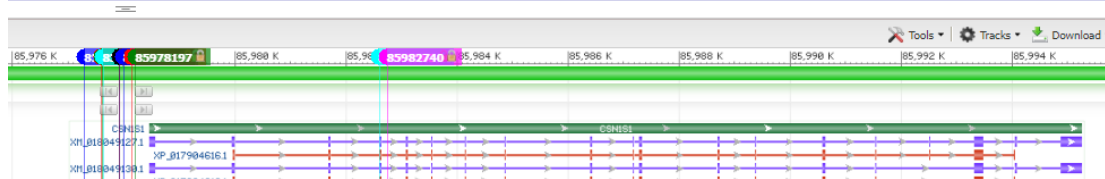
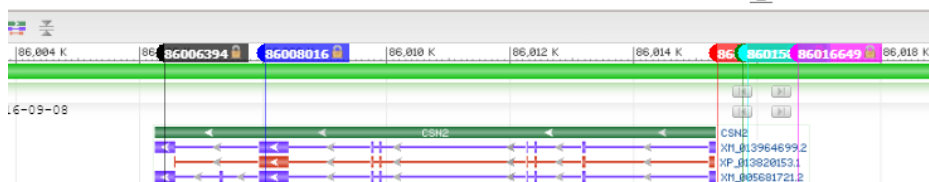


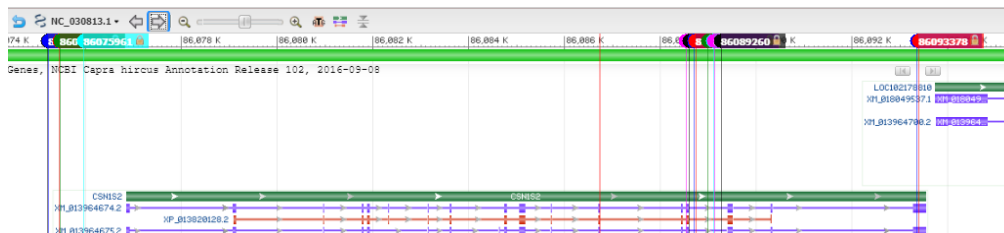
A



B



C



D

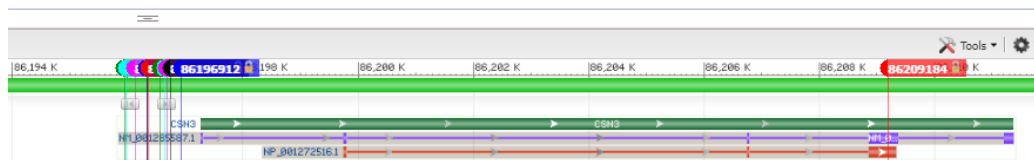


Figure S1. Distribution of SNPs on Casein genes, shown as colored tags, as retrieved from the Genome Data Viewer (<https://www.ncbi.nlm.nih.gov/genome/gdv/?org=capra-hircus>). Horizontal green bars represent the gene sequence. Horizontal purple bars represent mRNA. Vertical purple bars represent exon regions. A, CSN1S1. B, CSN2. C, CSN1S2. D, CSN3

