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A large population study to assess the magnitude of prenatal programming in cattle

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Context

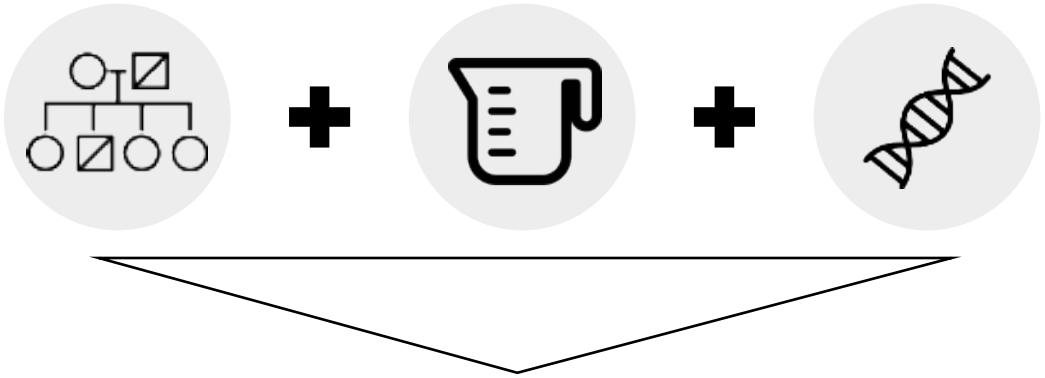
Barker hypothesis and **DOHaD**

- **Prenatal programming** : an event occurring before birth could impact the adult phenotype
  (e.g. « Large offspring syndrome» in calves conceived by in-vitro fertilisation)

Several studies in cattle: **assessing impact and understanding mechanisms**

- **Contrasting results**

French cattle population :



x 100,000s

Accurate **breeding values**
Not influenced by own performance

Objectives of the study: assess **systematic deviations** attributable to different **prenatal factors**

Material and methods

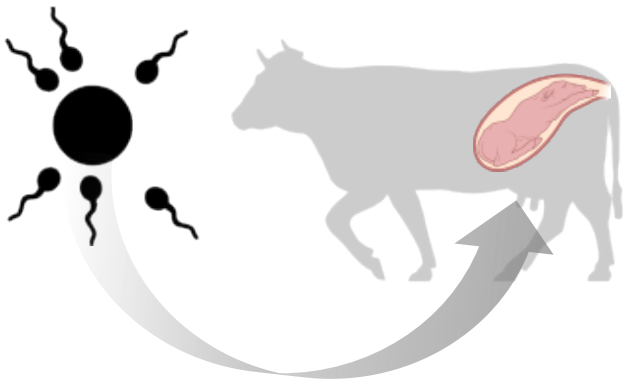
Cases studied (dairy cattle)

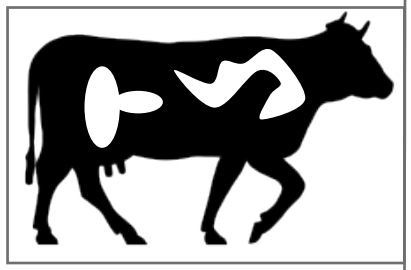
Assisted reproductive techniques

- **X-sorted semen vs. conventional semen**
- **Conception methods :**
  Conventional AI,
  Fresh (ET) or frozen-thawed embryo transfer (FET)
  In vitro fertilization (IVF-ET and IVF-FET)

Gestational factors

- **Age at first calving**
- **Parity**
- **Metabolic status** : Milk fat-to-protein ratio
- **Udder health :** Somatic cell score, mastitis





Daughters' studied traits

- ***Birth condition***
- ***Stature :*** *Height at sacrum, body depth, chest width*
- **Production** : Milk yield, fat yield, protein yield, fat content, protein content
- **Udder health :** Somatic cell score, mastitis incidence
- **Fertility :** Heifer conception rate, cow conception rate

Materials and methods

Data

- Genotyped females, born after 2015
- 2 breeds : **Montbéliarde & Holstein**

= breeds with the highest numbers of genotyped cows

- Depending on the breed, factor and trait, between 400 and 150,000 animals retained per analysis

Materials and methods

Model

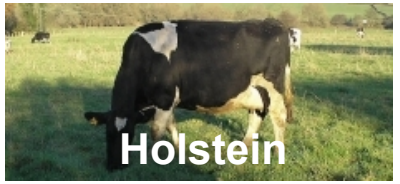
Linear model **:**

Performance *(e.g. milk yield)* **=**

GLM procedure (SAS)

