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Comparative genome analyses of two local cattle breeds reared in the Parmigiano Reggiano region

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- About 40 kg of cured cheese obtained from about 520 liters of milk
- No silage and no preservatives
- 2820 farms with a total of about 265,000 dairy cattle 
- About 16% of the milk produced in Italy
- 3.6 M cheese moulds y
- 2.4 billion of euro



Reggiana



Modenese (Bianca Val Padana)



Reggiana



Statistics 2018

4,051 cattle registered to the herd book
2,379 dairy cows in 129 farms



ANABoRaRe



Modenese (Bianca Val Padana)



1,035 cattle registered to the herd book
451 dairy cows in 46 farms

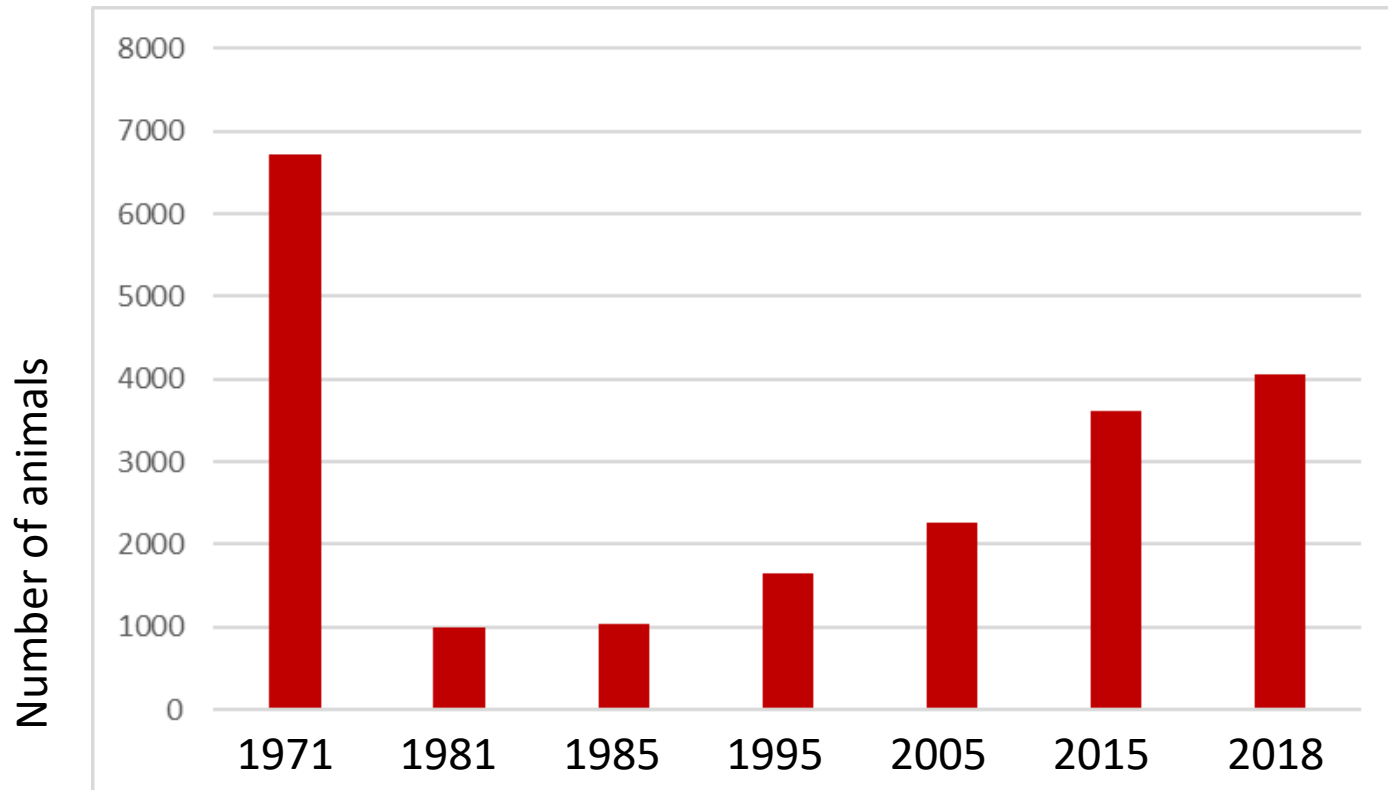
Reggiana



Modenese (Bianca Val Padana)



