# Genetic structure of five autochthonous and three commercial pig breeds using a high-density SNP chip

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# INTRODUCTION

Genetic markers are widely used in the main European pig breeds

- To analyze population structures
- To characterize genetic relationships and diversity

Few studies in autochthonous European breeds

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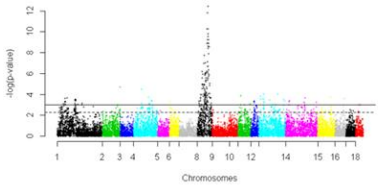
# INTRODUCTION

Potential **applications** of genomic characterization

1. Knowledge of potentially negative alleles

2. Genetic basis of specific traits




3. Development of traceability panels

*4. in-situ* management of genetic resources improves utilization of local breeds

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# OBJECTIVE

Characterization of the genetic relationships and diversity between 20 autochthonous European and five commercial pig breeds

Pilot Study

Iberian, Krskopolje, Casertana, Cinta Senese, Apulo Calabrese, Duroc, Large White and Landrace breeds

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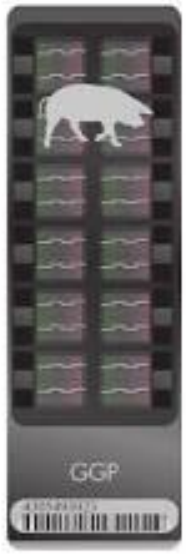
# GENOTYPING

GeneSeek® Genomic Profiler™ for Porcine HD

| Breed | N |
|---|---|
| Apulo Calabrese | 5 |
| Casertana | 5 |
| Cinta Senese | 5 |
| Duroc | 5 |
| Iberian | 12 |
| Krskopolje | 4 |
| Landrace | 4 |
| Large White | 4 |
| Total | 44 |




- 68,528 SNPs
- Evenly distributed median 25kb gap spacing
- 43k from the PorcineSNP60 BeadChip

Quality control (QC): plink

% missing values <2%

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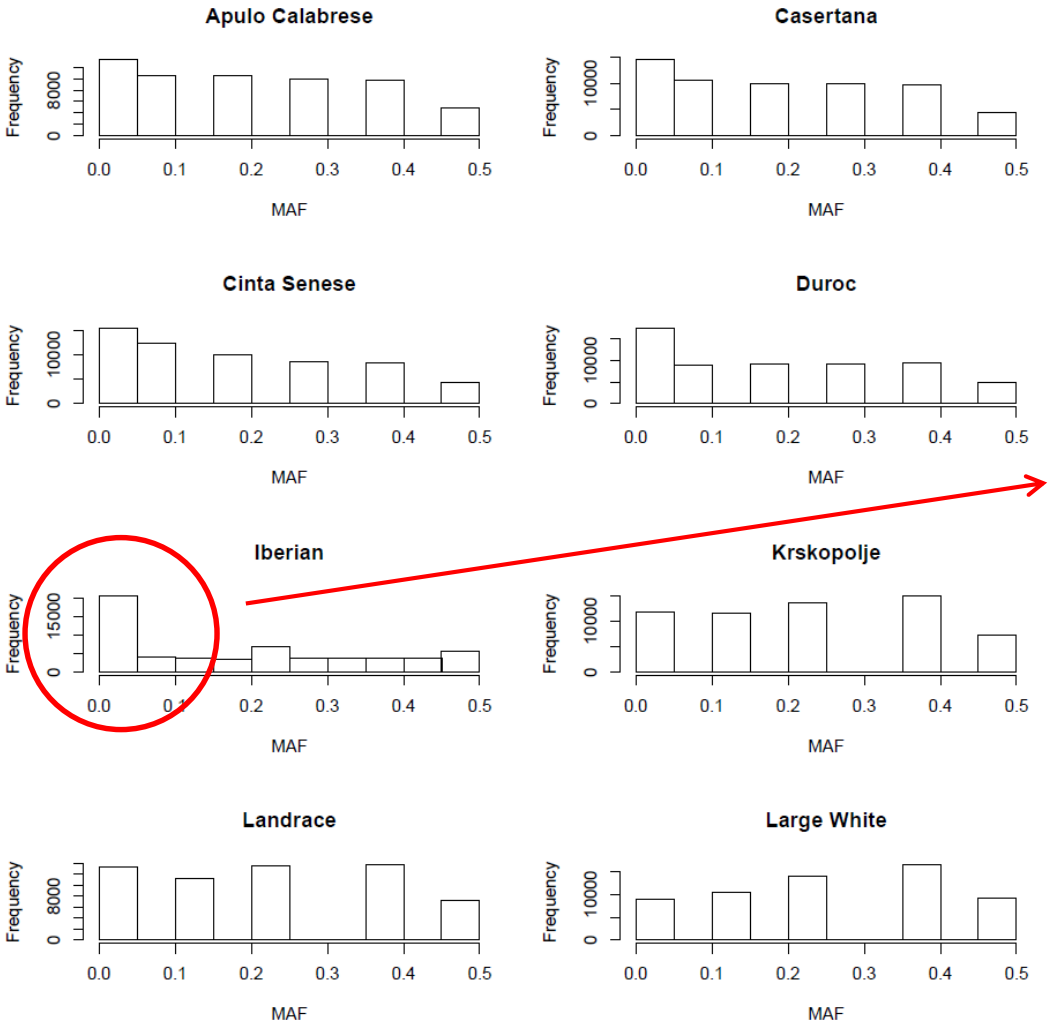
# RESULTS

