

Multi-omics data integration approach for resilience of dairy cattle to heat stress

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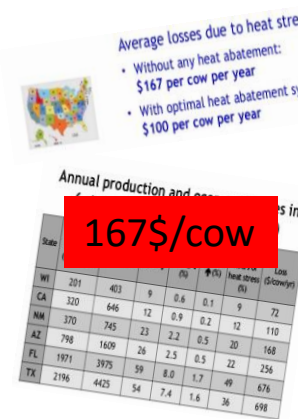
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Heat stress (HS): Context

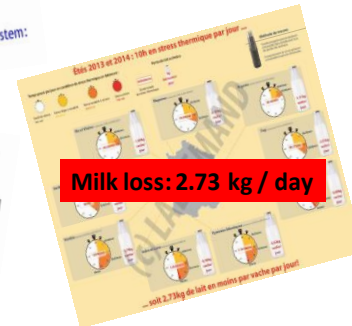
➤ Economic loss

2003
USA



St Pierre et al. (2003)

2013 & 2014
France & Switzerland



www.lallemandanimalnutrition.com
(2015)

2018
Ireland



**Heatwave costing for dairy farmers
1,750 € / week**

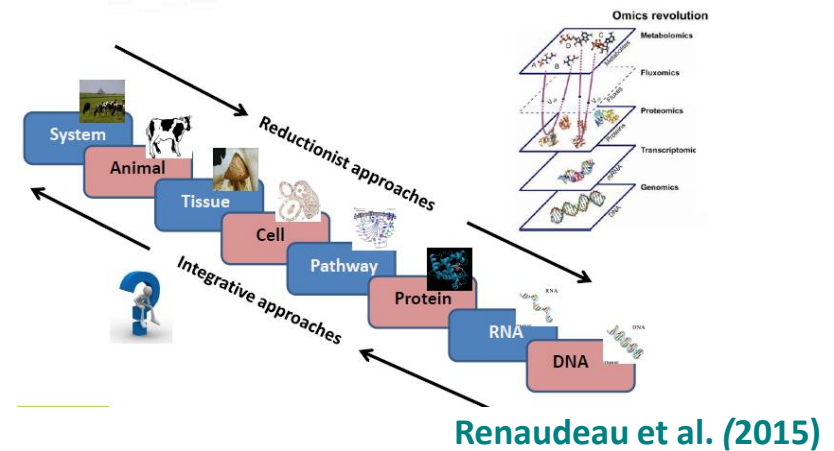
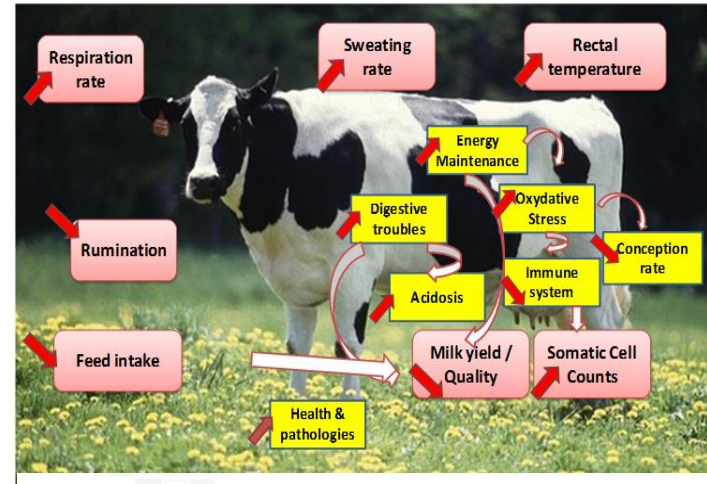
<https://www.agriland.ie/farming-news> (2018)