Reggiana cattle registered to the herd book



Years

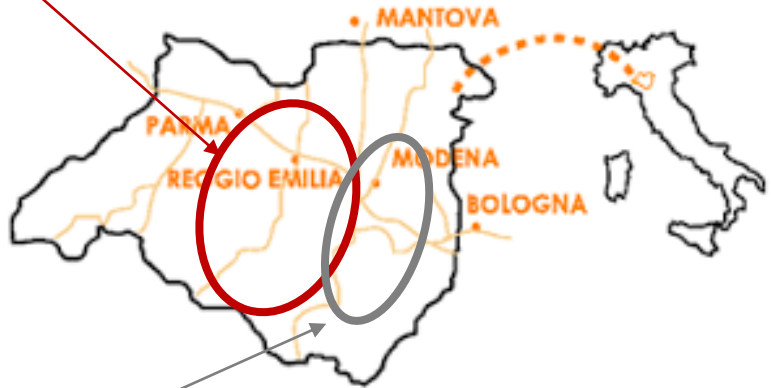


1991

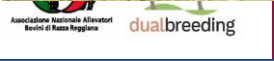


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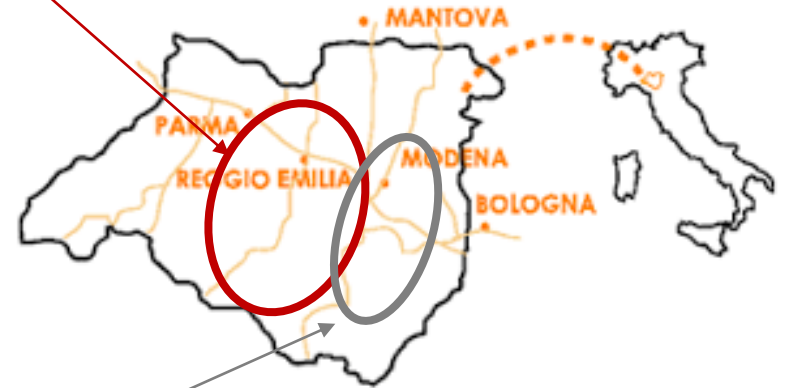
Reggiana



Modenese (Bianca Val Padana)



Reggiana



Modenese (Bianca Val Padana)



Reggiana



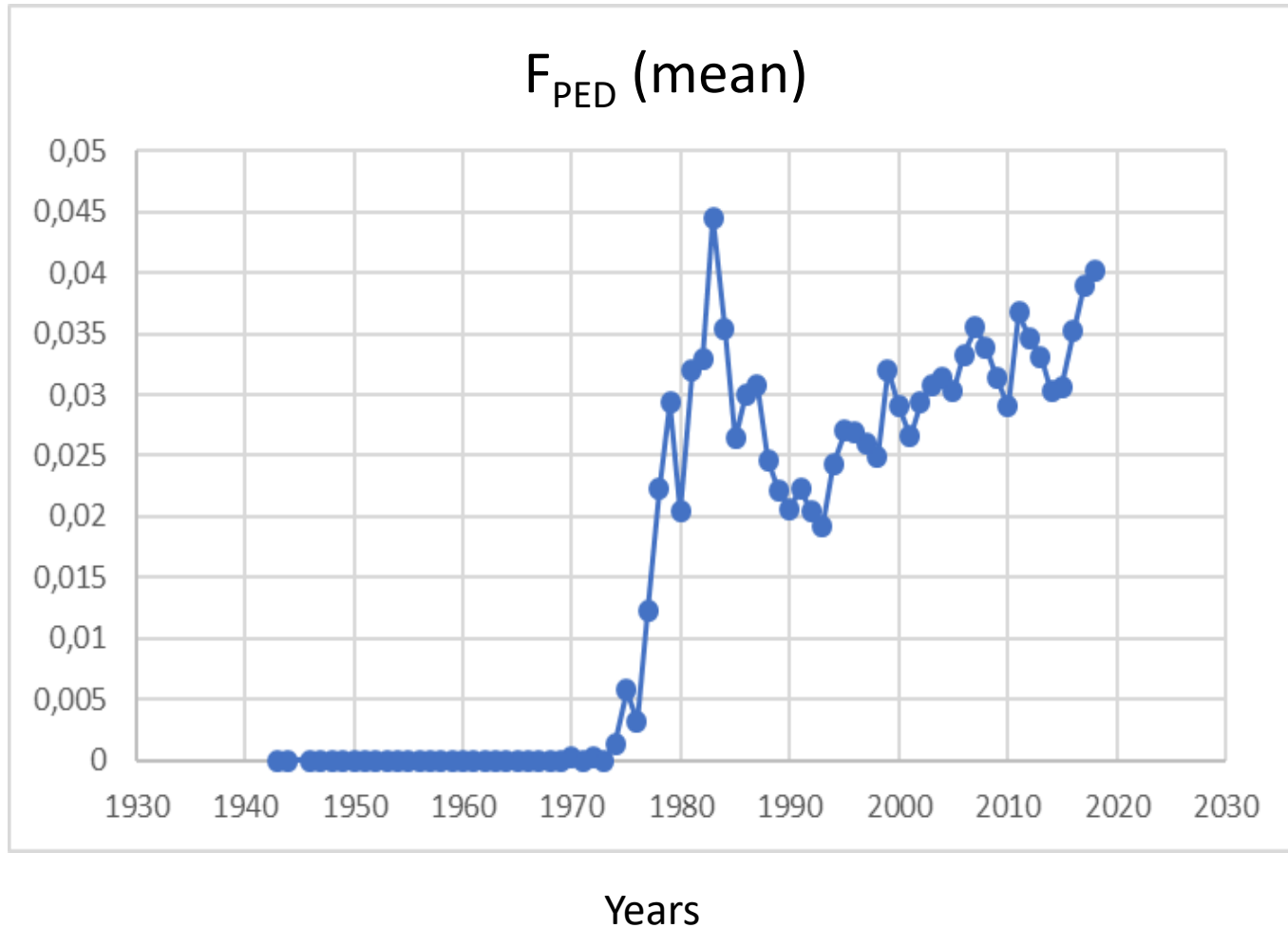
Modenese (Bianca Val Padana)



Conservation genetics

- Small populations
- Inbreeding
- Pedigree records (poor)
- Mating plans
- Breed-specific traits
- Sustainable productions
- Frauds
- Cheese-making properties of the milk
- Unknown genetic defects/deleterious alleles
- ...