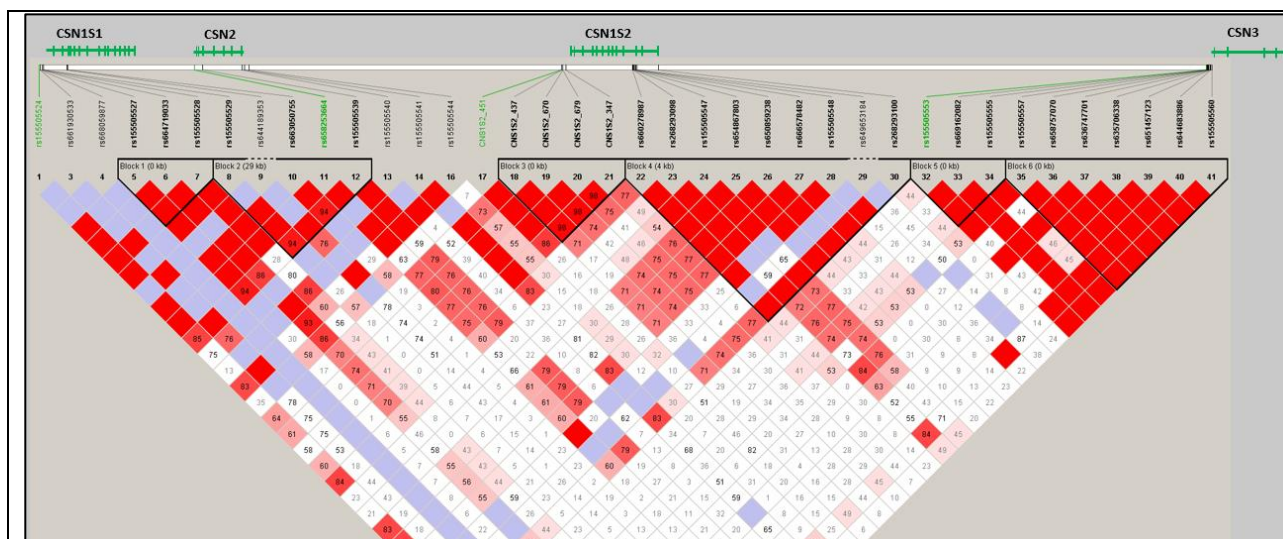


Figure S2. LD structure of the casein gene cluster in a population of 153 Sarda bucks. The structural organization of the four casein genes respects positions on goat chromosome 6, as represented in Genome Data Viewer (<https://www.ncbi.nlm.nih.gov/genome/gdv/?org=capra-hircus>, last accessed on 18 November 2023). LD plot of pairwise normalized coefficient of linkage disequilibrium (D'): coloured in red, $D' = 1.0$ and logarithm of the odds (LOD) ≥ 2.0 ; coloured in light blue, $D' = 1.0$ and LOD < 1.0 and LOD

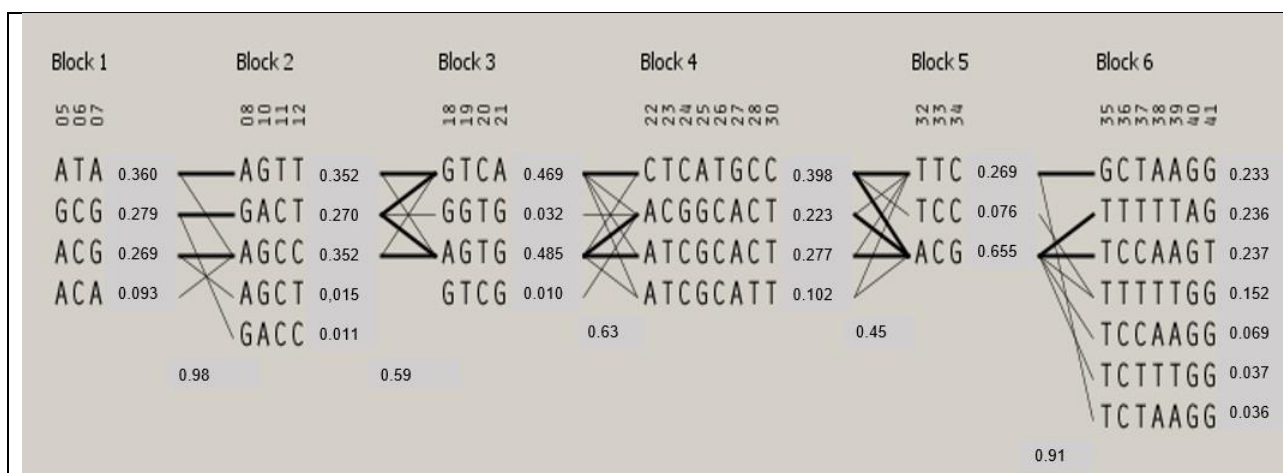


Figure S3. Description of haplotype blocks in 153 Sarda bucks. Haplotype frequencies are reported near each haplotype within a block. For each crossing area, a value of multiallelic normalized coefficient of linkage disequilibrium (D') is given for the haplotypes displayed, which represents the level of recombination between the 2 blocks. SNP numbers are reported in Table 1

