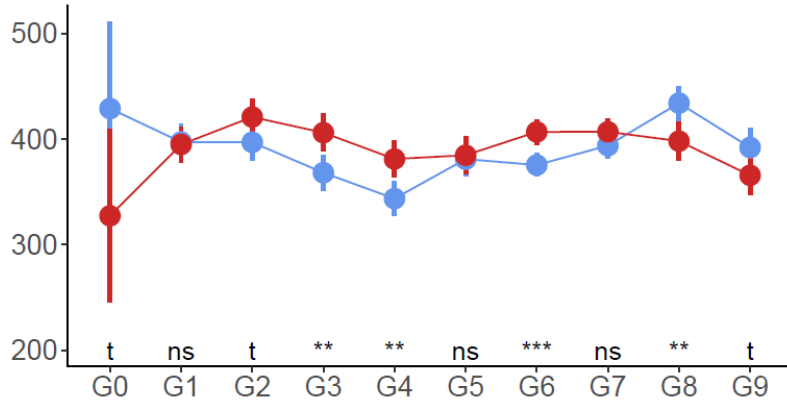
Does daily distribution differ between lines? Peaks



— HRFI — LRFI

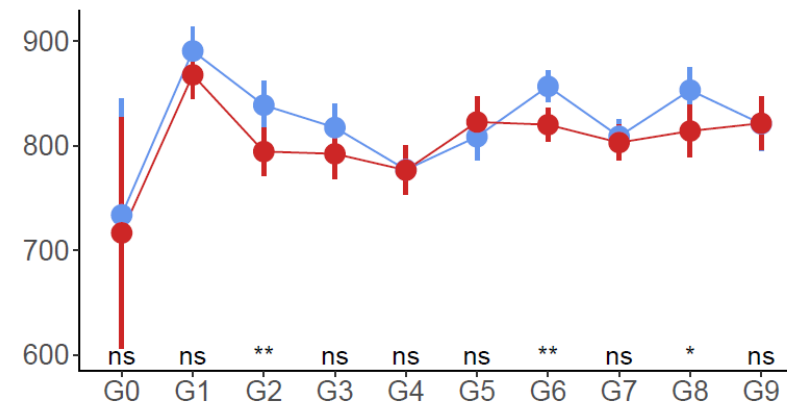
PEAK 1

Feed intake peak 1 (g/d)

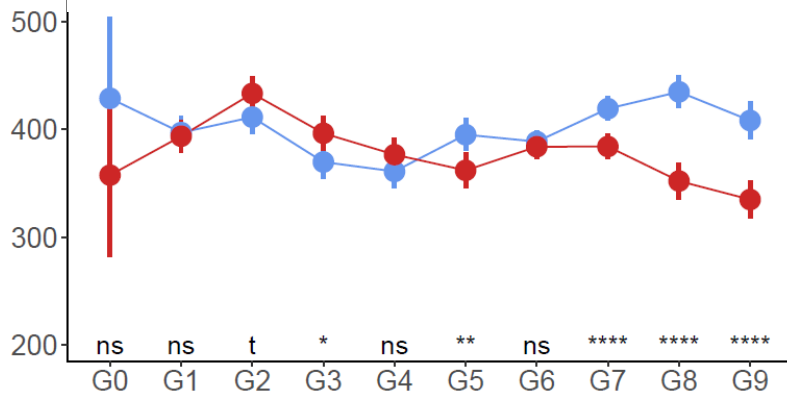


PEAK 2

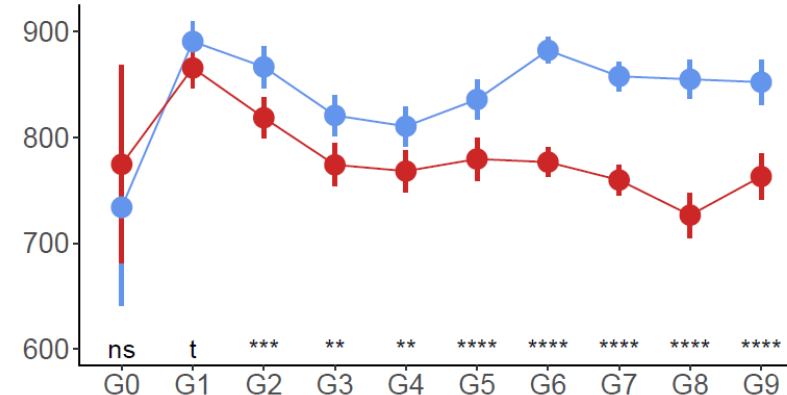
Feed intake peak 2 (g/d)



