Novel estimations of residual energy intake and their QTL in growing-finishing pigs

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Introduction

- Feed cost, highest costs in growing-finishing pigs
- Optimal selection criteria in feed efficiency influences effectiveness of selection
- Residual feed intake (RFI)
  - The difference between actual feed intake and that predicted
    - Average requirements for production (e.g. ADG & body composition)
    - Maintenance of body weight

Introduction

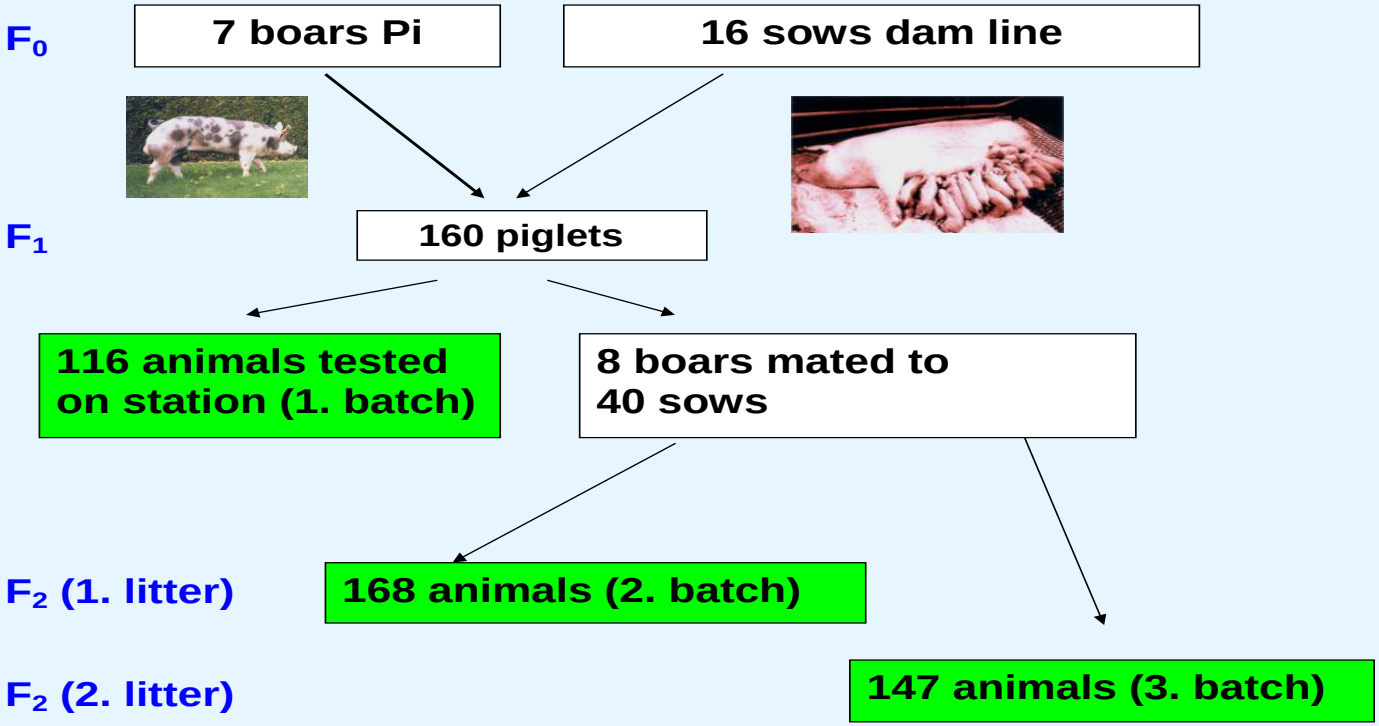
- Mostly RFI has been estimated by
  - Adjusting **feed** intake
    - ADG (lean growth)
    - Backfat (fat growth)
- Diet is changing during growing-finishing period
- In this study:
  - Metabolizable energy intake is used to estimate
    - Residual energy intake (REI)
  - To estimate a more accurate REI
    - Protein deposition (APD)
    - Lipid deposition (ALD)

Aims

- Optimisation of estimating REI
  - Higher R^2
  - Lower RMSE
- Genomic background of the REI
  - QTL Mapping
  - Association with QTL for other traits