➤ Heat wave of July 2018



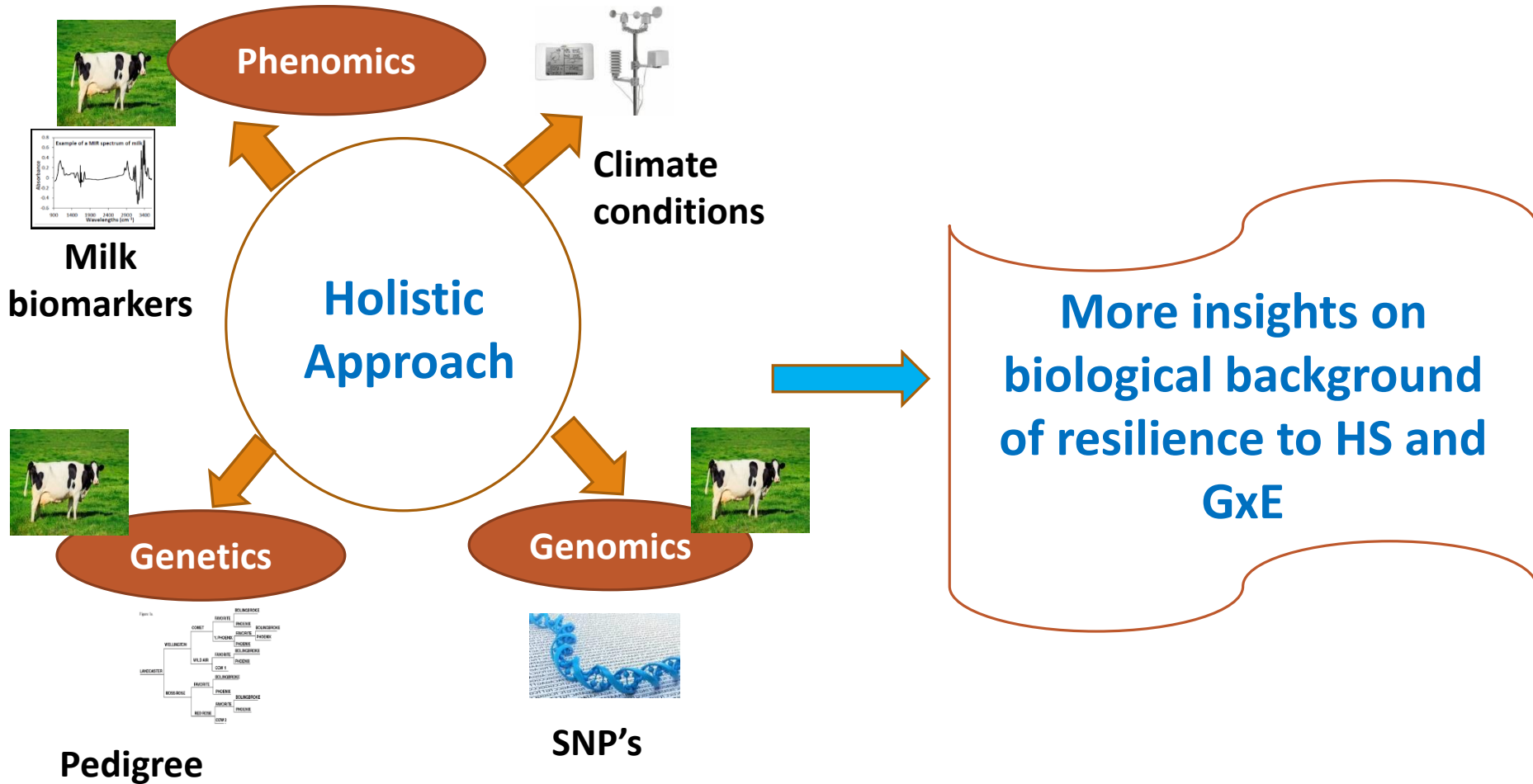
Breeding for resilience to HS: Challenges

- Biological mechanisms
 - Complex interactions
- Phenotyping strategies
 - mostly reductionist approaches



