Early-programming of dairy cattle, a potential explanation to the adaptation to climate change

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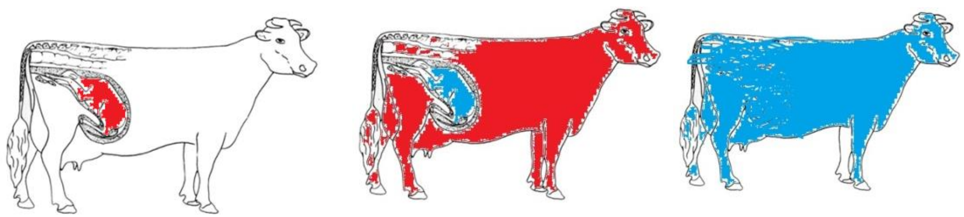
Context: Epigenetics

FEEDING

HEAT STRESS

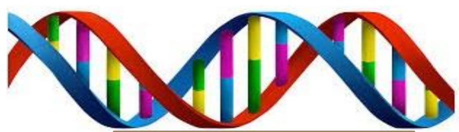


productive Female (G1)

Foetus (G2)

Foetus germ cells (G3)

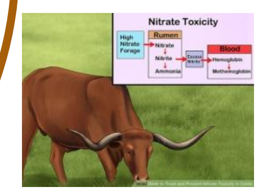
No DNA methylation



Active gene

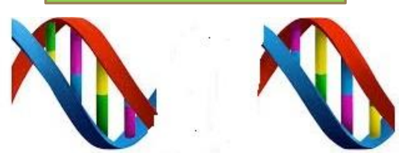
→ **Status A**

TOXICITY



HEALTH

DNA methylation



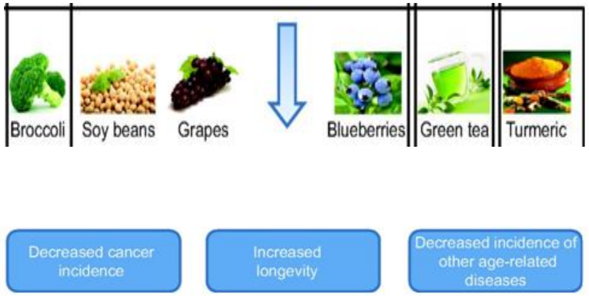
Silent gene

→ **Status B**

BARN

Opportunities in dairy cattle

- Human disease and prevention (e.g. cancer)
  - Genetic make-up of disease development (or not)
  - Early programming (e.g. epigenetic diets)



Michael Daniel, and Trygve O. Tollefsbol J Exp Biol 2015;218:59-70

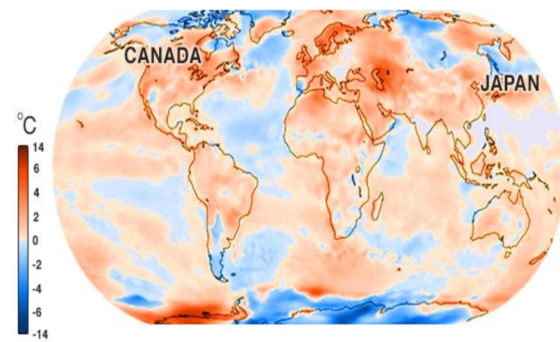
- Those studies can be explored dairy cattle:
  - Identify practices associated to epigenetic changes
  - Detect genotypes with reduced susceptibility to epigenetics

G x E & Epi-Genome Wide Studies

Challenges: adaptation to climate

- Heat stress (HS):
  - Temperate regions

Where in the world temperatures are above and below average for 1-20 July



Temperatures are measured against the average for the period 1981-2010

Source: Copernicus Climate Change Service, European Centre for Medium-Range Weather Forecasts — BBC

- Recent studies on expose of dairy cows to HS during the conception period

J. Dairy Sci. 100:6631–6639
https://doi.org/10.3168/jds.2017-12662

Season of conception is associated with future survival, fertility, and milk yield of Holstein cows

P. J. Pinedo*[1] and A. De Vries†

PLOS ONE

RESEARCH ARTICLE

Periconceptional Heat Stress of Holstein Dams Is Associated with Differences in Daughter Milk Production and Composition during Multiple Lactations