Material and methods

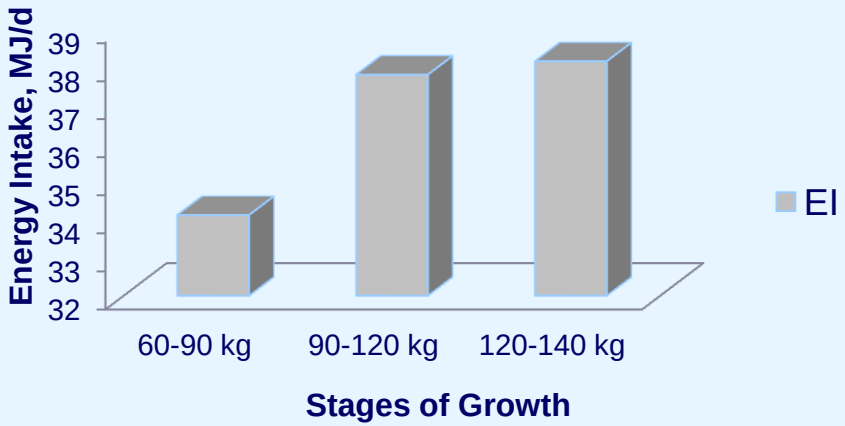
Three generation full-sib design



315 pigs of an F_2 population were used to estimate REI
386 animals from 49 families genotyped

Material and methods

- Stages of growth
  - 60-90 kg
  - 90-120 kg
  - 120-140 kg



- Feed data
  - *ad libitum* with 2 different pelleted diets
  - 13.8 MJ of ME/kg ⟹ 60-90 kg
  - 13.4 MJ of ME/kg ⟹ 90-140 kg
- Body composition
  - Backfat thickness measured
  - Protein and lipid deposition
    - Deuterium dilution technique

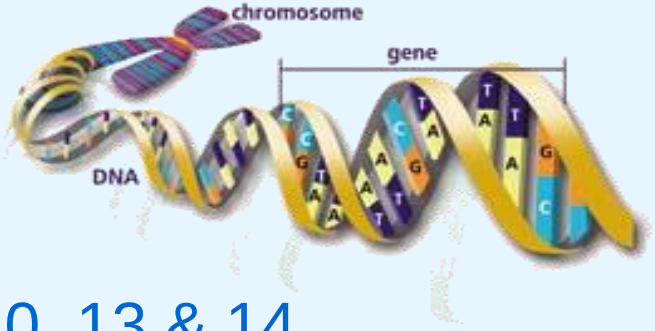
Estimations of REI

- Model 1
  - **EI** = μ + **ADG** + **BF** + **e (REI1)**

Fixed effects:
- Sex
- Pen
- Batch
- Halothane gene
- Birth farm
- Start weight
- End weight

- Model 2
  - **EI** = μ + **APD** + **ALD** + **e (REI2)**
- Model 3
  - **EI** = μ + Fixed effects + b_3 × **ADGadj** + b_4 × **BFadj** + **e (REI3)**
- Model4
  - **EI =** μ + Fixed effects + b_3 × **APDadj** + b_4 × **ALPDadj** + **e (REI4)**