Associating multiple-omics data → better view of resilience to HS

Objectives



Data & models

➤ Data

- 62,744 TD records
- + 3-days lag THI test-date
- 8,485 third-lactation cows

Production

- Milk, Fat, Prot yields

Fatty acids

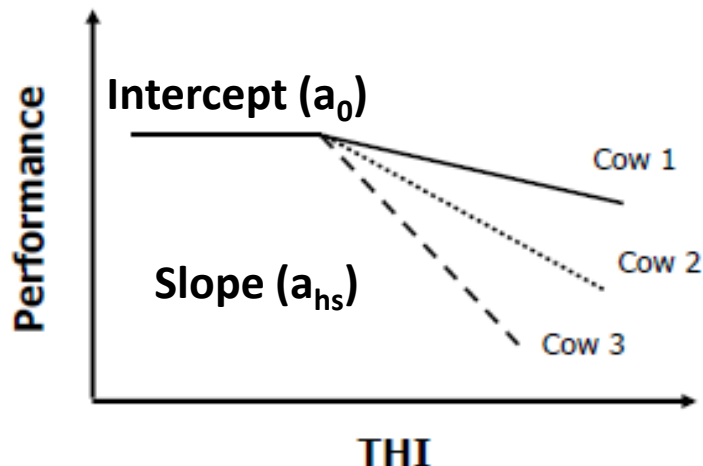
- C4:0, C18:1 cis-9, UFA, MUFA, LCFA

Milk metabolites

- Acetone and BHB

➤ Multivariate reaction norm model

- ✓ 3 lactation stage



Ratio of Slope-Intercept variances

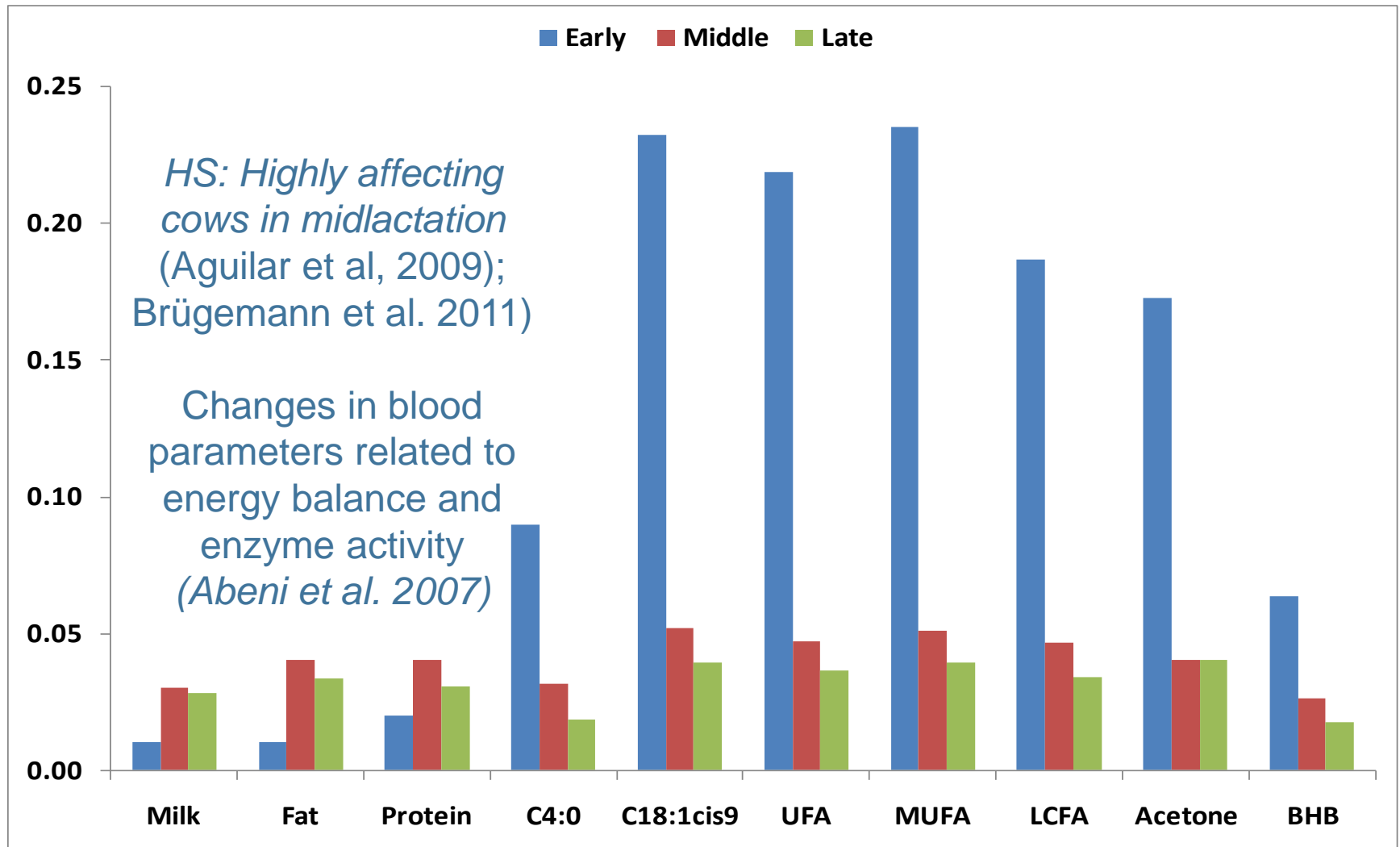
Small

Limited sensitivity to HS

Large

High sensitivity to HS

Ratios of slope-intercept genetic variances

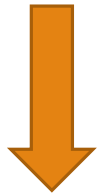


Resilience to HS: GWAS

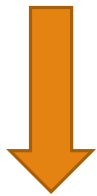
Solutions: - $EBV_{intercept}$
- EBV_{slope}