59,193 with % missing values <2%




Highest number of monomorphic SNPs (25.3%)

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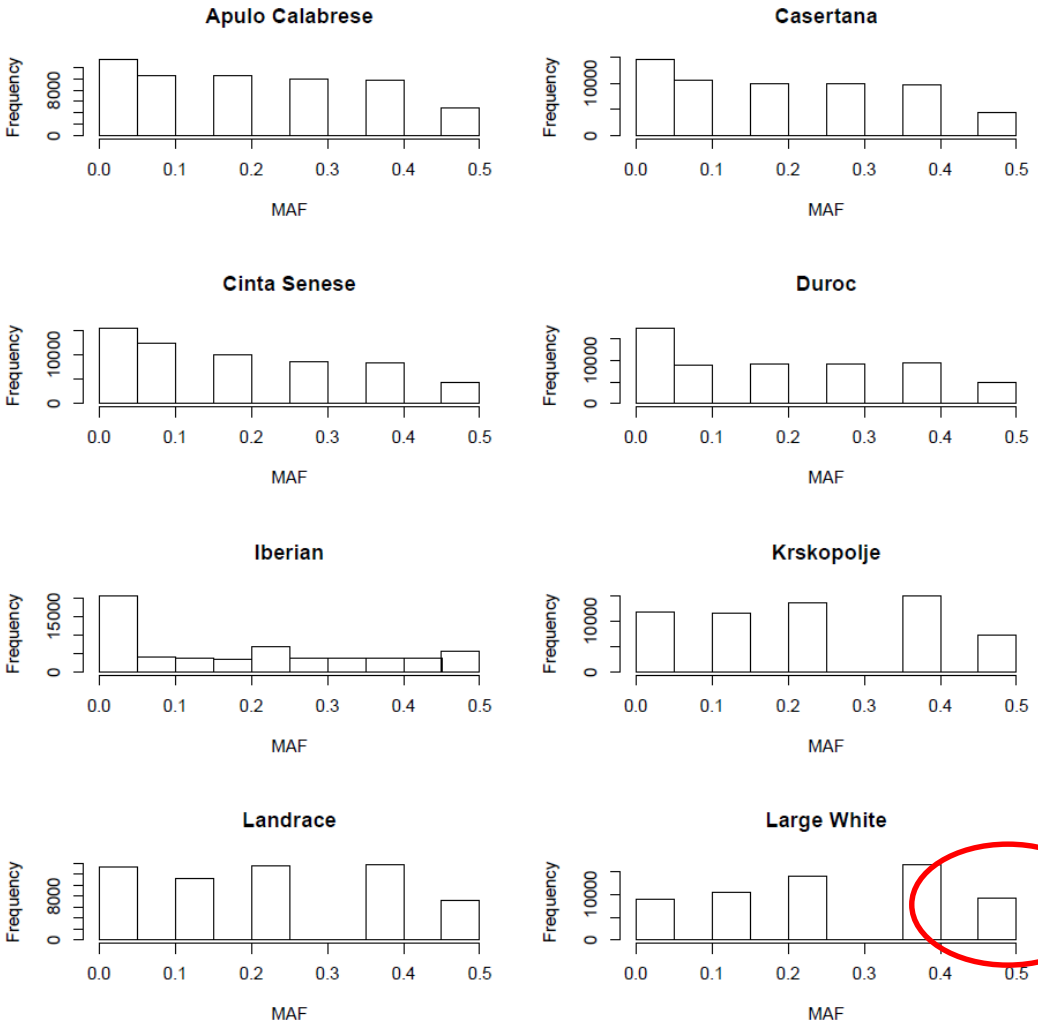
# RESULTS