Results : Assisted reproductive techniques

*Conventional semen (**CONV**) vs. X-sorted semen (**SS**)*

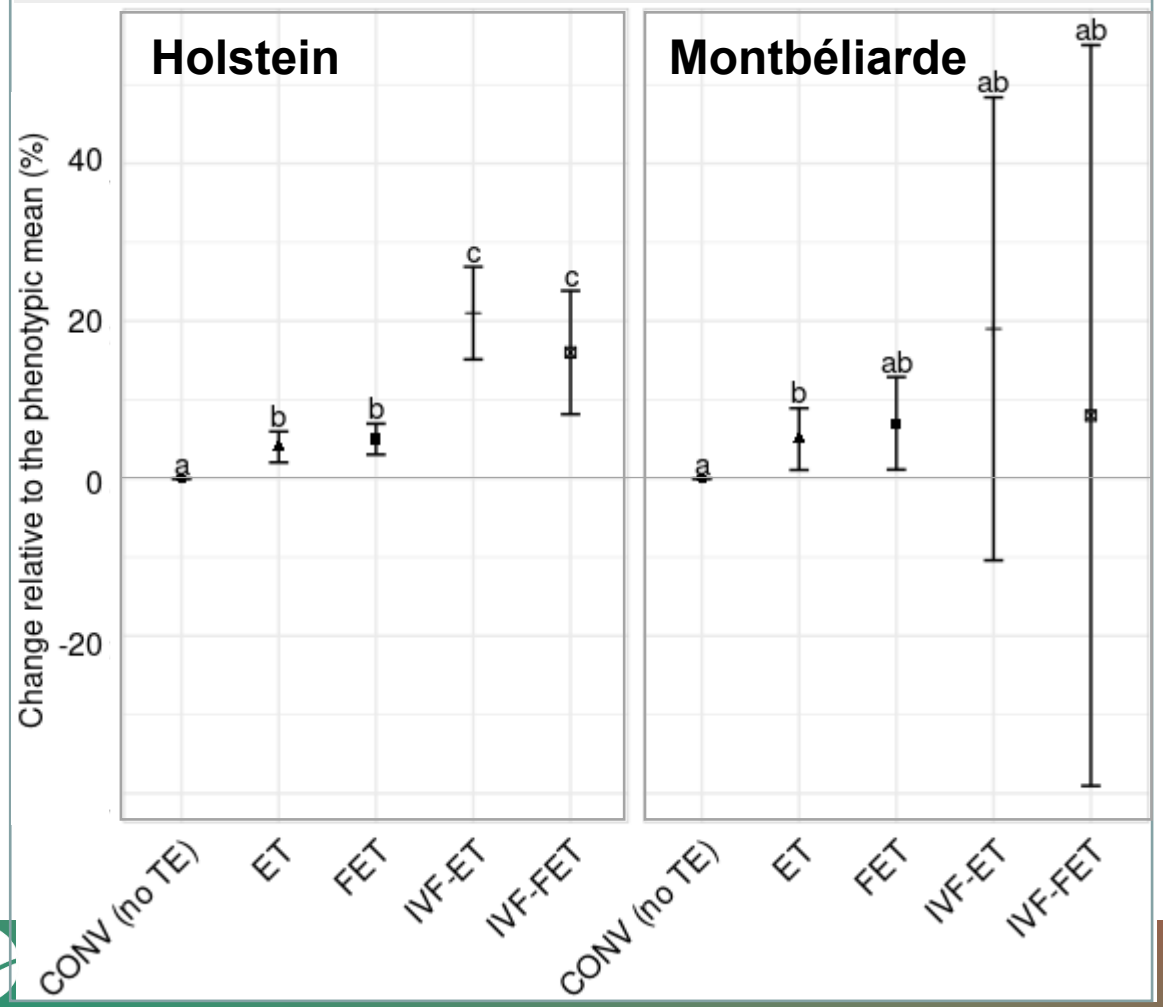


Trait	Class	Number	β estimate	Number	β estimate
Milk yield (kg)	CONV	53607	0	6083	**0[a]**
	SS	49695	-10.9	7269	**-51.8[b]**
Fat yield (kg)	CONV	33957	0	6083	**0[a]**
	SS	32120	0.21	7269	**-1.45[b]**
Protein yield (kg)	CONV	33957	0	6083	**0[a]**
	SS	32120	-0.35	7269	**-1.92[b]**
Fat content (g/kg)	CONV	33957	0	6079	**0[a]**
	SS	32120	-0.05	7265	**-0.22[b]**
Protein content (g/kg)	CONV	33916	**0[a]**	6079	**0[a]**
	SS	32079	**-0.12[b]**	7265	**-0.24[b]**
Somatic cell score	CONV	33957	0	6083	0
	SS	32120	0	7269	0.03
Clinical mastitis	CONV	21622	0	3631	0
	SS	20320	0	4221	0
Heifer conception rate	CONV	41483	0	5878	0
	SS	40782	0.01	6888	0.01
Cow conception rate	CONV	14022	0	630	0

Results : Assisted reproductive techniques

Embryo technologies