Table S1. List of SNPs of 153 Sarda bucks, mapping to the casein genes, with population parameters.

| Gene | # | SNP ID | ObsHET | PredHET | Hwpval | MAF | Alleles |
|--------|----|-------------|--------|---------|---------|------|----------|
| CSN1S1 | 01 | rs155505524 | 0.32 | 0.32 | 1.00 | 0.20 | A:(G) |
| | 03 | rs661930533 | 0.10 | 0.10 | 1.00 | 0.05 | C:(G) |
| | 04 | rs668059877 | 0.01 | 0.01 | 1.00 | 0.01 | A:(G) |
| | 06 | rs155505527 | 0.37 | 0.40 | 0.53 | 0.28 | A:(G) |
| | 07 | rs664719033 | 0.49 | 0.45 | 0.39 | 0.35 | C:(T) |
| | 08 | rs155505528 | 0.49 | 0.50 | 1.00 | 0.45 | G:(A) |
| | 09 | rs155505529 | 0.39 | 0.41 | 0.82 | 0.29 | A:(G) |
| | 10 | rs644189353 | 0.10 | 0.09 | 1.00 | 0.05 | A:(G) |
| | 11 | rs663050755 | 0.39 | 0.41 | 0.67 | 0.28 | G:(A) |
| CSN2 | 12 | rs658253664 | 0.50 | 0.45 | 0.33 | 0.35 | C:(T) |
| | 13 | rs155505539 | 0.49 | 0.46 | 0.57 | 0.36 | T:(C) |
| | 14 | rs155505540 | 0.12 | 0.11 | 1.00 | 0.06 | A:(G) |
| | 15 | rs155505541 | 0.13 | 0.15 | 0.43 | 0.08 | G:(A) |
| | 17 | rs155505544 | 0.52 | 0.49 | 0.62 | 0.44 | C:(T) |
| CSN1S2 | 18 | CNS1S2_451 | 0.18 | 0.23 | 0.04 | 0.13 | C:(T) |
| | 19 | CNS1S2_437 | 0.52 | 0.50 | 0.75 | 0.48 | G:(A) |
| | 20 | CNS1S2_670 | 0.53 | 0.50 | 0.64 | 0.48 | G:(T) |
| | 21 | CNS1S2_679 | 0.52 | 0.50 | 0.70 | 0.49 | T:(C) |
| | 22 | CNS1S2_347 | 0.49 | 0.50 | 1.00 | 0.47 | G:(A) |
| | 23 | rs660278987 | 0.45 | 0.48 | 0.61 | 0.40 | A:(C) |
| | 24 | rs268293098 | 0.34 | 0.34 | 1.00 | 0.22 | T:(C) |
| | 25 | rs155505547 | 0.33 | 0.34 | 0.78 | 0.22 | C:(G) |
| | 26 | rs654867803 | 0.45 | 0.48 | 0.58 | 0.40 | G:(A) |
| | 27 | rs650859238 | 0.46 | 0.48 | 0.62 | 0.40 | C:(T) |
| | 28 | rs666578482 | 0.45 | 0.48 | 0.61 | 0.39 | A:(G) |
| | 29 | rs155505548 | 0.19 | 0.18 | 1.00 | 0.10 | C:(T) |
| | 30 | rs649653184 | 0.02 | 0.02 | 1.00 | 0.01 | A:(G) |
| | 31 | rs268293100 | 0.45 | 0.48 | 0.58 | 0.40 | T:(C) |
| | 32 | rs638259886 | 0.16 | 0.49 | 7.9E-17 | 0.44 | C:(G) |
| CSN3 | 33 | rs155505553 | 0.48 | 0.45 | 0.52 | 0.34 | A:(T) |
| | 34 | rs669162082 | 0.39 | 0.39 | 0.95 | 0.27 | C:(T) |
| | 35 | rs155505555 | 0.47 | 0.45 | 0.86 | 0.34 | G:(C) |
| | 36 | rs155505557 | 0.35 | 0.35 | 0.92 | 0.23 | T:(G) |
| | 37 | rs658757070 | 0.48 | 0.48 | 1.00 | 0.39 | C:(T) |
| | 38 | rs636747701 | 0.40 | 0.42 | 0.62 | 0.30 | T:(C) |
| | 40 | rs635706338 | 0.48 | 0.49 | 0.91 | 0.42 | A:(T) |
| | 41 | rs651457123 | 0.51 | 0.49 | 0.66 | 0.42 | AATC:(_) |
| | 42 | rs644683886 | 0.37 | 0.36 | 0.94 | 0.23 | G:(A) |
| | 43 | rs155505560 | 0.33 | 0.36 | 0.48 | 0.24 | G:(T) |