Reggiana



Genomic analyses



Reggiana



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Modenese (Bianca Val Padana)



Reggiana



658 cattle genotyped with:

- the GeneSeek Genomic Profiler Bovine 150K (GGP-HD)
- several gene markers

Modenese (Bianca Val Padana)



110 cattle genotyped with:

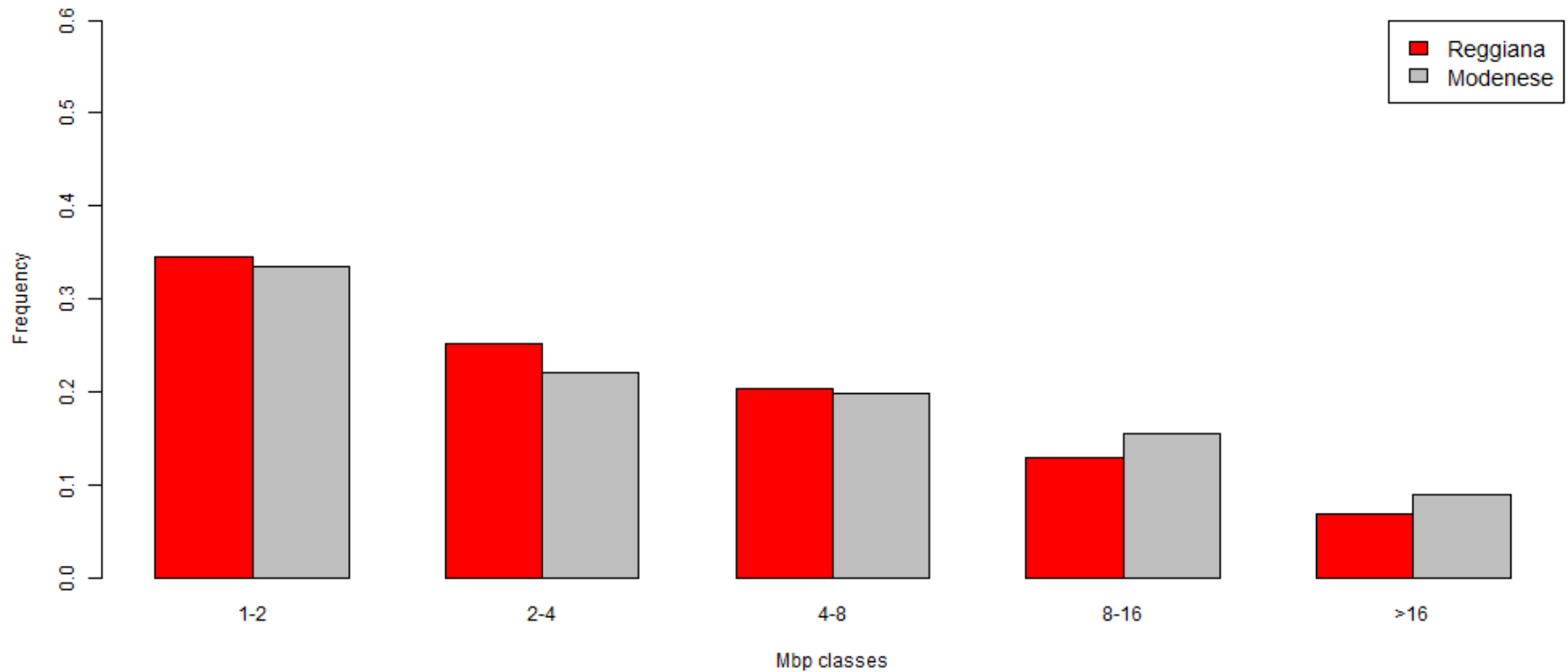
- the GeneSeek Genomic Profiler Bovine 150K (GGP-HD)
- several gene markers

Runs of Homozygosity (ROH)

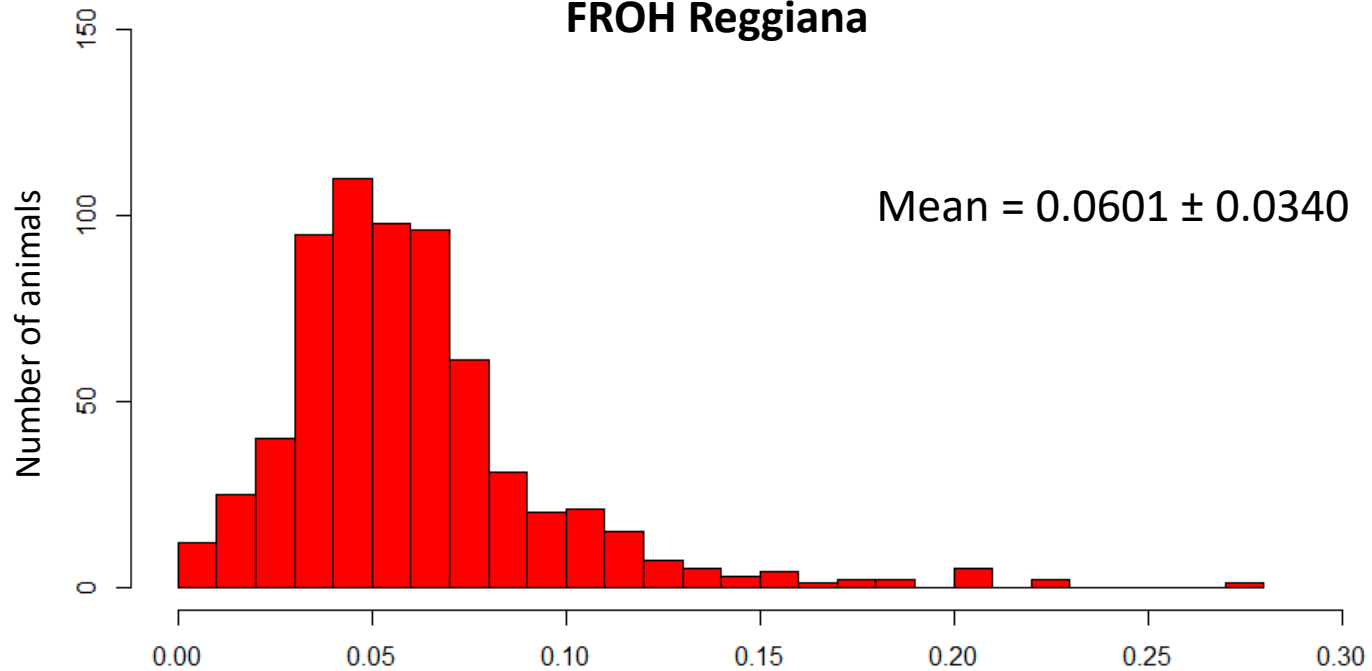
- Minimum number of consecutive SNPs: 15
Minimum homozygous density: 100
Heterozygous allowed: 0
Missing SNP allowed: 5
Minimum length of the segment: 1000 kb
- Different length classes (1-2, 2-4, 4-8, 8-16, >16 Mbp)
- FROH (the proportion of the autosomal genome covered by ROH)