Feed intake peak 1 (g/d) *adj for total intake*



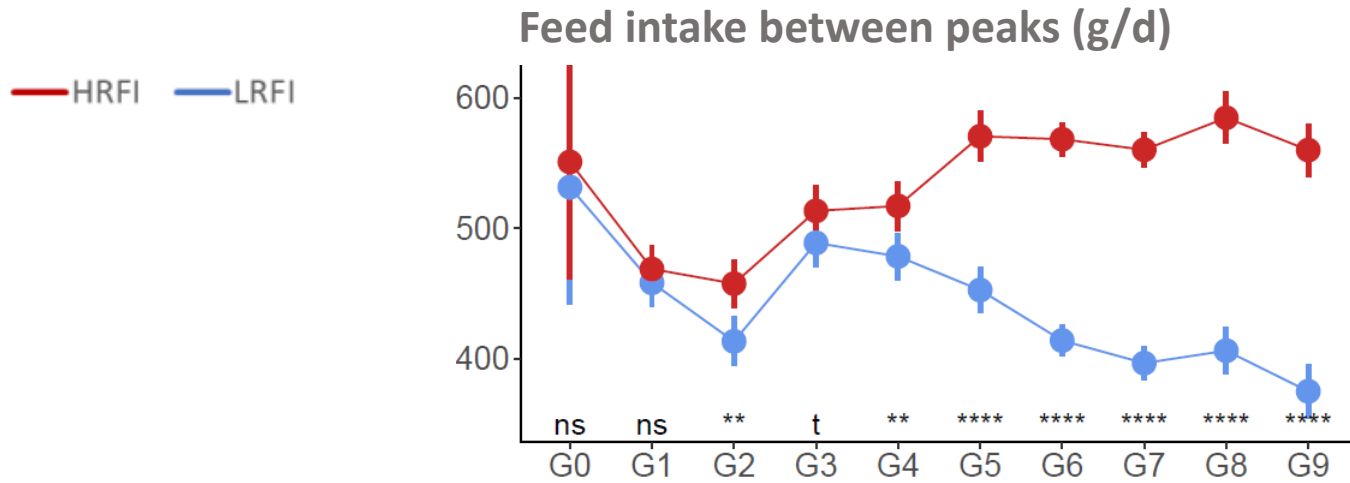
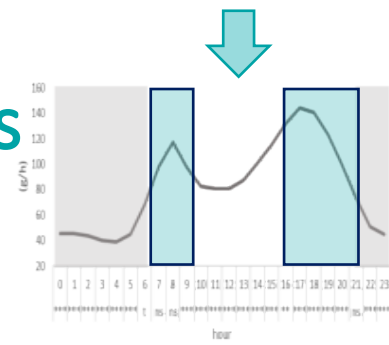
Feed intake peak 2 (g/d) *adj for total intake*