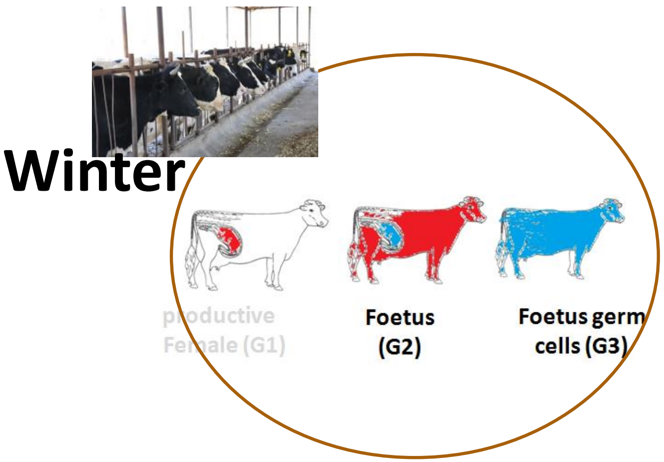
Britni M. Brown[1], Jon W. Stallings[2], John S. Clay[3], Michelle L. Rhoads[1]*

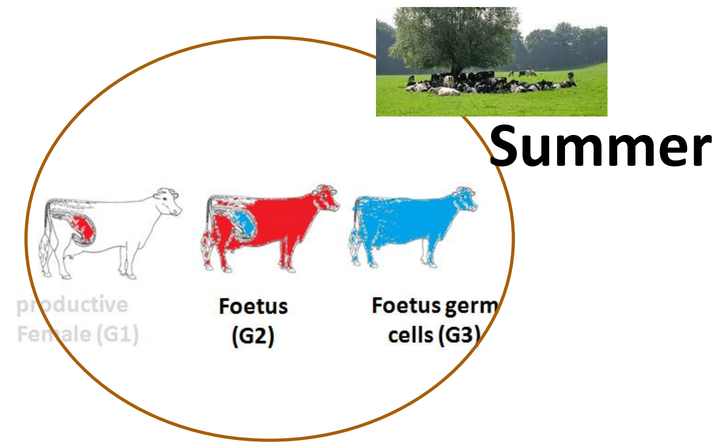
Evidence that season of conception affects offspring lifetime

- **Mainly at the phenotypic level**

Objectives

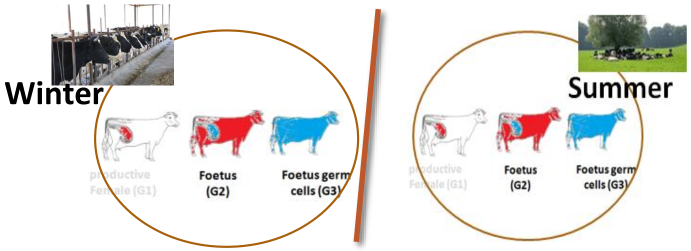
- **G** x **HS exposure** during the fetal development period





- Characterize **genomic regions** responsible for HS exposure at early life as affecting lifetime fertility

Data & models



First 3 Lact.　　First 3 Lact.

DO = Next calving date – 280

G x E

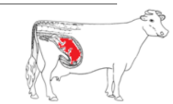
Multi-trait character state model

SNP effects

SSGBlup
PostGSf90

Conception date (CP) = date of birth - 280

Milk recording + Meteo



productive Female (G1)

399,449 TD records linked to THI values
83,502 first-3 lact.
412 herds

+

2957 animal Genotypes (50K)