¹ SNP ID = dbSNP reference records (<https://www.ncbi.nlm.nih.gov/projects/SNP/>)² ObsHET = observed heterozygosity³ PredHET = predicted heterozygosity⁴ HWpval = Hardy-Weinberg test P-value.⁵ MAF = minor allele frequency (minor allele in brackets)

Table S2. Descriptive statistics of milk yield and composition of 825 milk samples of Sarda goat.

| Trait | Mean | SD | Min | Max | CV % |
|--------------|-------|------|-------|-------|------|
| MY | 1.05 | 0.47 | 0.12 | 3.00 | 45 |
| Fat | 5.50 | 1.38 | 1.37 | 9.94 | 25 |
| Protein | 3.99 | 0.48 | 2.77 | 5.54 | 12 |
| Lactose | 4.64 | 0.26 | 3.81 | 5.33 | 6 |
| Total solids | 15.10 | 1.69 | 11.33 | 20.16 | 11 |
| pH | 6.72 | 0.10 | 6.41 | 7.02 | 2 |
| NaCl | 235.0 | 49.4 | 98.0 | 389.7 | 21 |
| SCS | 6.52 | 1.81 | 2.11 | 11.06 | 28 |
| LBC | 1.66 | 0.80 | 0.30 | 4.23 | 48 |
| Milk energy | 3.86 | 0.60 | 2.30 | 5.66 | 16 |

SD, standard deviation; CV %, coefficient of variation

Table S3. Analysis of variance (F-value and significance) of each SNP for milk yield and composition of 825 Sarda does milk samples.