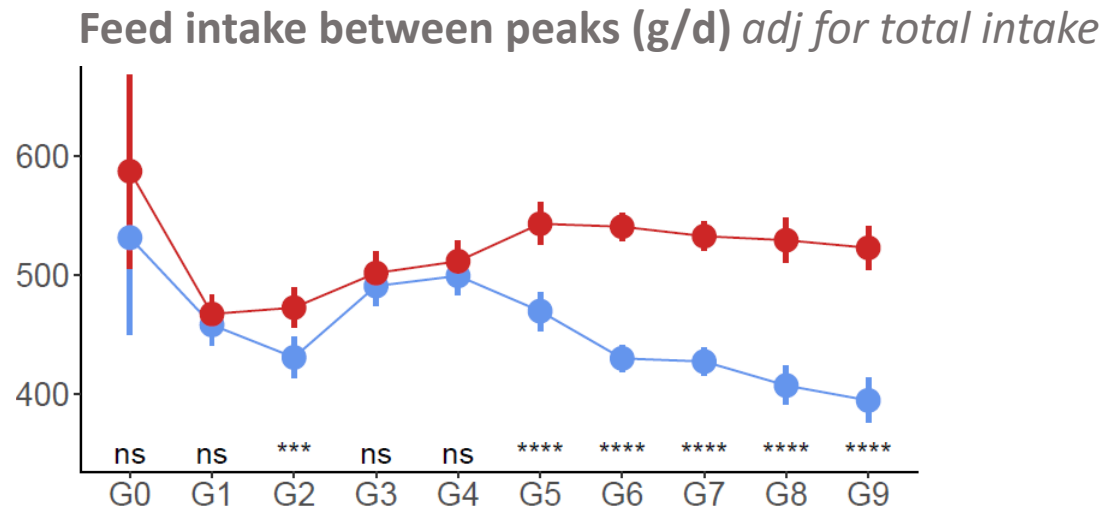
➔ No clear response to selection

➔ After adjusting for total intake: +80 g/d LRFI ***

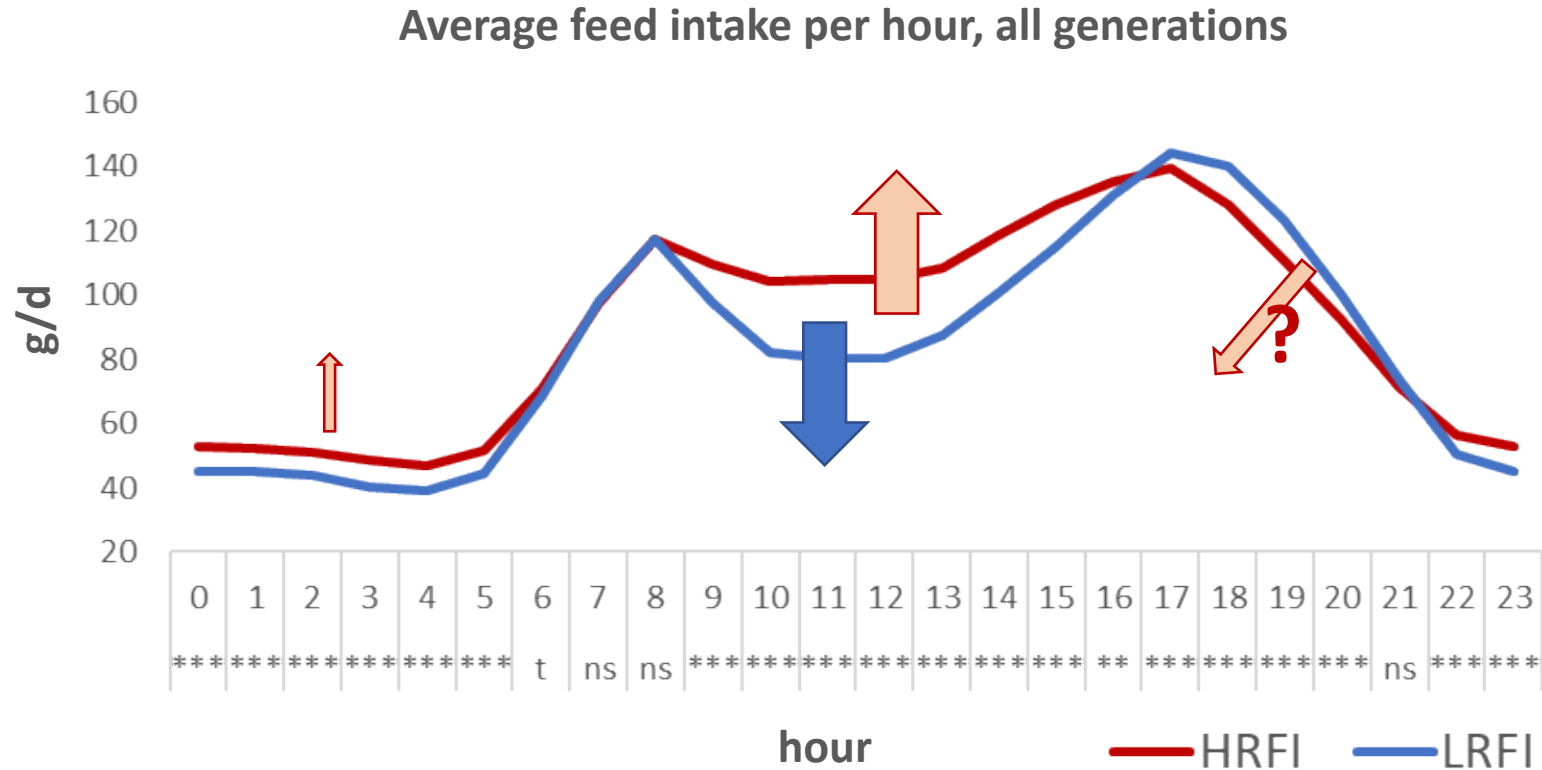
➤ Does daily distribution differ between lines? Between peaks