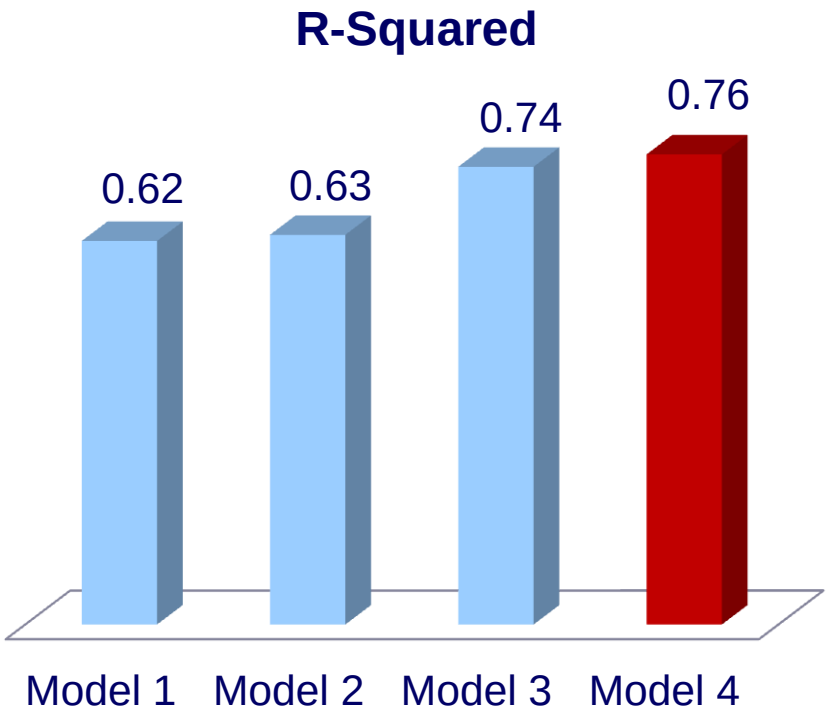
Genomic Analysis

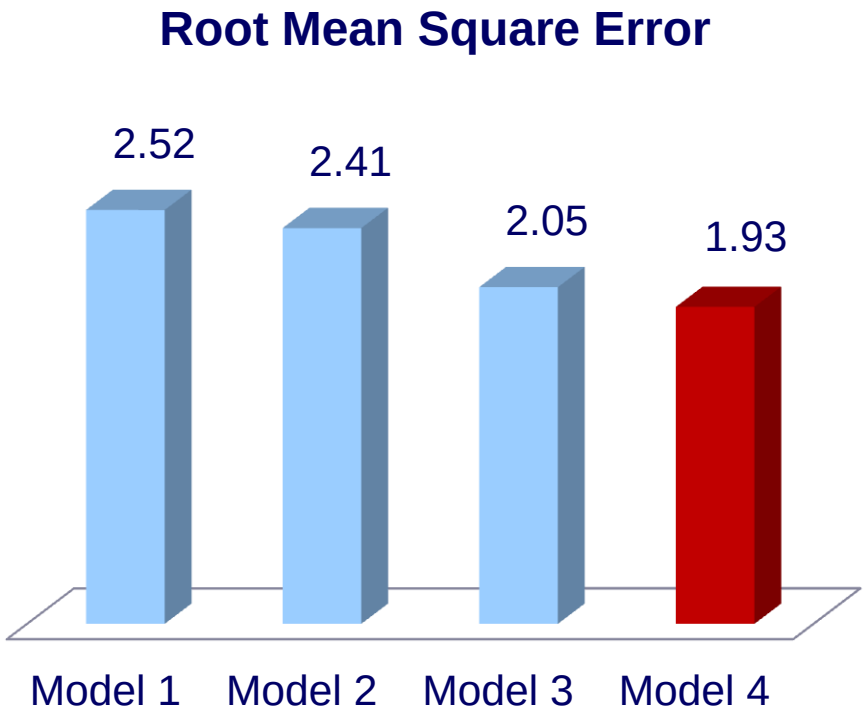


- Genotype information:
  - 88 molecular markers
  - Chromosomes 1, 2, 4, 6, 7, 8, 9, 10, 13 & 14
- QTL Express software used
  - Regression model
- More insight into the genomic regulation of REI