Genotypes: 4077 animals (50 K SNP)
20943 animal with pedigree



ssGBlup
PostGSf90



SNP effects

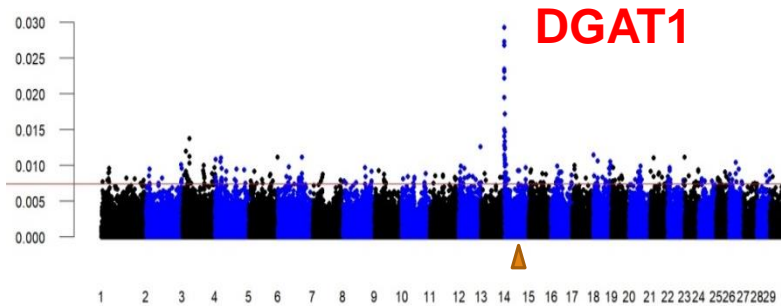


Gene mapping

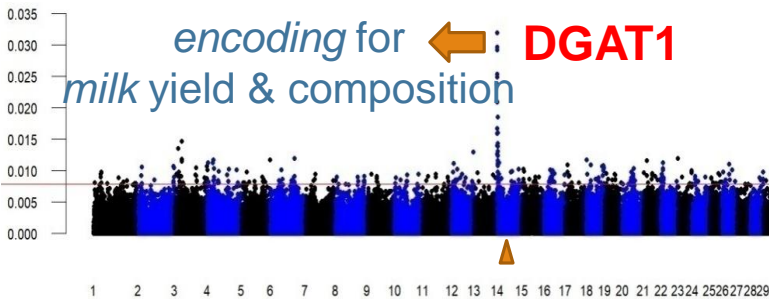
ORG.MESH.BTA.DB

Milk yield: Intercept

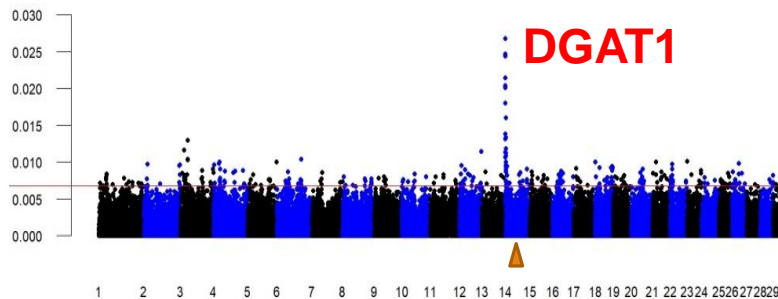
Early



Middle



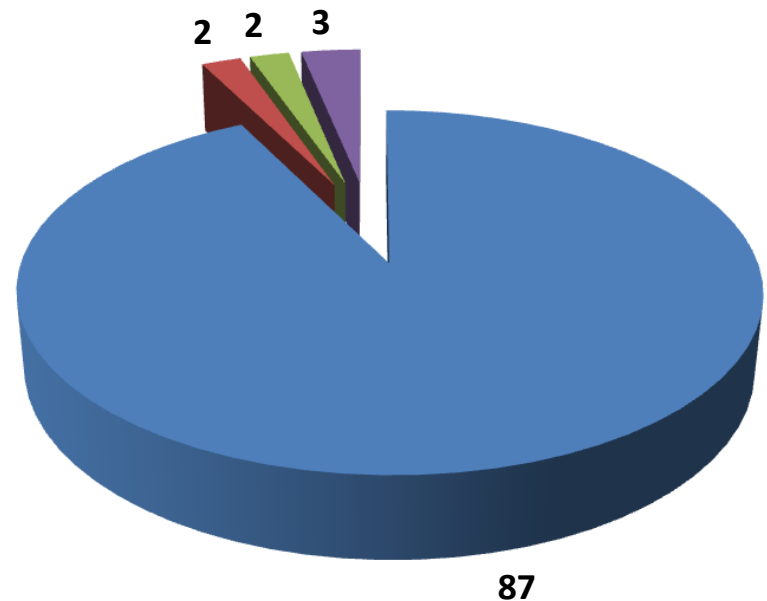
Late



Chromosome

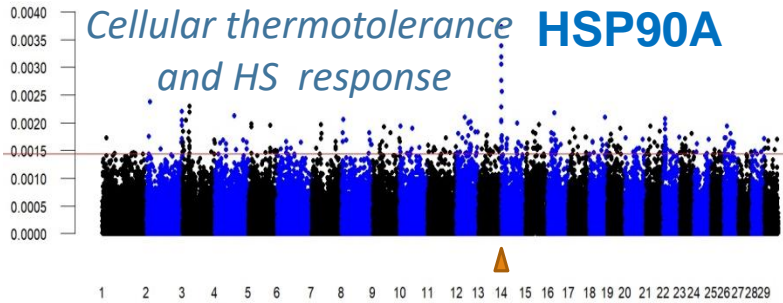
Number of genes shared in all periods vs specific lactation stage genes