➔ Between peaks:
-119 g/d LRFI ***

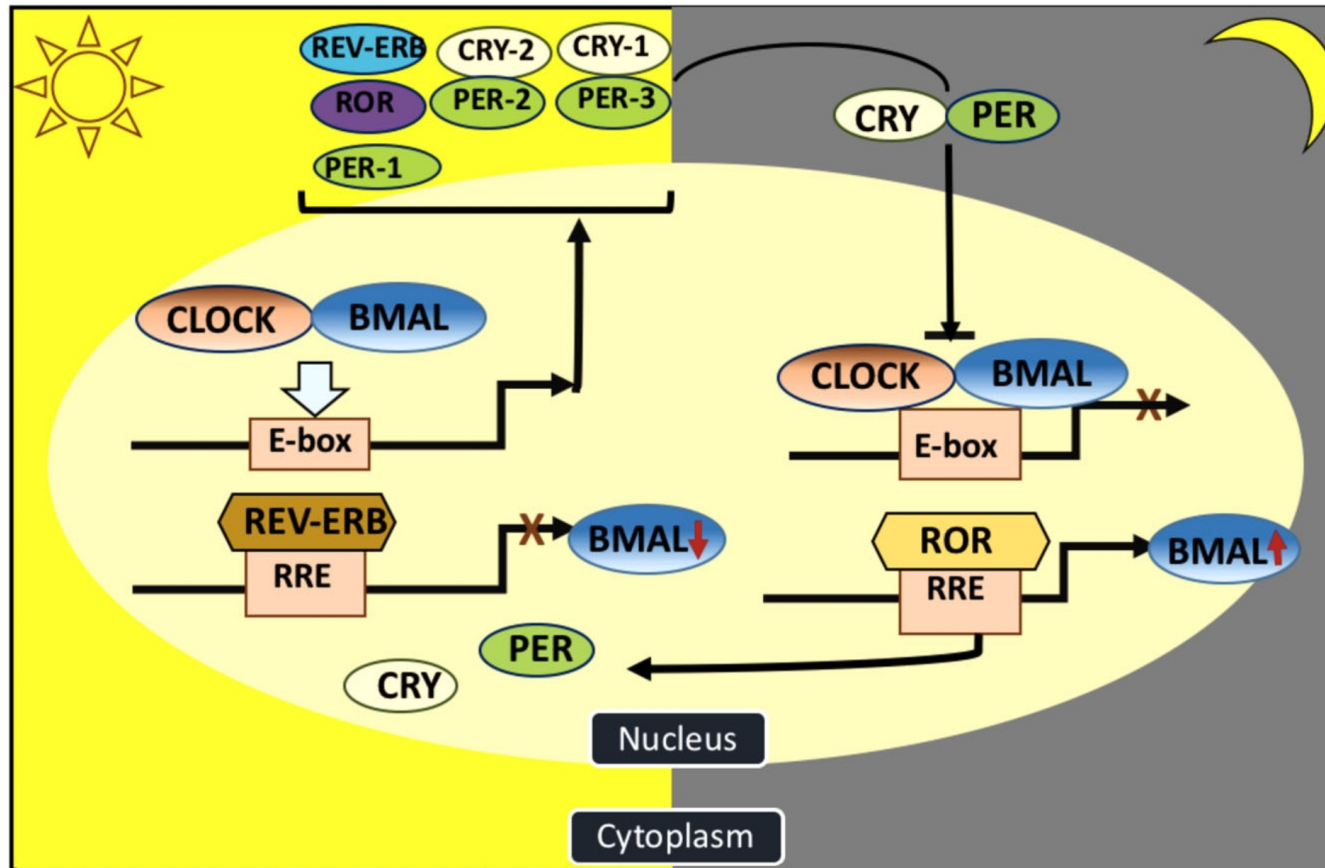


➤ Summary: dynamics of feed intake changed with divergent selection for feed efficiency



➔ Spline modeling to better capture individual differences