Gene mapping

ORG.MESH.BTA.DB

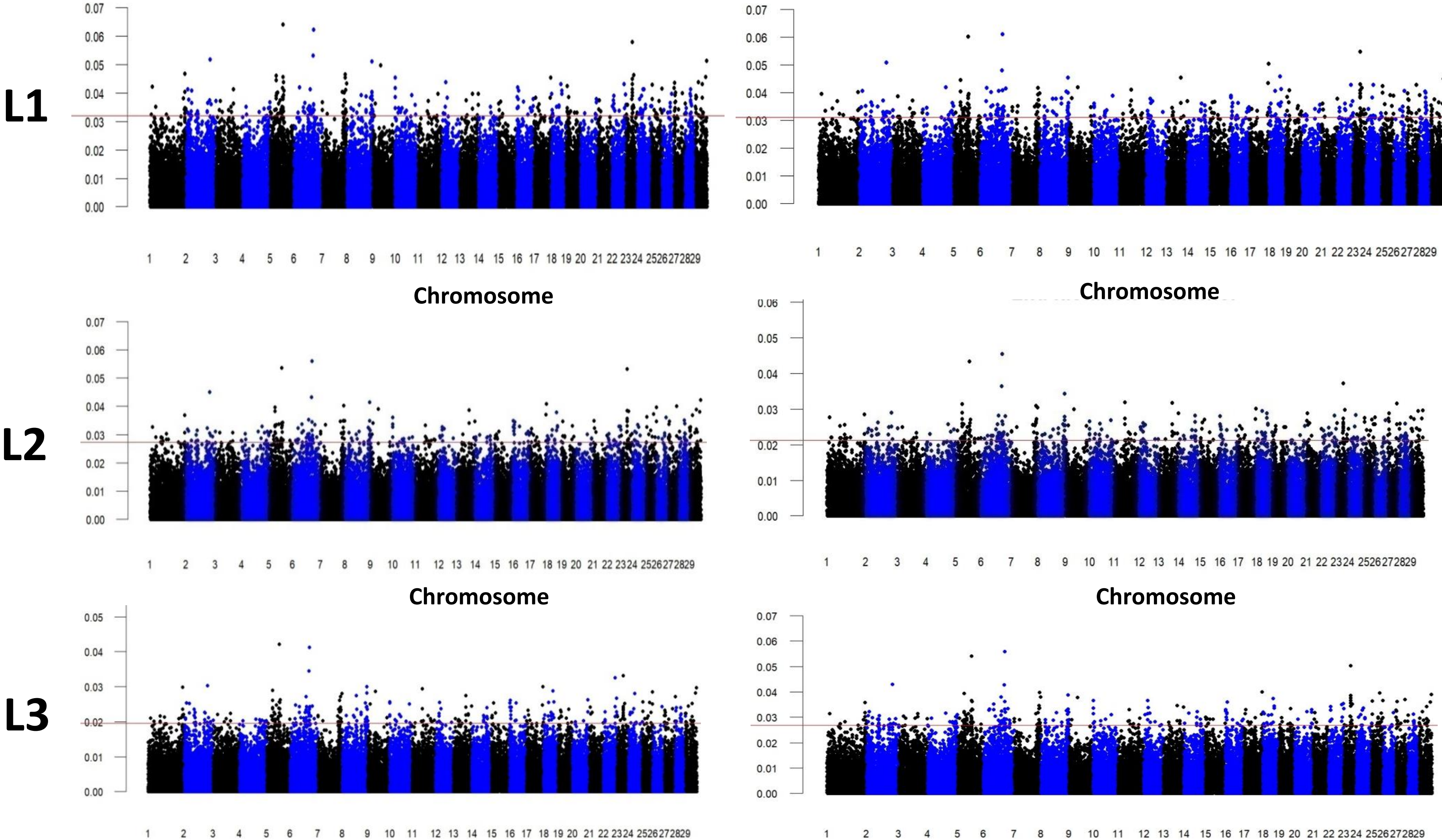
Genetic correlations

		Winter			Summer		
		L1	L2	L3	L1	L2	L3
Winter	L1	.07	.77	.71	**.73**	**.61**	**.62**
	L2		.06	.74	**.75**	**.68**	**.60**
	L3			.06	**.70**	**.58**	**.58**
Summer	L1				.07	.68	.62
	L2					.05	.63
	L3						.05