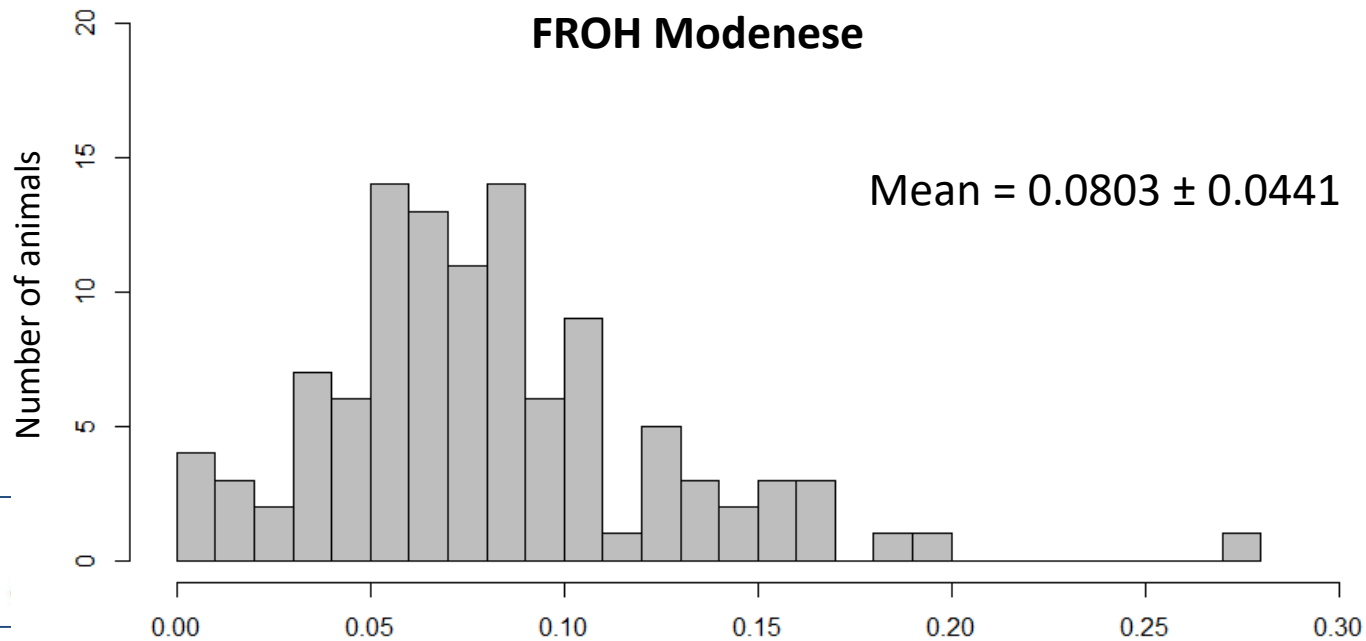
Runs of Homozygosity (ROH)