➤ Are there correlated changes in allele frequencies of the core-clock genes?



BMAL1=ARNTL

CLOCK

NPAS2

PER1

PER2

PER3

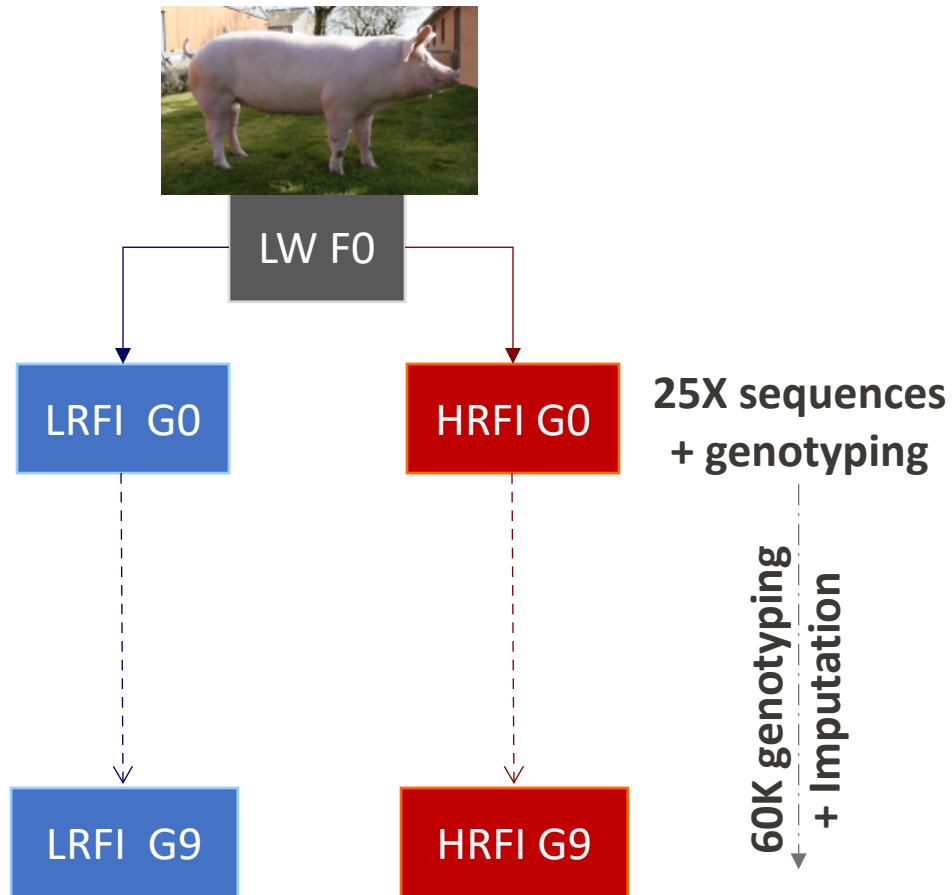
CRY1

CRY2

RORA

REV-ERB (NR1D1)

➤ Are there correlated changes in allele frequencies of the core-clock genes?