- Shared in all periods
- Early-specific
- Middle-specific
- Late-specific

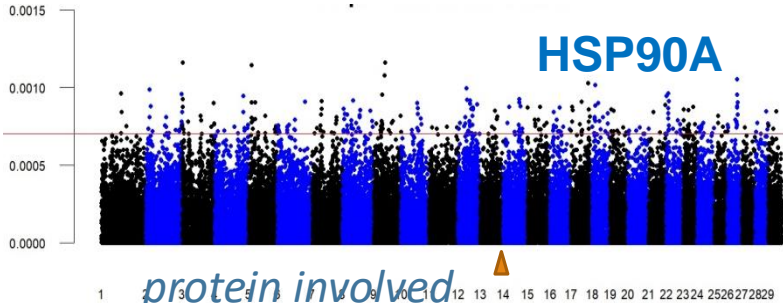


Milk yield: Slope

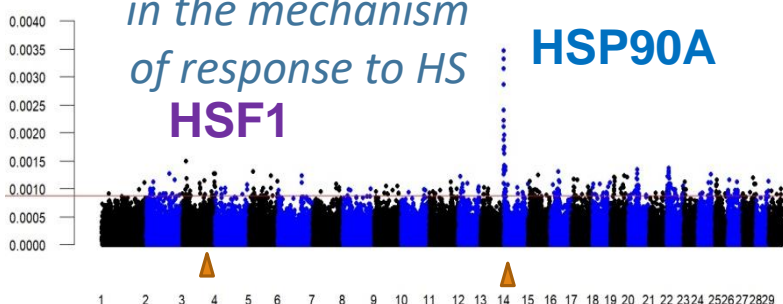
Early