Birth conditions of female calves derived from different conception methods



Embryo transfer leads to :

- **More difficult birth conditions** in both breeds (Large Offspring Syndrome?)
- No clear effects on stature
- Lower milk production in Holstein (no effect in Montbéliarde)
- No effects on udder health and fertility

Results : Gestational factors

Age at first calving

Decrease of milk fat yield (-6% of the phenotypic s.d.) derived for **late calving** dams (>33 months)

No effect on all other traits (milk yield, protein yield, milk content, fat content, protein content, somatic cell score, clinical mastitis, heifer conception rate, cow conception rate)

No effect on any traits in **Montbéliarde**

In both breeds, **early calving** does **not** appear **detrimental** for the derived **daughter**

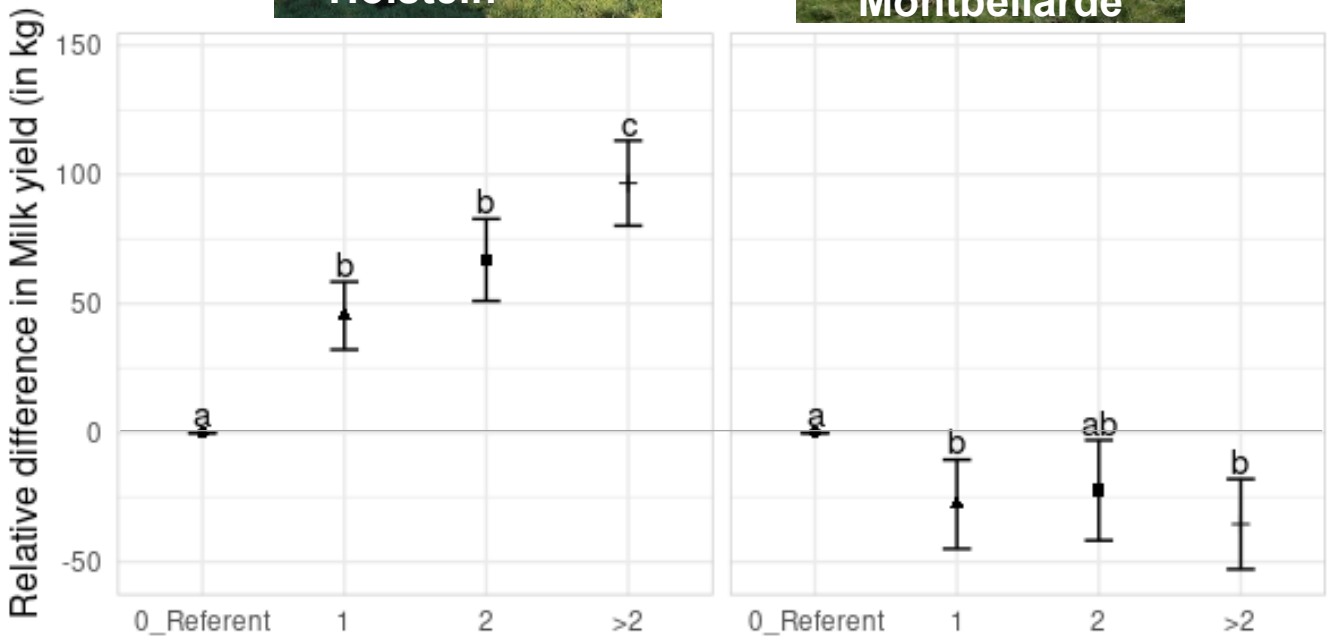
Results : Gestational factors

Parity

Increased dam's parity **is linked to** :