Results: Model comparison

The entire growing-finishing period 60-140 kg

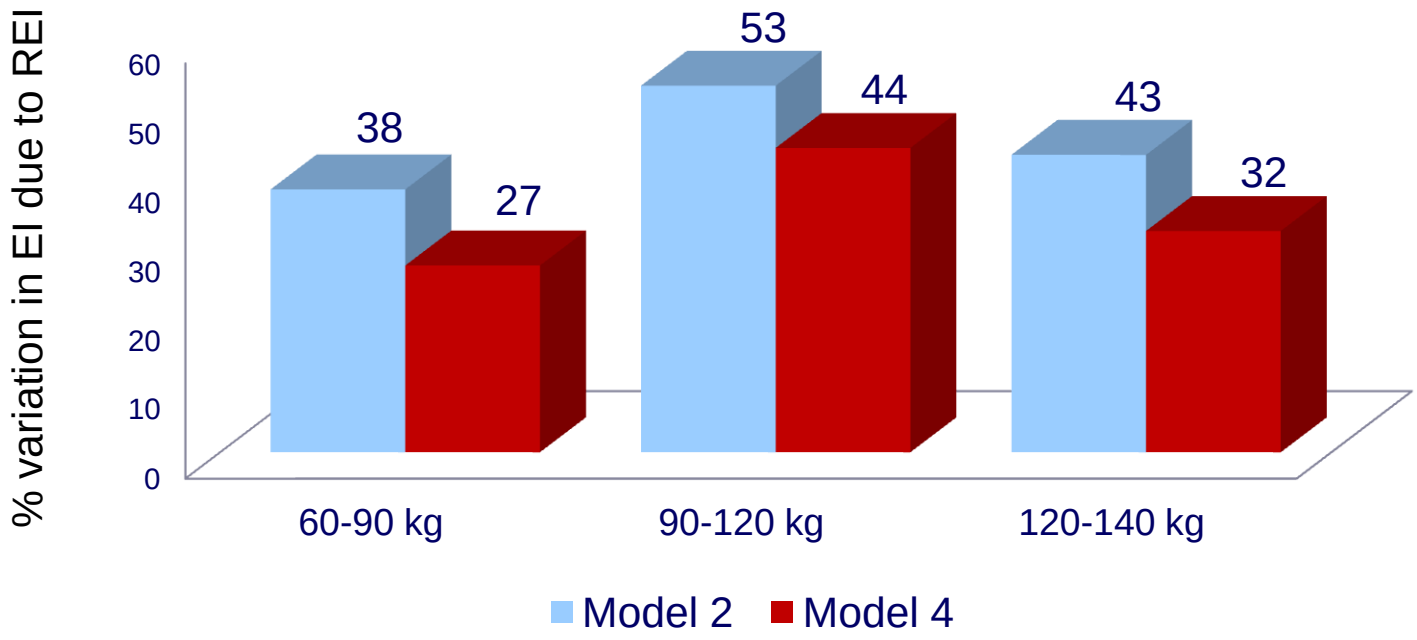




Model 1: EI = ADG + BF + e(REI1)
Model 2: EI = APD + ALD + e(REI2)
Model 3: EI = fixed effects + ADGadj + BFadj + e(REI3)
Model 4: EI = fixed effects + APDadj + ALDadj + e(REI4)

