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# Including $\alpha$ s1 casein gene effect on genomic evaluations of French dairy goats

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66th EAAP meeting, 02 September 2015, Warsaw, Poland





# Why adding major gene in genomic evaluations?

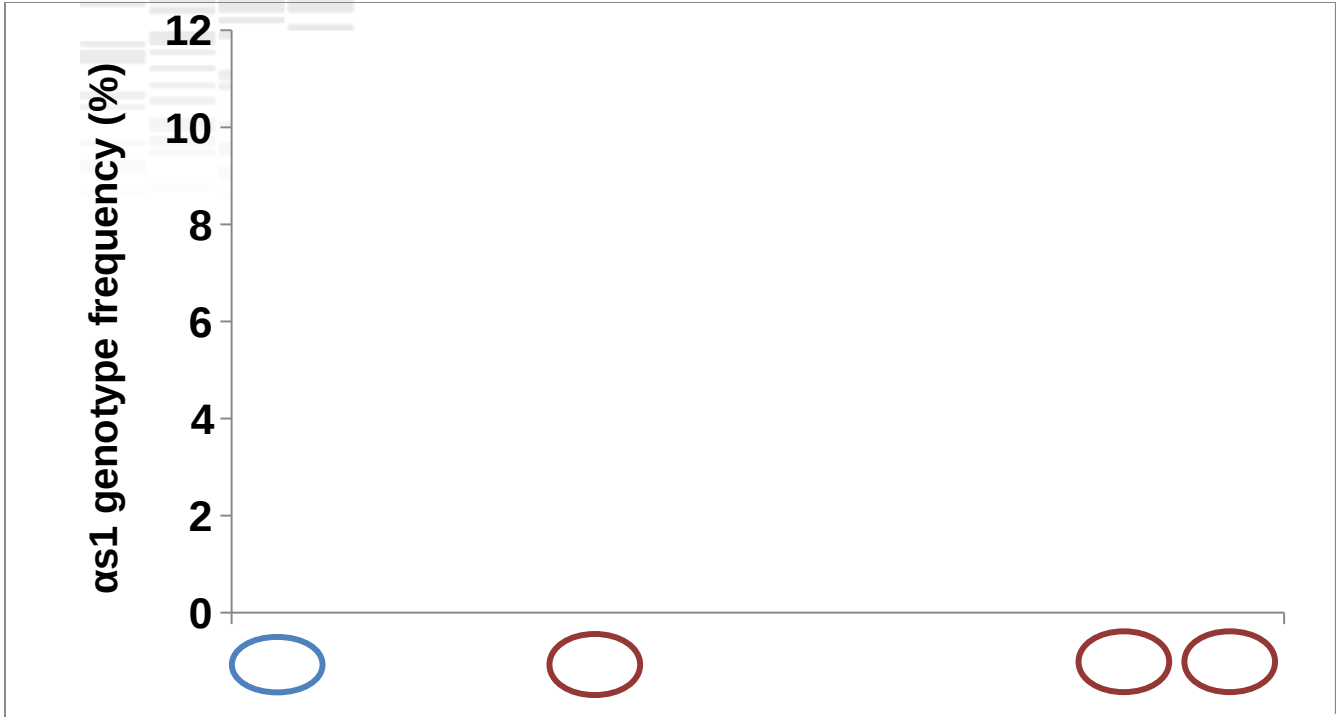
- $\alpha$ 1 casein major gene in dairy goat
- genomic selection : all SNP = equal part of variance

French dairy cattle 1: Adding QTL in genomic evaluation  $\square$  accuracy +3% to +12 %

## Goats with $\alpha$ 1 casein genotypes:

-  3 861 bucks  $\longrightarrow$  823 with 50k genotypes
  -  2 949 dams of bucks
- } Alpine  
+  
Saanen