59,193 with % missing values <2%




9,229 SNPs

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# RESULTS

Library hierfstat (R)

| | Ho | Hs | Fis |
|---|---|---|---|
| Apulo Calabrese | 0.251 | 0.319 | 0.164 |
| Casertana | 0.249 | 0.310 | 0.147 |
| Cinta Senese | 0.289 | 0.285 | -0.026 |
| Duroc | 0.287 | 0.288 | -0.012 |
| Iberian | 0.230 | 0.262 | 0.102 |
| Krskopolje | 0.348 | 0.355 | -0.013 |
| Landrace | 0.360 | 0.337 | -0.086 |
| Large White | 0.320 | 0.396 | 0.130 |

Highest Ho in Landrace & lowest in Iberian

Highest Fis in Apulo Calabrese & lowest in Duroc

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# RESULTS

Genetic Distance: Ds (Nei's standard genetic distance)

| | Calabrese | Casertana | Cinta Senese | Duroc | Iberian | Krskopolje | Landrace | Large White |
|---|---|---|---|---|---|---|---|---|
| Calabrese | 0 | | | | | | | |
| Casertana | 0.15 | 0 | | | | | | |
| Cinta Senese | 0.15 | 0.15 | 0 | | | | | |
| Duroc | 0.20 | 0.20 | 0.19 | 0 | | | | |
| Iberian | 0.13 | 0.14 | 0.10 | 0.18 | 0 | | | |
| Krskopolje | 0.14 | 0.15 | 0.14 | 0.17 | 0.13 | 0 | | |
| Landrace | 0.15 | 0.15 | 0.16 | 0.22 | 0.15 | 0.14 | 0 | |
| Large White | 0.14 | 0.15 | 0.14 | 0.09 | 0.14 | 0.13 | 0.15 | 0 |

Genetic Distance: Fst

| | Calabrese | Casertana | Cinta Senese | Duroc | Iberian | Krskopolje | Landrace | Large White |
|---|---|---|---|---|---|---|---|---|
| Calabrese | 0 | | | | | | | |
| Casertana | 0.27 | 0 | | | | | | |
| Cinta Senese | 0.27 | 0.28 | 0 | | | | | |
| Duroc | 0.33 | 0.34 | 0.33 | 0 | | | | |
| Iberian | 0.26 | 0.27 | 0.22 | 0.32 | 0 | | | |
| Krskopolje | 0.24 | 0.25 | 0.25 | 0.29 | 0.24 | 0 | | |
| Landrace | 0.27 | 0.26 | 0.28 | 0.34 | 0.27 | 0.23 | 0 | |
| Large White | 0.23 | 0.24 | 0.24 | 0.17 | 0.24 | 0.20 | 0.23 | 0 |