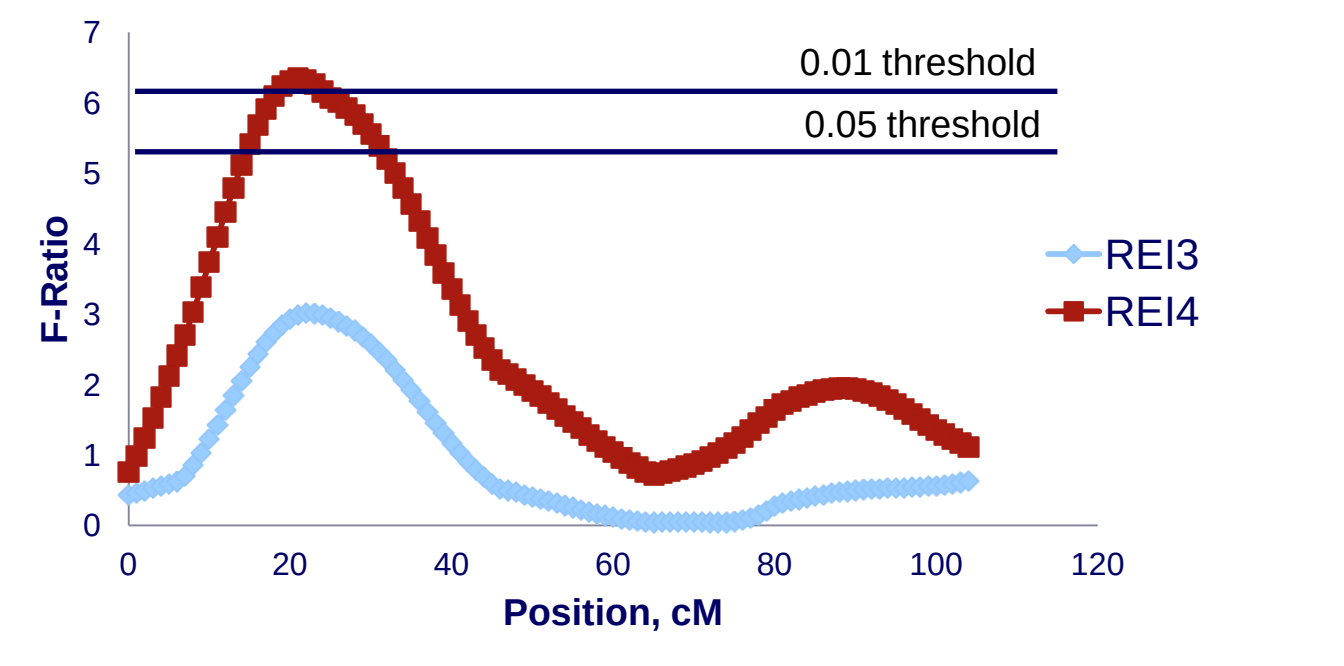
Results: Over estimation of REI

- Proportion of variation in energy intake explained by models 2 & 4 at different growth stages