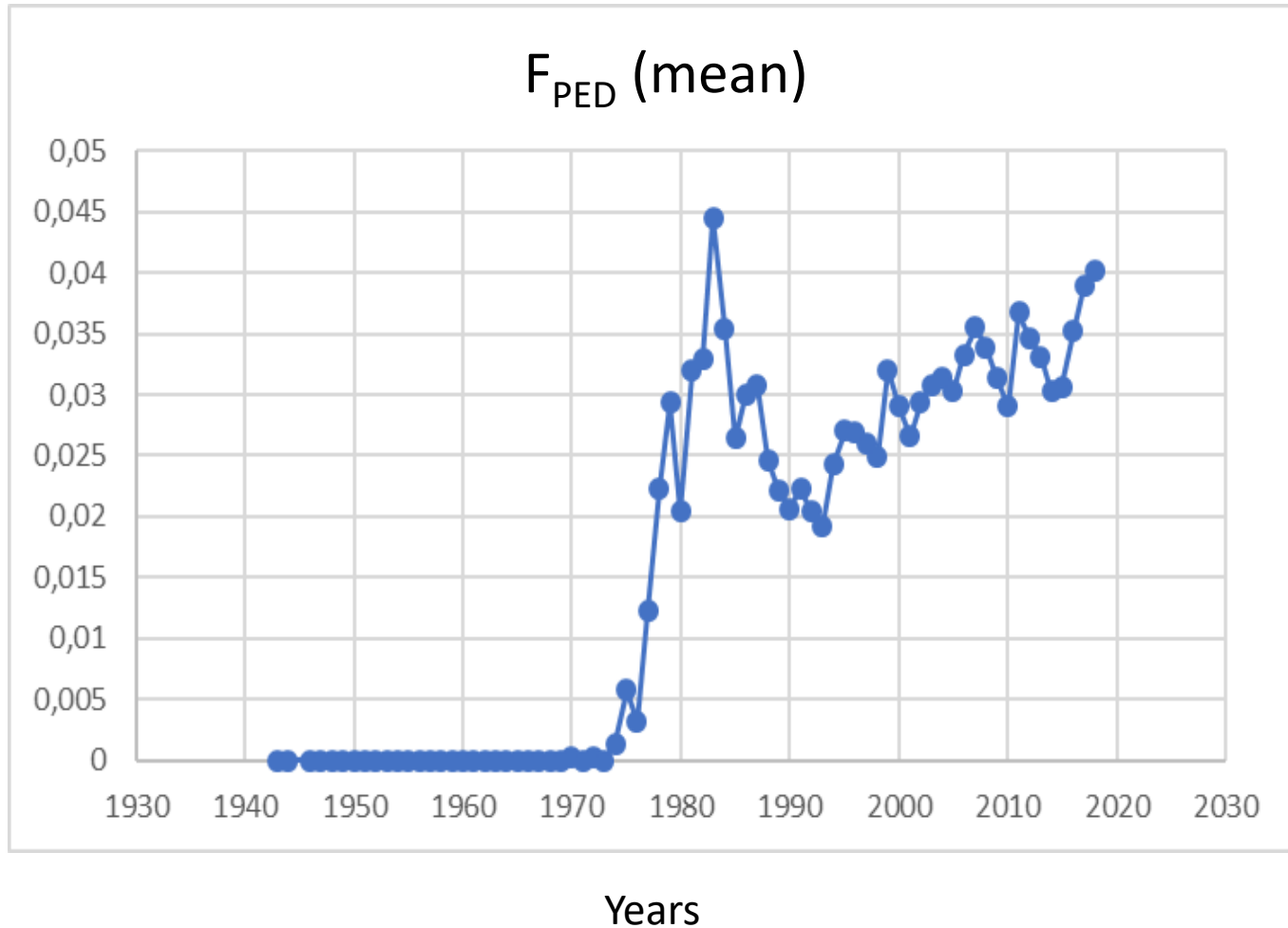
FROH Reggiana



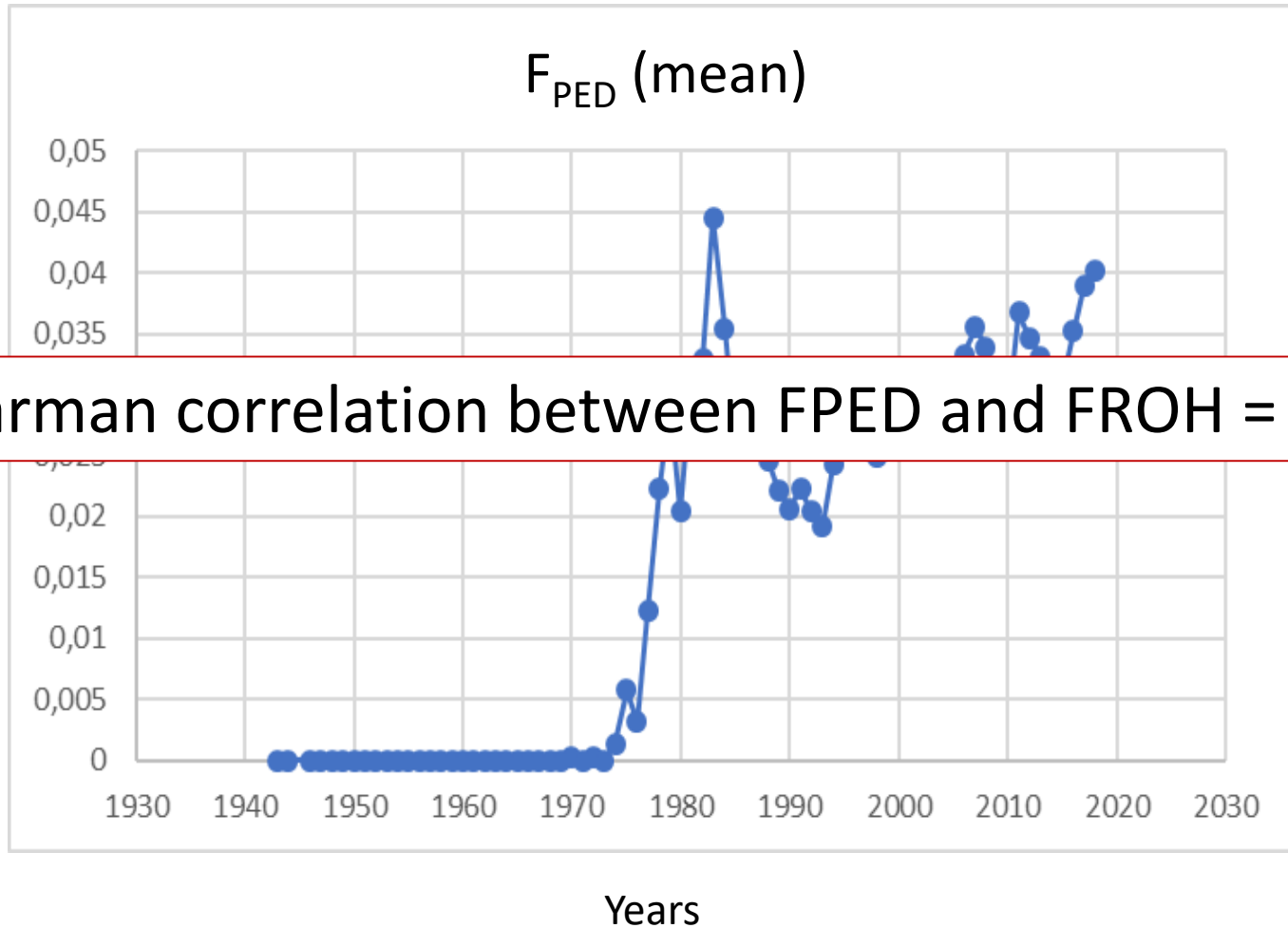
FROH Modenese



Reggiana



Reggiana



Reggiana



Modenese (Bianca Val Padana)