| | SNP ID | MY | Fat | Protein | Lactose | Total solids | pH | SCS | LBC | NaCl | Milk energy |
|---------------|-------------|------|-------|---------|---------|--------------|------|-------|-----|-------|-------------|
| <i>CSN1S1</i> | rs155505524 | 0.7 | 1.0 | 1.8 | 2.7 | 0.5 | 1.7 | 0.2 | 0.0 | 0.4 | 1.2 |
| | CSN1S1_419 | 2.7 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.2 | 0.4 | 0.0 |
| | rs661930533 | 0.2 | 1.4 | 0.1 | 0.7 | 1.1 | 1.7 | 0.2 | 0.2 | 0.2 | 1.3 |
| | rs668059877 | 0.0 | 0.1 | 1.0 | 1.2 | 0.8 | 1.1 | 3.1 | 1.8 | 1.5 | 0.4 |
| | rs155505526 | 0.8 | 3.8* | 2.8 | 0.1 | 4.5* | 1.9 | 0.1 | 0.0 | 0.1 | 4.4* |
| | rs155505527 | 2.7 | 0.7 | 0.3 | 0.1 | 0.5 | 0.4 | 1.6 | 1.2 | 0.2 | 1.1 |
| | rs664719033 | 0.7 | 4.5* | 13.8*** | 0.1 | 7.4*** | 1.0 | 1.6 | 1.9 | 4.6* | 7.4*** |
| | rs155505528 | 1.0 | 6.9** | 10.7*** | 0.0 | 9.8*** | 1.0 | 0.5 | 2.2 | 3.1* | 9.8*** |
| | rs155505529 | 2.6 | 0.6 | 0.5 | 0.0 | 0.4 | 0.2 | 1.5 | 1.2 | 0.0 | 0.9 |
| | rs644189353 | 0.6 | 1.3 | 0.2 | 0.9 | 1.2 | 1.7 | 0.3 | 0.2 | 0.5 | 1.3 |
| | rs663050755 | 2.7 | 0.6 | 0.4 | 0.2 | 0.5 | 0.4 | 1.6 | 1.0 | 0.3 | 1.0 |
| <i>CSN2</i> | rs658253664 | 0.9 | 4.8** | 13.5*** | 0.0 | 7.4*** | 1.7 | 1.7 | 2.3 | 4.1* | 7.5*** |
| | rs155505539 | 1.0 | 0.9 | 5.2** | 0.3 | 2.2 | 0.9 | 4.3** | 1.5 | 2.7* | 1.2 |
| | rs155505540 | 0.6 | 0.4 | 0.3 | 0.4 | 0.7 | 2.1 | 0.0 | 0.1 | 0.1 | 0.5 |
| | rs155505541 | 1.4 | 4.6* | 6.1** | 0.2 | 5.8** | 1.6 | 0.6 | 0.7 | 4.0* | 5.3** |
| | rs639868773 | 2.6 | 0.0 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.2 | 0.4 | 0.0 |
| | rs155505544 | 1.4 | 5.0** | 8.8*** | 0.5 | 6.7** | 1.1 | 2.8 | 2.4 | 4.9** | 6.3** |
| <i>CSN1S2</i> | CNS1S2_451 | 1.4 | 0.3 | 1.4 | 2.8 | 0.5 | 1.8 | 0.7 | 1.2 | 1.9 | 0.5 |
| | CNS1S2_437 | 1.2 | 2.7 | 12.0*** | 1.1 | 5.0** | 2.1 | 1.9 | 0.4 | 2.2 | 4.9** |
| | CNS1S2_670 | 1.3 | 3.0 | 12.8*** | 1.3 | 5.1** | 3.4* | 0.9 | 0.4 | 1.1 | 5.5** |
| | CNS1S2_679 | 1.5 | 2.8 | 12.7*** | 1.0 | 5.0** | 3.4* | 1.1 | 0.3 | 1.3 | 5.2** |
| | CNS1S2_347 | 1.6 | 2.5 | 11.2*** | 0.7 | 4.4* | 2.8 | 1.4 | 0.4 | 1.1 | 4.6* |
| | rs660278987 | 3.8* | 5.2** | 13.8*** | 2.7 | 7.8*** | 4.2* | 6.1** | 0.8 | 4.8** | 8.3*** |
| | rs268293098 | 1.1 | 1.3 | 2.8 | 2.9 | 2.6 | 4.2* | 3.3* | 0.3 | 1.2 | 2.3 |
| | rs155505547 | 1.1 | 1.2 | 3.4* | 2.9 | 2.7 | 3.9* | 3.3* | 0.8 | 1.6 | 2.2 |
| | rs654867803 | 4.4* | 5.9** | 13.5*** | 3.3* | 8.7*** | 4.2* | 6.4** | 0.8 | 4.8** | 9.3*** |
| | rs650859238 | 3.5* | 5.1** | 13.6*** | 2.2 | 8.1*** | 3.7* | 5.5** | 0.9 | 4.3* | 8.4*** |
| | rs666578482 | 3.7* | 4.6* | 13.4*** | 2.5 | 7.5*** | 3.7* | 5.9** | 0.8 | 4.5* | 7.8*** |
| | rs155505548 | 0.2 | 0.6 | 0.7 | 0.3 | 1.1 | 0.8 | 0.4 | 1.7 | 0.5 | 0.8 |