Results: QTL for REI4 on SSC14

QTL mapping for REI3 & REI4 at 60-140 kg

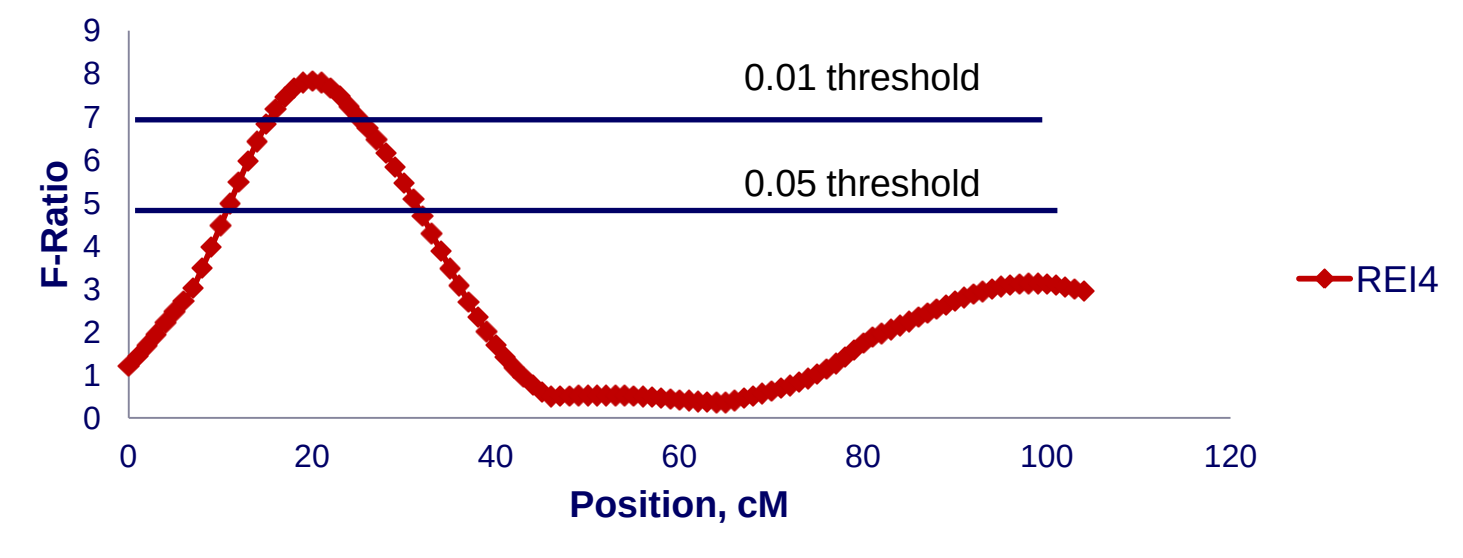


REI4

- **d = - 0.92 ± 0.33**
- **4.7%** of phenotypic variance

Results: QTL for REI4 on SSC14

QTL for REI4 at 60-90 kg

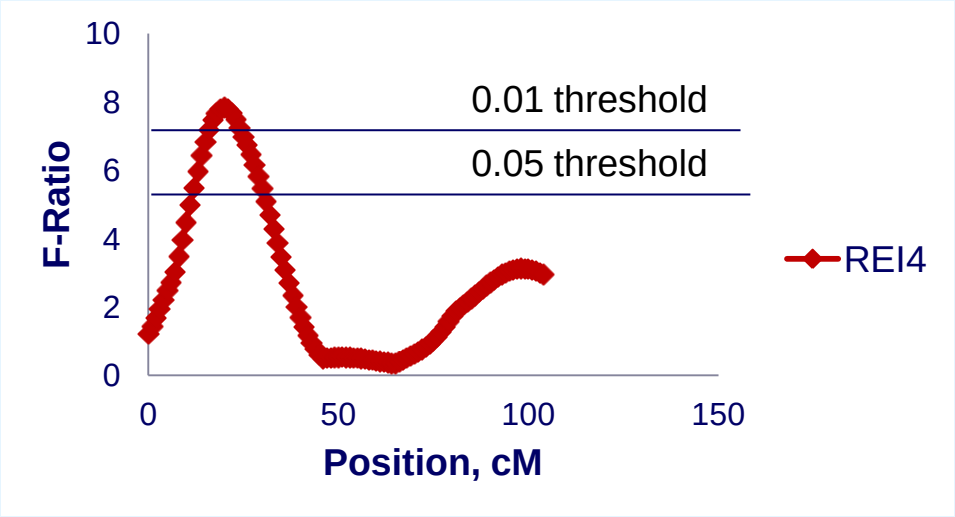


REI4

- **d = - 1.57 ± 0.40**
- **5.3%** of phenotypic variance

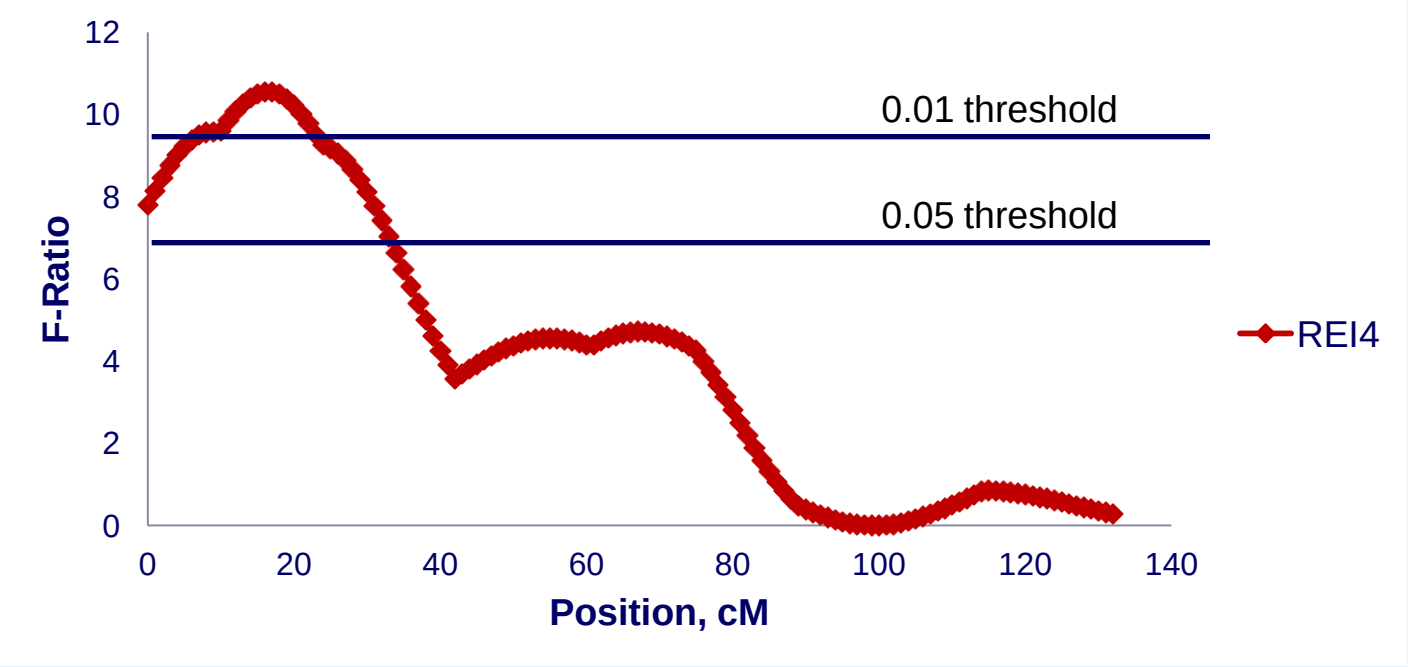
Results: QTL for REI4 on SSC14

- Novel dominance REI QTL on SSC14 position 19
  - No individual QTL in this region
  - Epistatic QTL for APD at 60-90 kg (Duthie et al., 2010)
    - 8(67) ⟺ 14(12.4) AA⇩ & AD⇧