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Reggiana

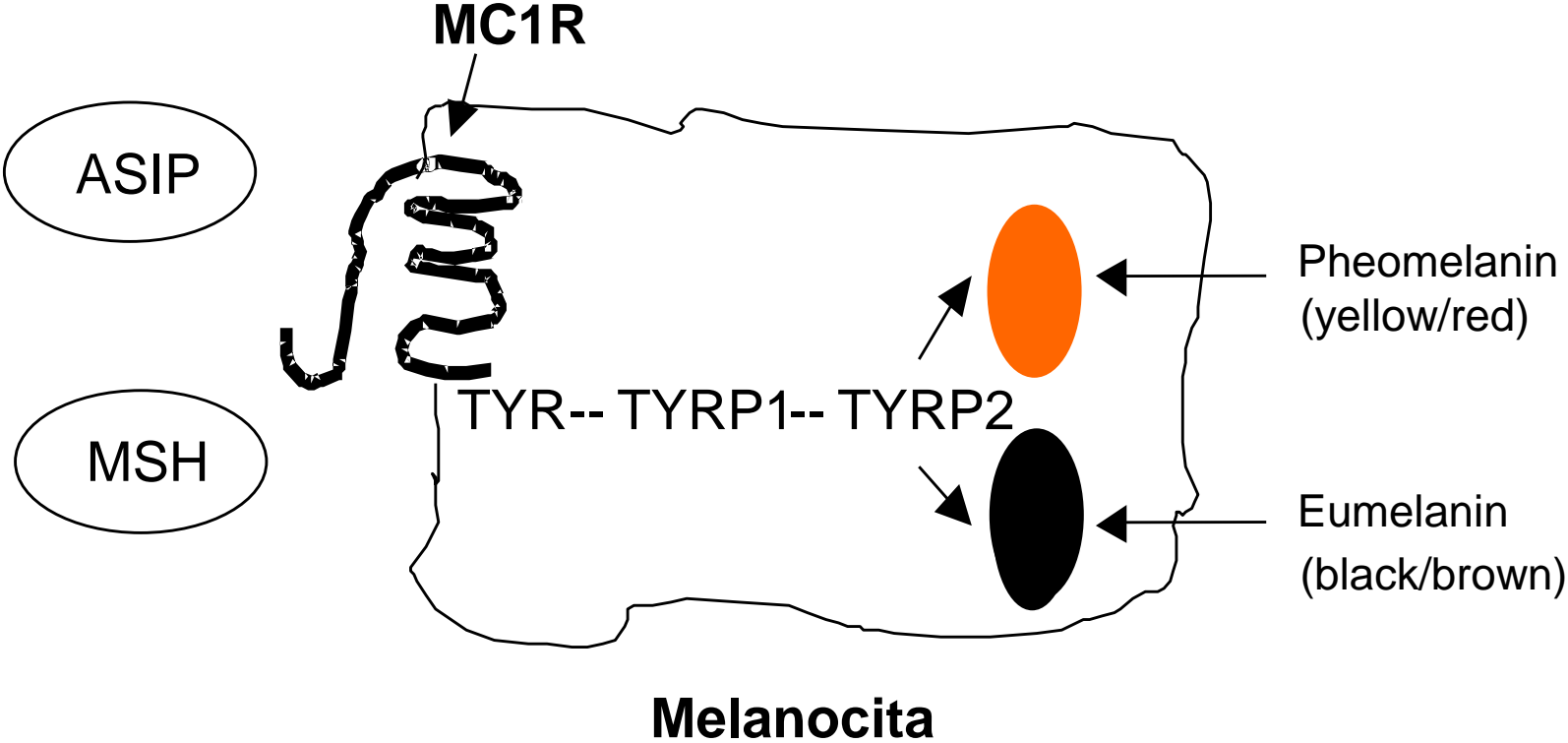


Mono-breed Parmigiano
Reggiano cheese

Frauds are an urgent
problem for the Reggiana
production chain



Breed-specific traits: Coat colour



Holstein



E^d

Brown



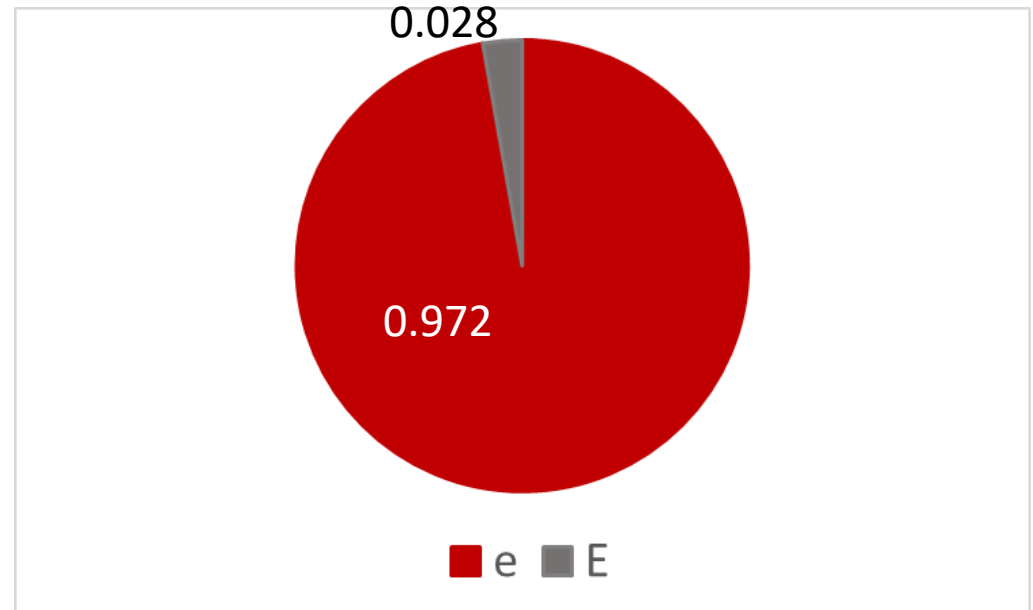
E^+



Reggiana