- **Favorable** effects for all milk production traits in **Holstein**
- Higher milk fat content in **Montbéliarde**
- In both breeds, **no effects** or low effect on **udder health and fertility**

Milk yield



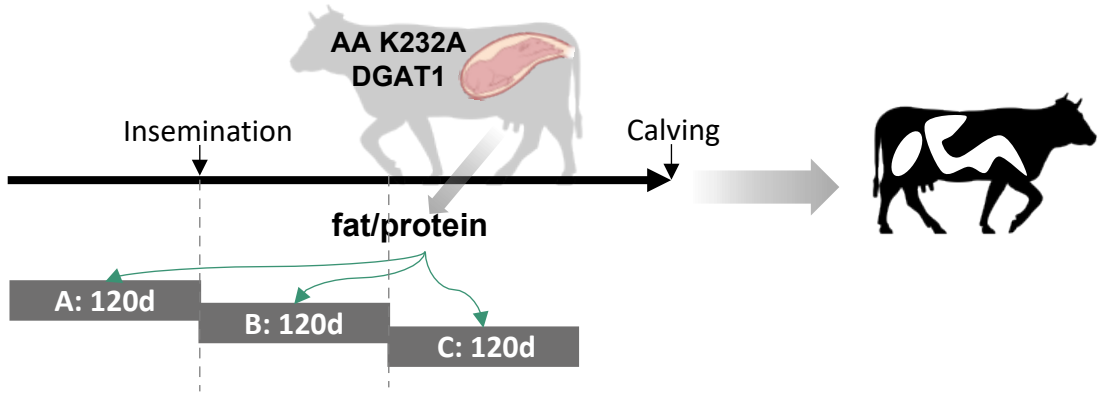
Parity 0

First calving dams

Results : Gestational factors

Metabolic status *related traits*

- ***fat-to-protein ratio***



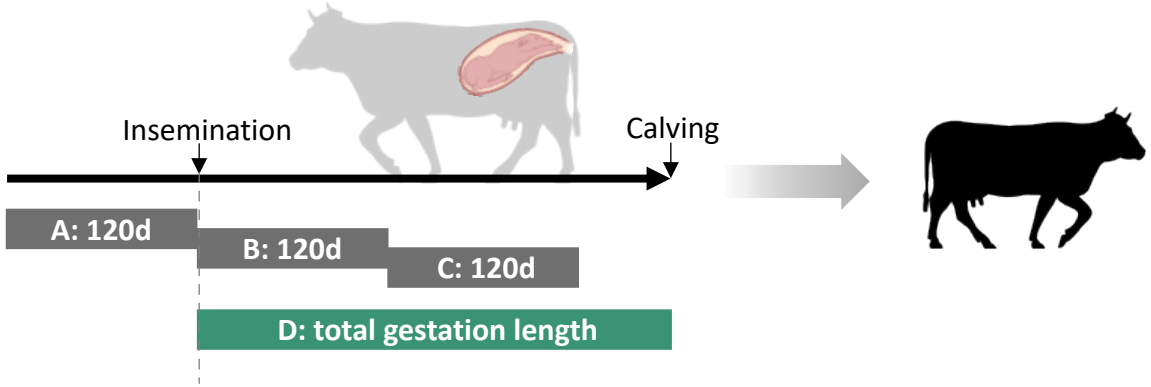
- Availability of data :
  - Only in Holstein breed

- **No effect on milk production, SCS, clinical mastitis or heifer conception rate**
- Depending on the window considered for measuring the factor, we obtained **unconsistent effects that were always low**

Results : Gestational factors

Udder health related factors :

- ***somatic cell score***
- ***clinical mastitis***



- **Not associated** with any large effects in daughter's performance

Discussion

- **In Human,** most of the effects described concern **health** (e.g. cardiovascular diseases); traits not precisely measured on a large scale in cows

- Strong **environmental effects** could have a direct impact on the **fertility** of dams

  ⇒ No reproduction

    ⇒ No observable performance in daughters

Take home message

1. Very limited effect **<0.1 of the phenotypic standard deviation** for most traits

2. **Minimal** practical implications

3. **Widely used technologies** (e.g. sexed semen)

4. Differences observed could be linked to epigenetic variations

Acknowledgements

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