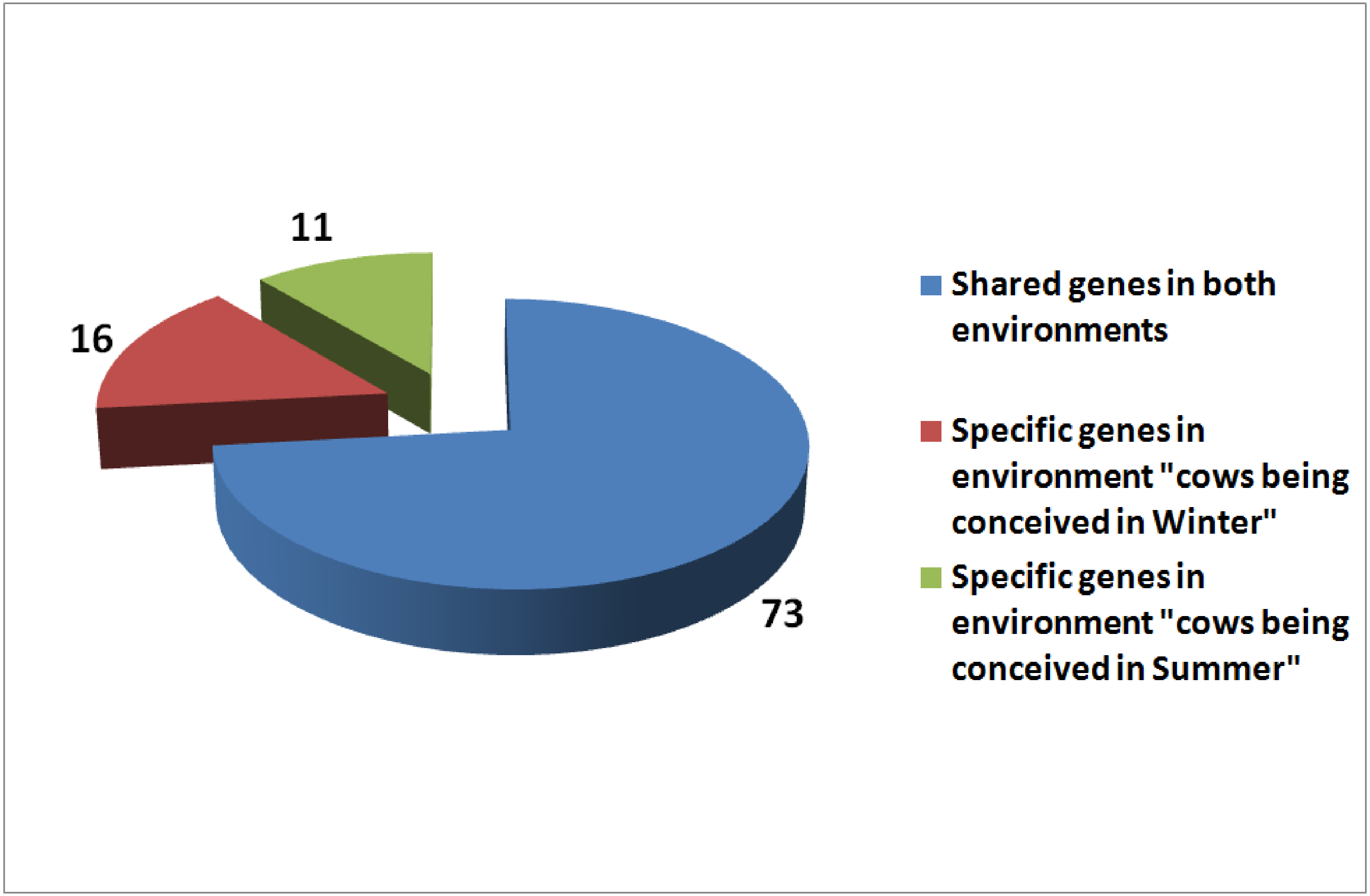
Winter

Manhattan plots

Summer



Proportions of identified genes



Functional gene enrichment (shared)

MeSH ID	Term	Number of signif. genes	Total genes	P-Value
D011270	Pregnancy, Animal	12	71	0.001
D013312	Stress, Physiological	6	23	0.002
D030762	Estrous Cycle	12	86	0.004
D047109	Fetal Development	3	7	0.006
D044127	Epigenesis, Genetic	6	29	0.006

Functional gene enrichment (specific summer)

Summer

MeSH ID	MeSH term Name	Signif. Genes	P-value
D050883	HSC70 Heat-Shock Proteins	4	0.003
D019791	Guanidine	4	0.006
D018384	Oxidative Stress	9	0.009
D007335	Insulin-Like Growth Factor II	4	0.014

Functional gene enrichment (specific winter)

Winter

MeSH ID	MeSH term Name	Signif. Genes	P-value
D001120	Arginine	10	0.001
D051766	Early Growth Response Protein 1	3	0.017
D004847	Epithelial Cells	19	0.025
D000222	Adaptation, Physiological	3	0.029

Take home messages

- r_g correlations across both early-life environments were lower than .80
- Differentially expressed genes when offspring being conceived in summer compared to winter
- Ongoing work in the identification of potential gene candidates for metabolism and physiology traits

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Wallonie

DGO 3

Walloon Breeding Association

awe association wallonne de l'élevage

CECI Consortium for computational resources

C.E.C.I

GE PLUS Genotype plus Environment

Integration for a more sustainable dairy production system

OptiMIR

WITH THE SUPPORT OF

Wallonie

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