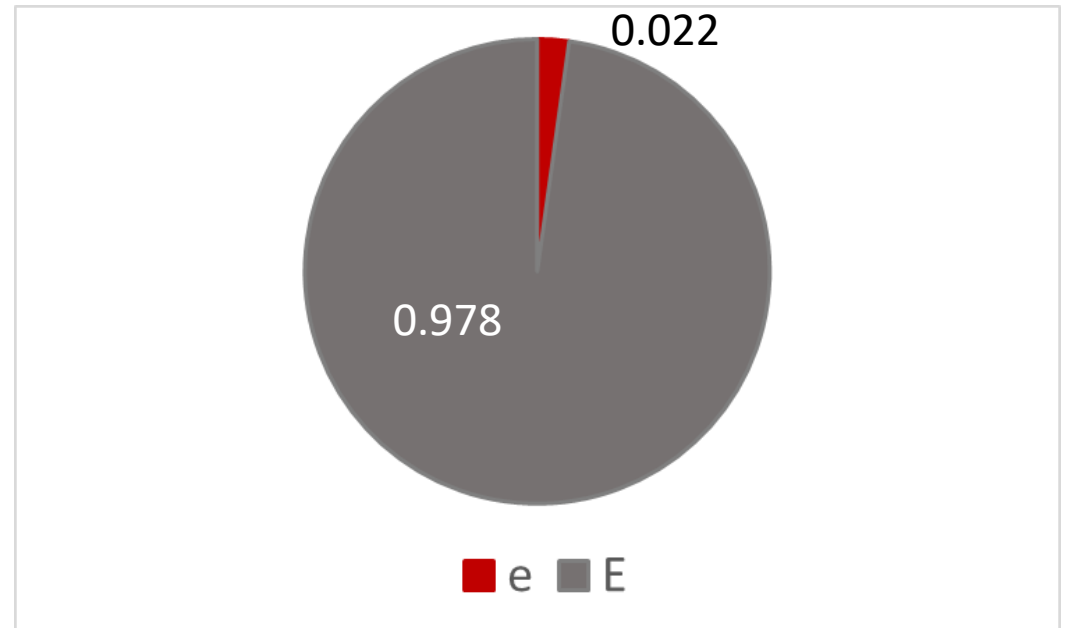
MC1R allele frequencies of the analysed Reggiana cattle



Modenese (Bianca Val Padana)



MC1R allele frequencies of the analysed Modenese cattle



Reggiana



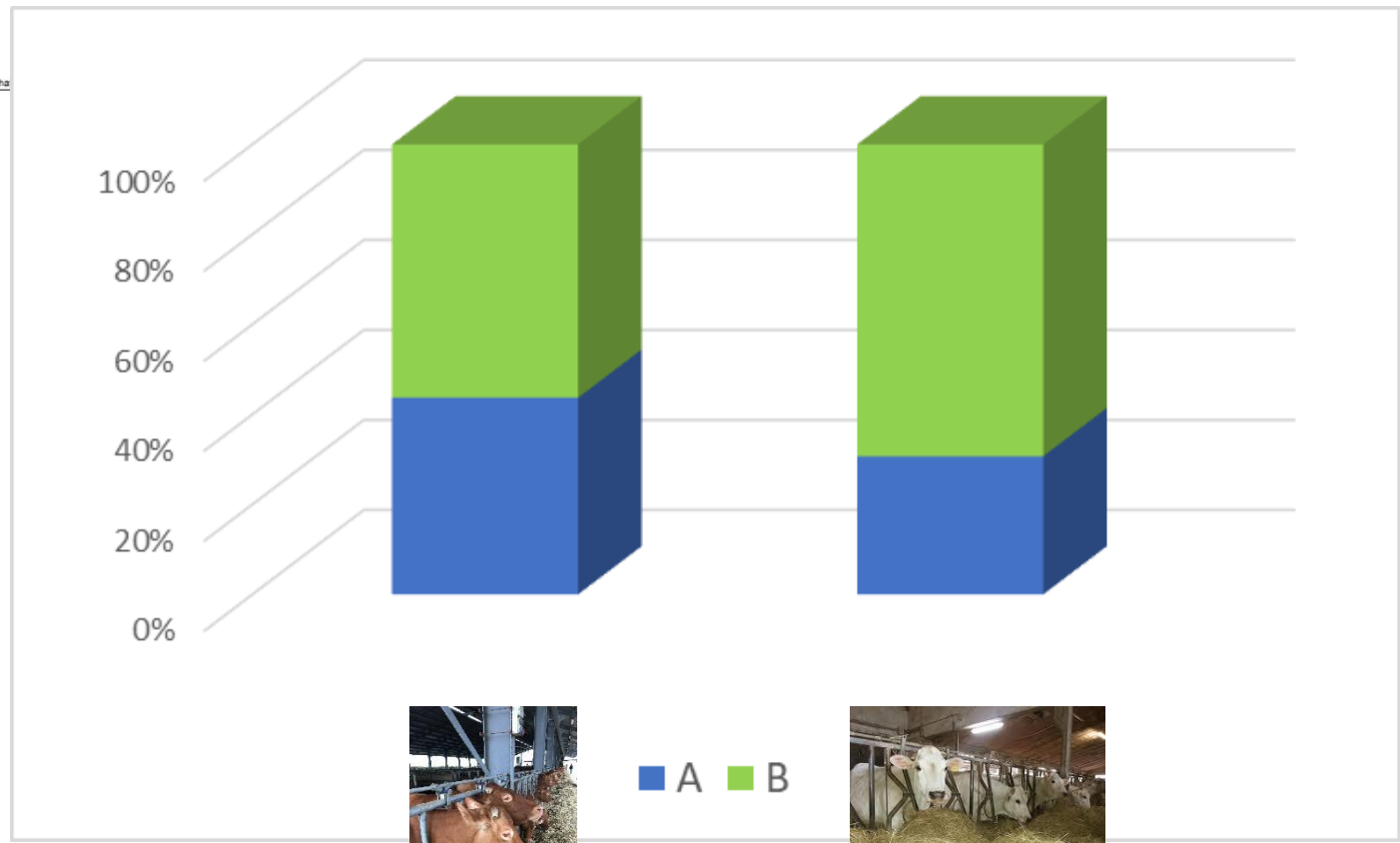
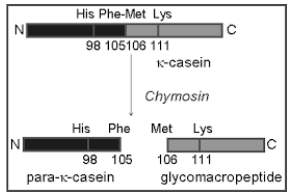
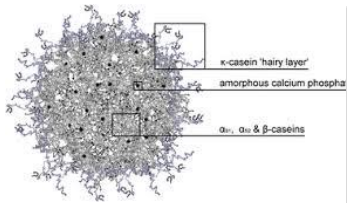
Modenese (Bianca Val Padana)