Middle



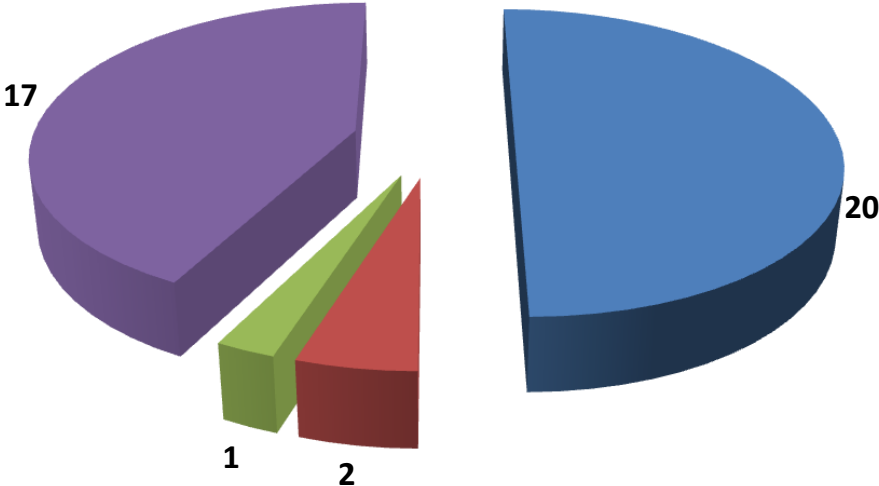
Late



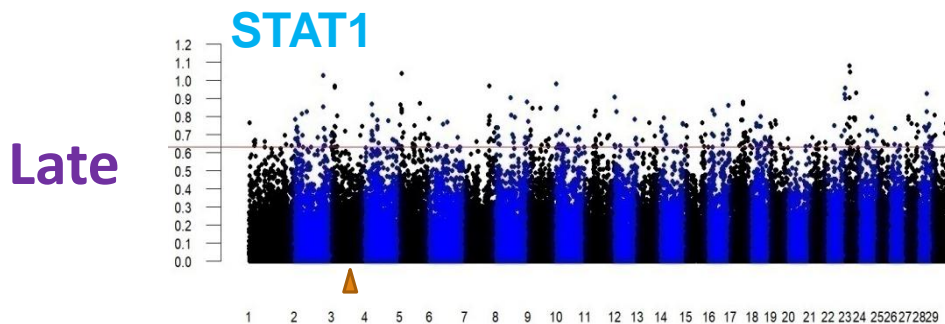
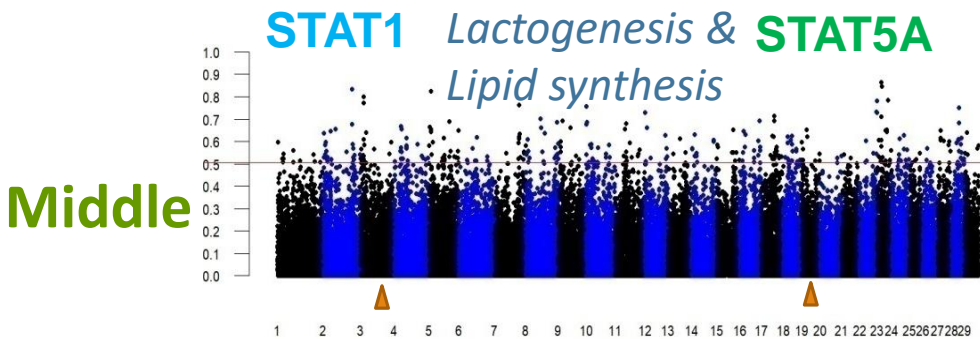
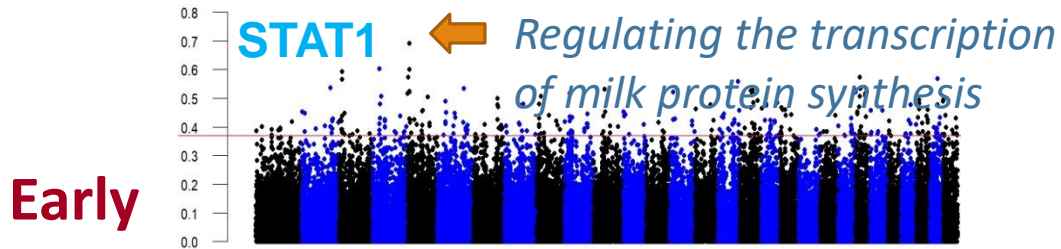
Chromosome