FOR EACH LINE

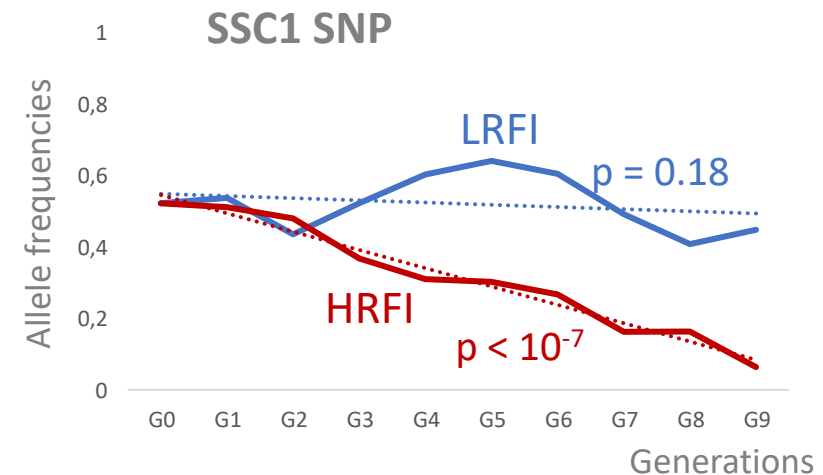
6556 sequence variants in the ten core-clock genes