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Cheese-making properties of the milk: k-casein (*CSN3*) genotypes



■ A ■ B



Conclusions (1)

Reggiana herd book actions

1. For all animal records:
 - Inclusion of FROH in addition to FPED
 - Inclusion of *MC1R* genotype
 - Inclusion of *CSN3* genotype
2. Carriers of other alleles at the *MC1R* gene will not be registered anymore
3. The mono-breed authentication system based on the DNA analysis is driving the Reggiana production chain



Conclusions (2)

4. We are working to implement the use of FROH in mating plans in the Reggiana and Modenese breeds
5. We are working to detect deleterious alleles in the two breeds
6. We are moving from a simple description to the use of genomic variability/information for the sustainable conservation of cattle genetic resources



Acknowledgments

Massimo Bonacini
Roberto Motti
Marco Prandi



Roberto Mantovani



«Fondo europeo agricolo per lo sviluppo rurale: l'Europa investe nelle zone rurali»

Autorità di gestione:



Direzione generale dello sviluppo rurale Ministero delle politiche agricole alimentari e forestali

ANABORARE



Associazione Nazionale Allevatori Bovini di Razza Reggiana



dualbreeding



Thank you!










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MC1R genotypes in different cattle breeds

Breeds	N.	Genotypes (n. of animals)								
		$E^D E^D$	$E^D e$	$E^+ E^+$	$E^+ e$	$E^+ E1$	$E1 E1$	$E1 e$	ee	
Italian Holstein* 	253	209	44	-	-	-	-	-	-	
Italian Brown 	247	-	-	75	4	107	31	7	-	
Italian Simmental 	208	-	-	1	10	-	-	-	197	
Reggiana 	284	-	-	-	-	-	-	-	284	
Modenese 	74	-	-	68	6	-	-	-	-	
Rendena 	84	-	-	43	2	36	3	-	-	
Jersey 	100	-	-	91	9	-	-	-	-	
Total	1250									

(Russo et al. 2007)

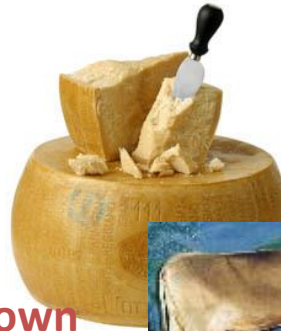


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*Spotted black

Genotypes

$E^+ E^+$
 $E^+ e$
 $E1 E1$
 $E^+ E1$
 $E1 e$



Italian Brown

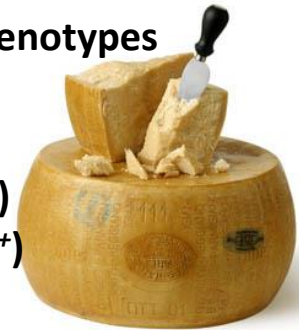


No: $E^+ e$

Genotypes

$e e$
 $(E^+ e)$
 $(E^+ E^+)$

Italian Simmental



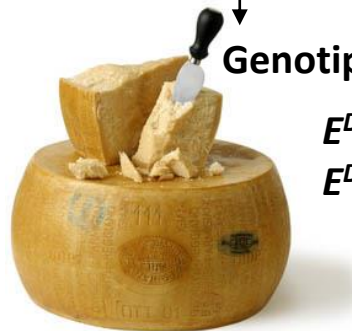
Yes
 E^D

Genotipi

$E^D E^D$
 $E^D e$

Yes
 E^D

Italian Holstein*



Yes
 $E^+ E1$

Genotypes
 $e e$

Reggiana



Yes
 E^D