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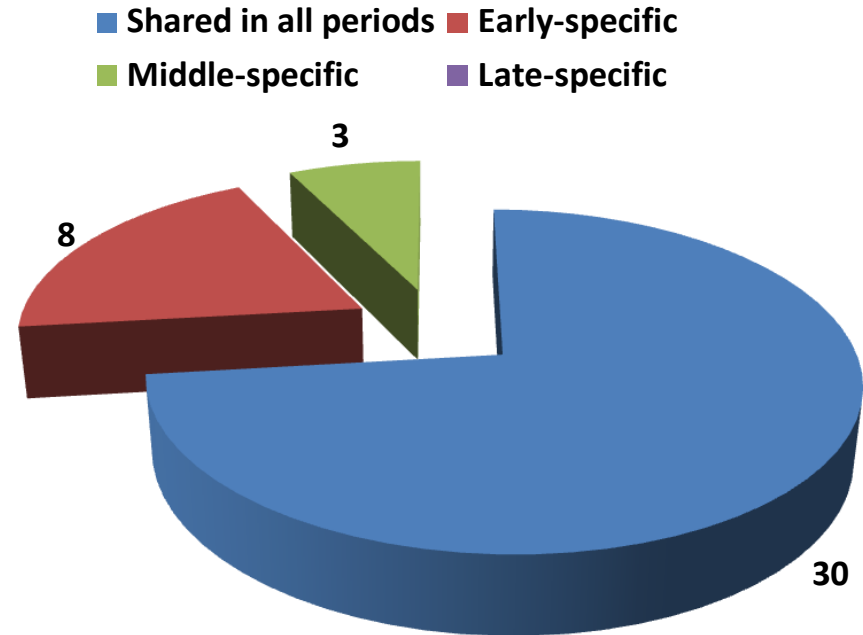