| | | | | | | | | | | | |
|------------------|-------------|------|-------|---------|------|--------|------|-------|-----|-------|---------|
| | rs649653184 | 0.0 | 0.0 | 0.8 | 0.0 | 0.3 | 0.0 | 0.4 | 0.0 | 1.9 | 0.3 |
| | rs268293100 | 3.2* | 3.6* | 8.8*** | 1.7 | 1.8 | 3.3* | 4.6** | 1.5 | 3.3* | 5.6*** |
| | rs638259886 | 4.1* | 6.8** | 11.1*** | 2.4 | 9.9*** | 3.0* | 5.8** | 0.5 | 5.0** | 10.1*** |
| CSN3 | rs155505553 | 1.2 | 2.4 | 1.5 | 1.3 | 2.2 | 0.0 | 0.3 | 0.6 | 0.6 | 3.3* |
| | rs669162082 | 1.1 | 3.2* | 6.1** | 0.0 | 5.2** | 0.2 | 0.4 | 0.3 | 0.6 | 4.8** |
| | rs155505555 | 1.0 | 2.6 | 1.4 | 1.2 | 2.3 | 0.0 | 0.4 | 0.6 | 0.6 | 3.5* |
| | rs155505557 | 0.2 | 0.9 | 2.5 | 0.6 | 2.0 | 1.2 | 1.2 | 1.6 | 1.8 | 1.7 |
| | rs658757070 | 1.0 | 1.5 | 12.9*** | 1.2 | 4.3* | 1.6 | 2.0 | 0.3 | 3.3* | 3.3* |
| | rs636747701 | 0.4 | 0.0 | 2.3 | 0.4 | 0.2 | 0.2 | 1.9 | 0.3 | 1.0 | 0.1 |
| | rs666872112 | 2.2 | 2.6 | 2.5 | 0.4 | 2.7 | 0.8 | 0.1 | 1.0 | 0.1 | 2.9 |
| | rs635706338 | 1.0 | 1.2 | 10.6*** | 0.3 | 3.5* | 0.3 | 1.0 | 0.2 | 2.1 | 2.6 |
| | rs651457123 | 1.5 | 1.2 | 11.2*** | 0.7 | 3.7* | 0.9 | 1.2 | 0.0 | 2.8 | 2.8 |
| | rs644683886 | 1.9 | 3.1* | 6.7** | 0.1 | 4.1* | 1.8 | 1.1 | 2.4 | 1.2 | 4.6** |
| | rs155505560 | 1.9 | 0.8 | 1.8 | 2.2 | 1.6 | 2.7 | 3.9* | 0.5 | 2.1 | 1.5 |
| | rs268293114 | 1.4 | 2.0 | 1.7 | 0.2 | 1.8 | 1.2 | 0.4 | 1.5 | 0.2 | 2.0 |
| Haplotype Blocks | Block 1 | 1.1 | 2.2 | 13.6*** | 0.4 | 5.4* | 0.7 | 1.5 | 2.8 | 1.5 | 4.5* |
| | Block 2 | 0.3 | 1.0 | 3.3* | 3.9* | 2.1 | 1.4 | 0.3 | 0.5 | 4.3* | 1.4 |
| | Block 3 | 0.0 | 0.8 | 15.1*** | 0.0 | 1.9 | 6.4* | 0.2 | 0.1 | 1.5 | 3.6 |
| | Block 4 | 0.0 | 0.5 | 5.1* | 0.3 | 1.6 | 4.2* | 3.8 | 0.2 | 0.2 | 1.7 |
| | Block 5 | 0.2 | 0.7 | 3.3 | 1.8 | 2.0 | 0.1 | 0.0 | 0.5 | 0.6 | 1.6 |

* = P < 0.05; ** = P < 0.01; *** = P < 0.001