Results: QTL for REI4 on SSC2

QTL for REI4 at 90-120 kg

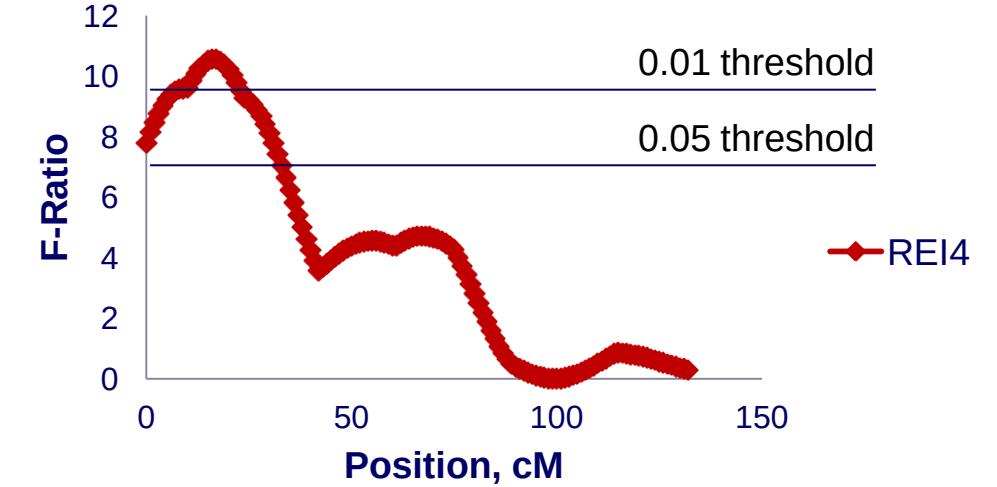


REI4

- **a = - 1.00 ± 0.31**
- **4.0%** of phenotypic variance

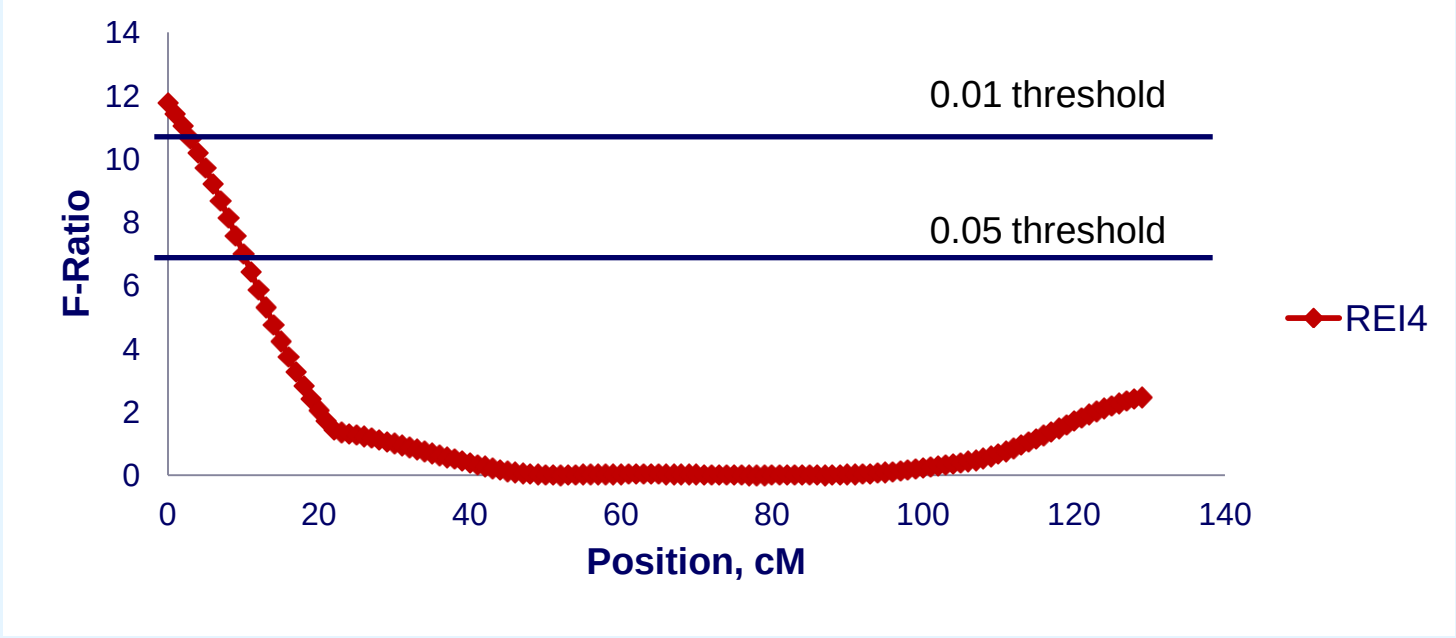
Results: QTL for REI4 on SSC2

- REI additive QTL on SSC2 position 16 at 90-120 kg
  - No QTL for feed efficiency in this region
  - QTL for loin eye area, loin and ham weight without external fat in the same region (SW2623-SWR783)
  - Genetic correlation between RFI and loin muscle area (Cai et al., 2010)



Results: QTL for REI4 on SSC8

QTL for REI4 at 120-140 kg

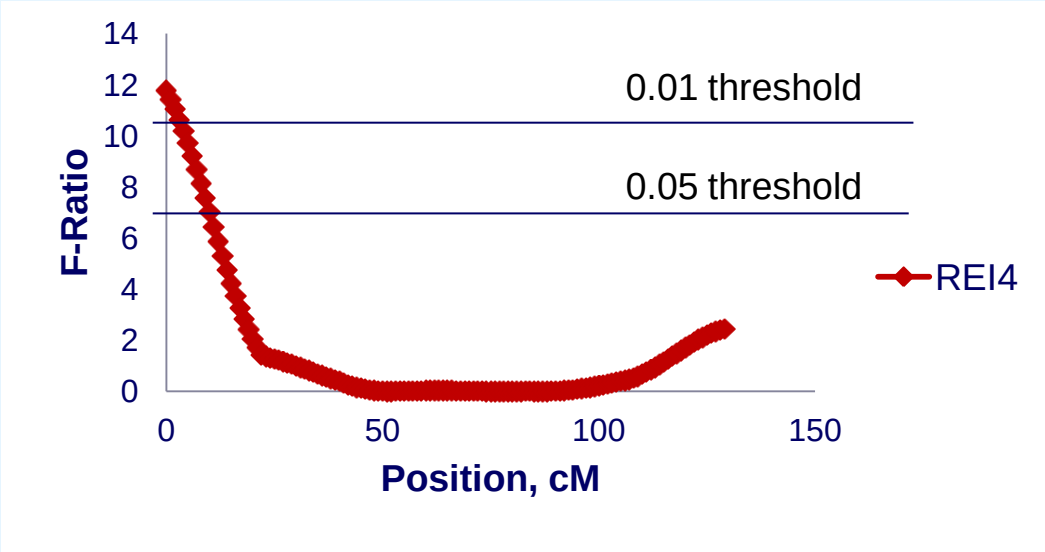


REI4

- **a = - 1.14 ± 0.20**
- **4.2%** of phenotypic variance

Results: QTL for REI4 on SSC8

- REI QTL on SSC8 position 0 at 120-140 kg
  - No individual QTL for DFI and FCR in this region
  - Epistatic QTL for FCR 60-90 kg (Duthie et al., 2010)
    - 8(1) ⇔ 7(107) AA ⇑ & AD ⇓
  - QTL for entire ham weight, lean content of belly, loin lean meat weight (SW2410-SW905)



Summary & Discussion

- Model 4 explained higher % variation in energy intake (76%)
- Adjusted values better reflect the impact of growth traits on energy intake
- APD & ALD important for
  - QTL mapping
  - Breeding for REI
- Increase in variation due to REI in later growth stages
  - Lower production
  - Higher maintenance requirements

Conclusion

- REI influenced by QTL other than feed efficiency and growth traits
- Different REI QTL at different growth stages
- Epistatic effect of REI should be investigated
- REI QTL can be used for marker assisted selection to improve feed efficiency

Acknowledgments

- Thank you

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