C18:1cis9: Intercept

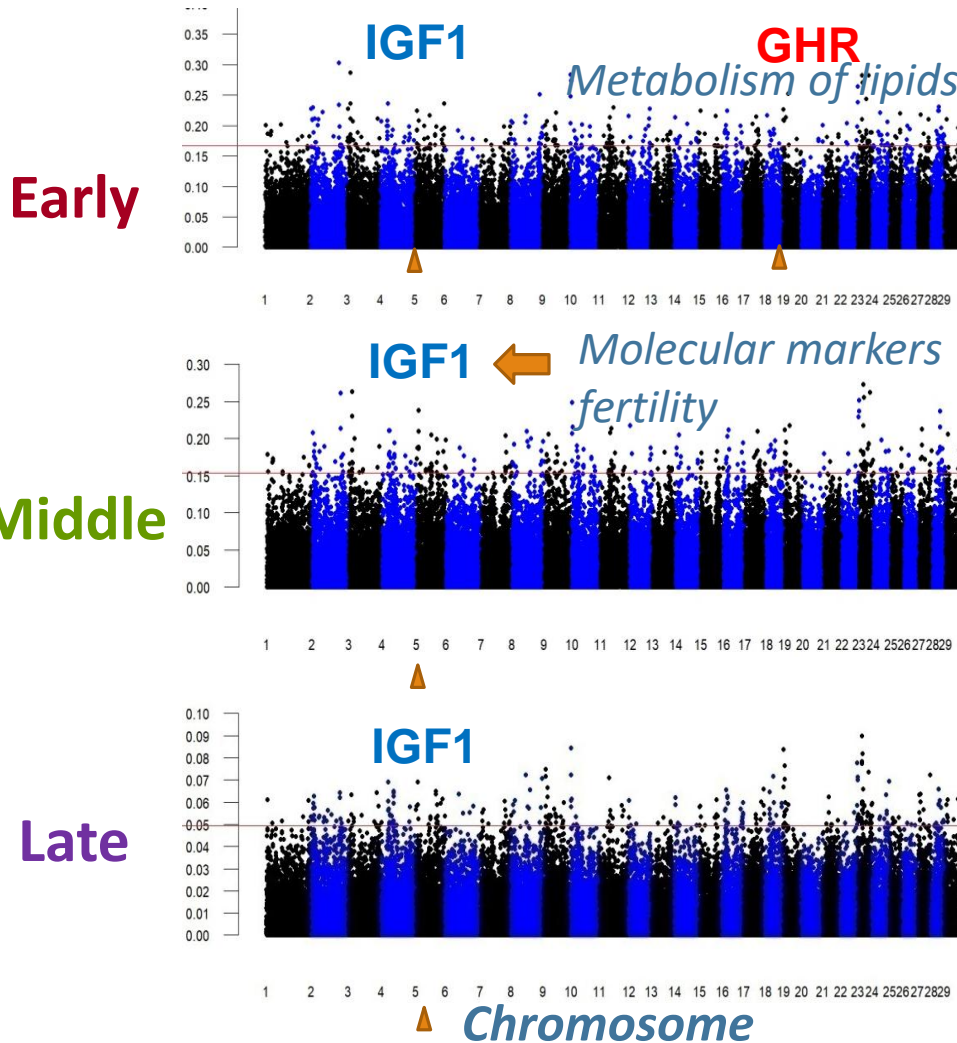


Chromosome

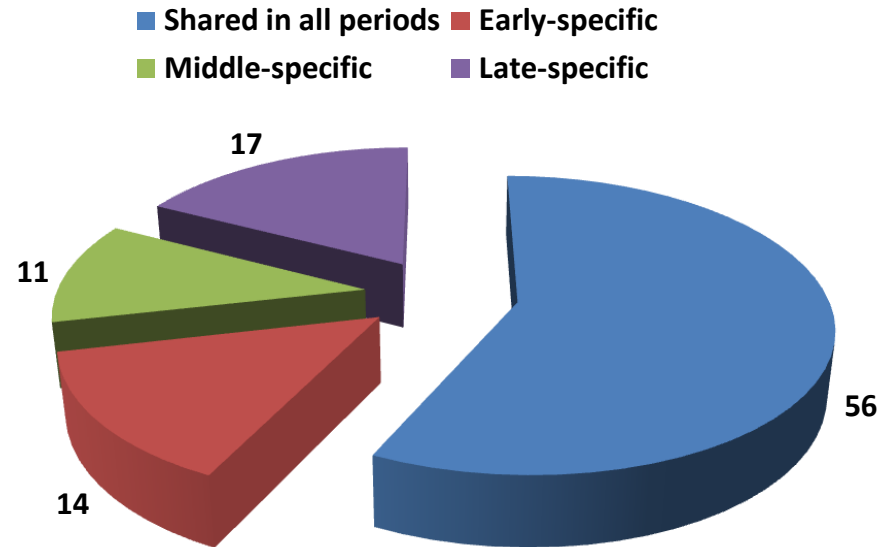
Number of genes shared in all periods vs specific lactation stage genes



C18:1cis9: Slope



Number of genes shared in all periods vs specific lactation stage genes



Take home messages

- Milk production traits: Middle lactation vs Milk biomarkers: Early
- Changes in milk-based biomarkers under high THI are more affordable to better elucidate pathways
- Ongoing investigation using the holistic approach integrating phenomics (milk-biomarkers) and genomics is promising
 - to be consolidated for both case study traits
 - benefit from current pipelines to go one with the rest of traits

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