# Breed differences in $\alpha$ s1 casein allele frequencies



**Alpine : supremacy of allele A**

**Saanen : supremacy of genotypes AE, CO and EE**

# $\alpha$ s1 casein: a major gene for dairy goat

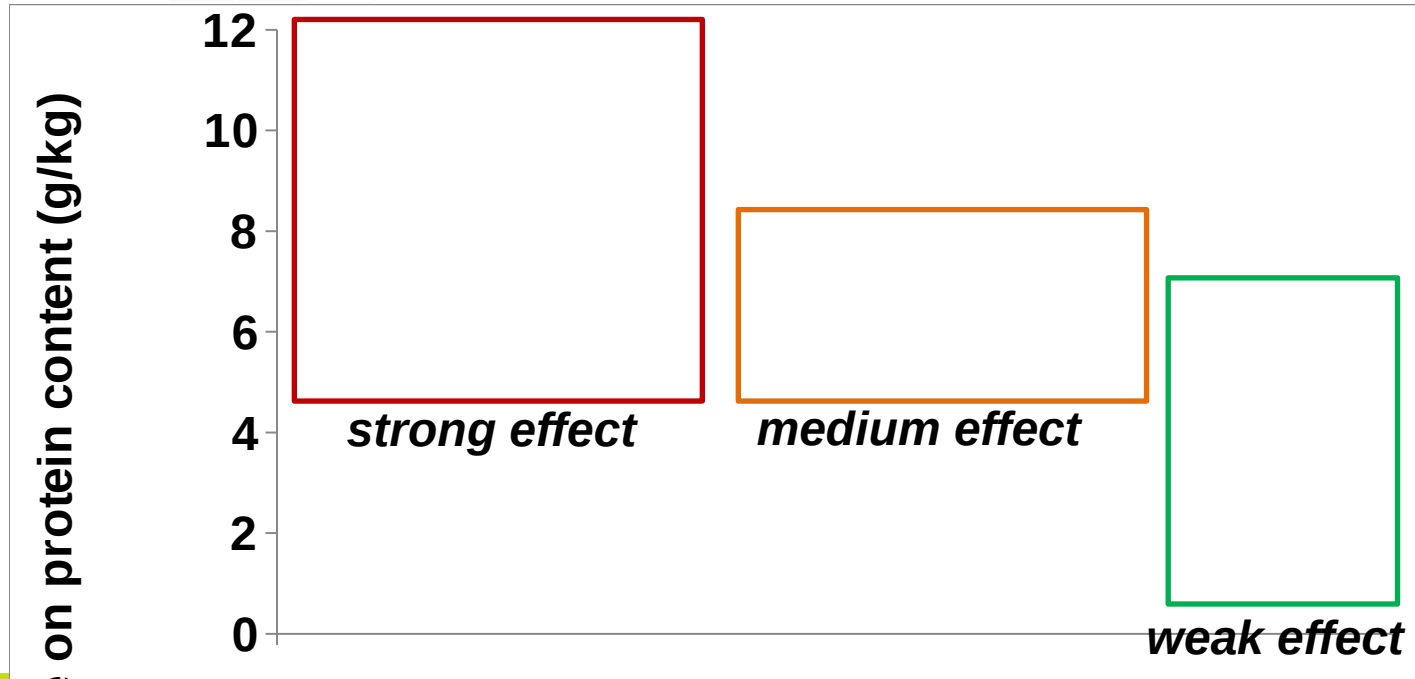
**Genetic Model used:**  $y = Zu + Tw + e$

with  $y$ : DYD,  $u$ : polygenic part,  $w$ :  $\alpha$ s1 casein genotype random effect

**Part of genetic variance (%) explained by  $\alpha$ s1 casein genotype:**

	Multi-breed	Alpine	Saanen
Milk yield	9	12	7
Fat content	20	24	17
Protein content	41	43	38

# Three classes of $\alpha$ s1 casein genotypes (strong, medium and weak effects)



# How to integrate $\alpha$ s1 casein genotype in genomic evaluations?

1. **Based on male phenotypes (DYD) and genotypes**
  - fixed  $\approx$  random effect
  - no significant effect on milk yield and fat content



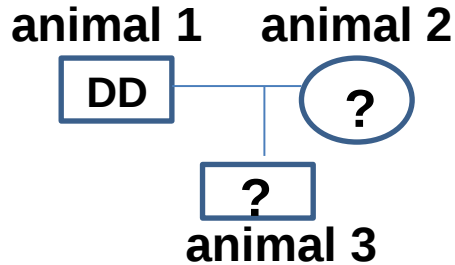
# How to integrate $\alpha s1$ casein genotype in genomic evaluations?

## 2. Based on female phenotypes (genotyped or not)

### 2.1 Predict genotype for females using peeling iterative method2

**Example (biallelic marker):** frequencies in population (%):

D	d
58,5	41,5



**Probability for genotype of animal 2:**

→ *Frequencies in population (%)*

DD	Dd	dd
32	53	15

**Probability for genotype of animal 3 (%):**

DD	Dd	dd
58,5	41,5	0



# How to integrate $\alpha$ s1 casein genotype in genomic evaluations?

## 2.1 Predict genotype for females using peeling iterative method2

□ probabilities for each 19 possible genotypes

	AA	AB	AC	AE	AF	AO	BB	BC	BE	...	FF
Female 1	0,10	0,05	0	0,05	0,25	0,05	0,15	0,10	0		0
...											
Female n	0	0,15	0	0	0	0,25	0	0,35	0,20		

Including probabilities in genomic evaluation:

- 1) **Random probabilities** : each combination of 19 probabilities = level of random effect
- 2) **3 groups of probabilities** : 3 fixed effects (strong, medium and weak effects)