Allele frequencies in each generation

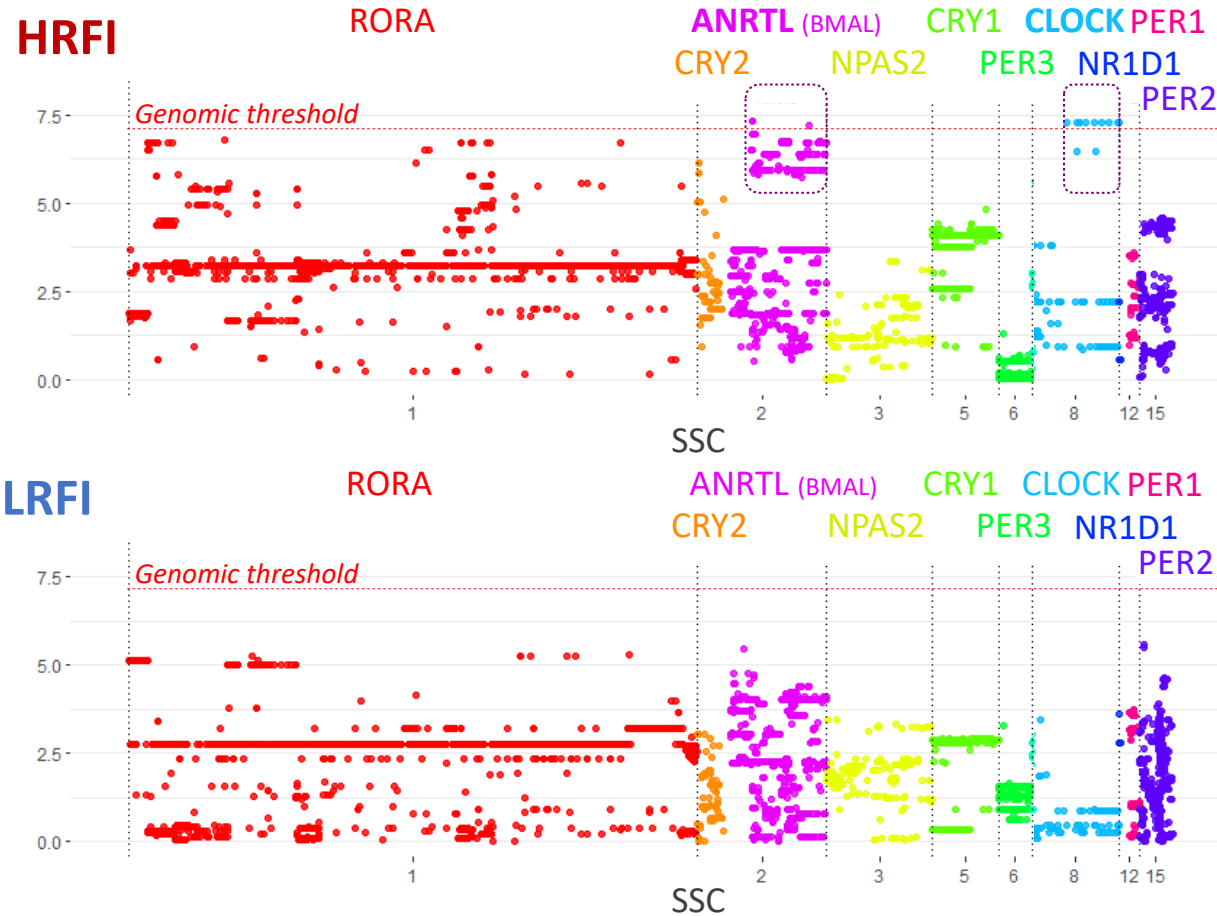


Test changes of allele frequencies along generations
(*regression of generation number on frequency*)



➤ Are there correlated changes in allele frequencies of the core-clock genes?

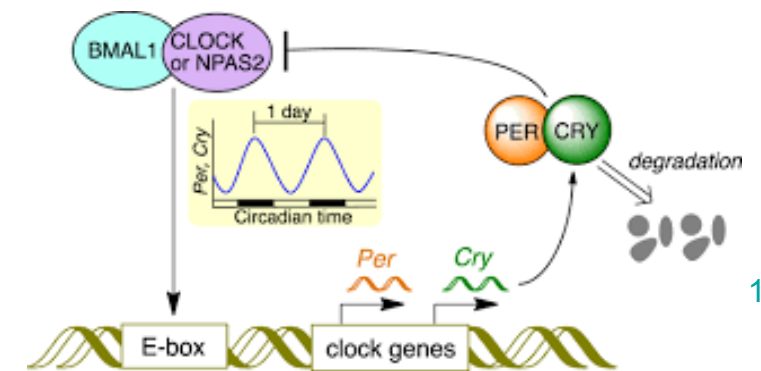
$-\log_{10}(p)$ of the regressions for each SNP



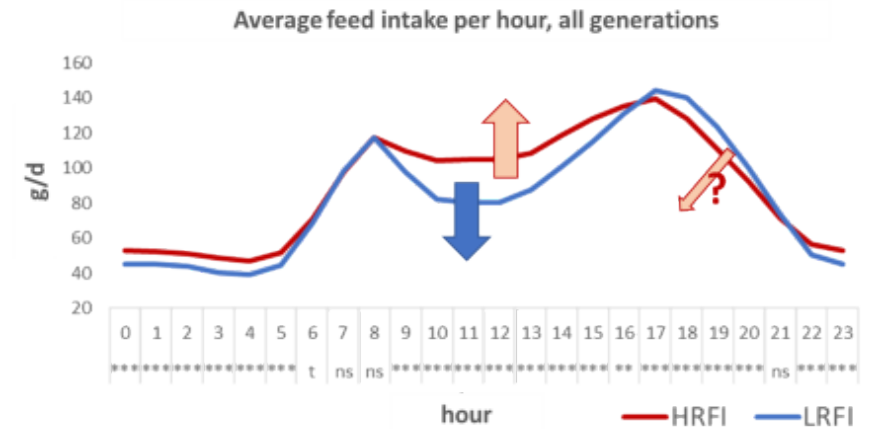
➔ ANRTL (BMAL1) and CLOCK are the transcription factors that dimerize to regulate all core clock genes

➔ Some haplotypes have changed **frequency** in HRFI

➔ Nothing in LRFI



➤ Conclusions



- ➔ HRFI pigs (less efficient) partly lost the daily distribution of feeding patterns
 - ➔ It matches with some metabolic differences seen by van Erp et al (2020) when feeding rhythms were purposely modified in pigs
- ➔ Changes were observed in allelic variants in core-clock genes
- ➔ *Alteration of feeding rhythms could contribute to differences in feed efficiency in pigs*

➤ Thank you

Acknowledgements:

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