# How to integrate $\alpha$ s1 casein genotype in genomic evaluations?

## 2. Based on females phenotypes

### 2.2 Predict genotype for females using gene content<sup>3,4</sup> approach:

multiple trait model using simultaneously pedigree, known genotypes and phenotypes

$$\left\{ \begin{array}{l}
 \mathbf{y} = \mathbf{X}_g \boldsymbol{\beta}_g + \mathbf{Z}_g \mathbf{u}_g + \mathbf{W}_g \mathbf{p}_g + \mathbf{e}_g \quad \text{model for genetic evaluation of phenotype} \\
 \mathbf{y}_A = \boldsymbol{\mu}_1 + \mathbf{Z}_1 \mathbf{u}_1 + \mathbf{e}_1 \\
 \mathbf{y}_B = \boldsymbol{\mu}_2 + \mathbf{Z}_2 \mathbf{u}_2 + \mathbf{e}_2 \\
 \mathbf{y}_C = \boldsymbol{\mu}_3 + \mathbf{Z}_3 \mathbf{u}_3 + \mathbf{e}_3 \\
 \mathbf{y}_E = \boldsymbol{\mu}_4 + \mathbf{Z}_4 \mathbf{u}_4 + \mathbf{e}_4 \\
 \mathbf{y}_F = \boldsymbol{\mu}_5 + \mathbf{Z}_5 \mathbf{u}_5 + \mathbf{e}_5 \\
 \mathbf{y}_O = \boldsymbol{\mu}_6 + \underbrace{\mathbf{Z}_6 \mathbf{u}_6}_{\text{polygenic}} + \mathbf{e}_6
 \end{array} \right.$$

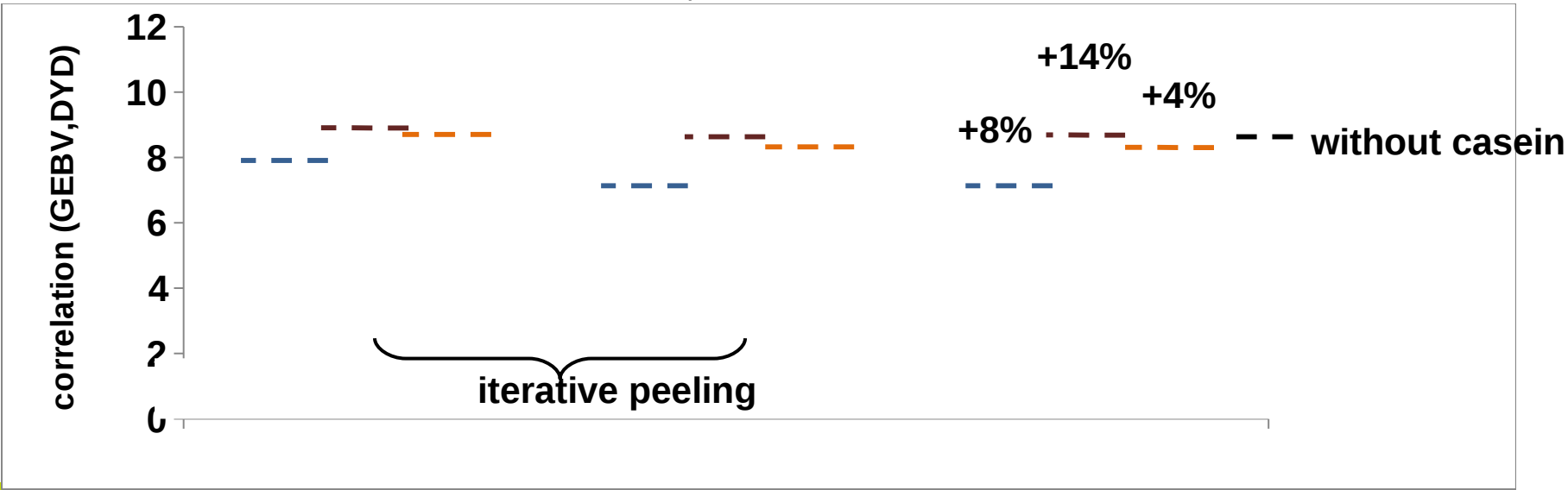
model for gene contents of each allele (  $y_A, \dots, y_O$ ;  
 number of copie of allele (0,1 or 2))

$$\mathbf{u}_i \sim N(\mathbf{0}, \mathbf{A}\sigma_{u_i}^2)$$

# Using gene content approach improved GEBV prediction

## 2. Based on females phenotypes

Three models used : iterative peeling { 1) Random probabilities  
2) 3 groups of probabilities  
3) Gene content



# Include $\alpha$ s1 casein genotype in genomic evaluation improved prediction of breeding values

$\alpha$ s1 casein major gene : 40% of genetic variance of protein content

genomic evaluation

*Based on male performances :*

- fixed effect  $\approx$  random effect
- gain Saanen > gain Alpine > gain multi-breed

*Based on female performances :*

- Predict genotypes of non genotyped females
- gene content >> peeling iterative
- gain : 4 to 14% on protein content

Include  $\alpha$ s1 casein effect improved breeding values prediction



# Appendix

# Design of cross validation