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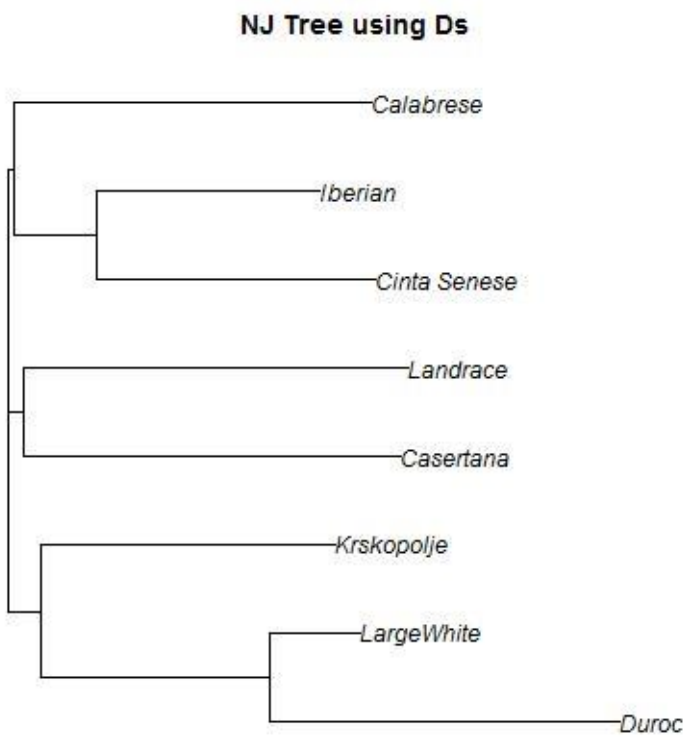
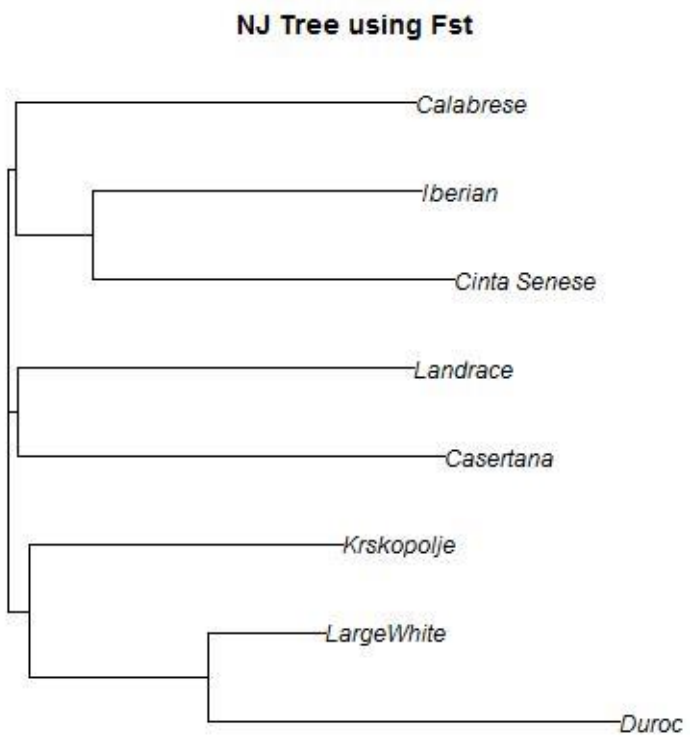
# RESULTS

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# SOME RESULTS ALL BREEDS

| Breeds | Code | Number of succesfully genotyped animals with 70K SNP chip |
|---|---|---|
| Alentejano | AL | 48 |
| Basque | BA | 39 |
| Bisaro | BI | 49 |
| Calabrese | CA | 53 |
| Casertana | CS | 54 |
| Cinta Senese | CI | 54 |
| Crna Slavonska | CR | 49 |
| Duroc | DU | 5 |
| Gascon | GA | 48 |
| Iberian | IB | 49 |
| Kroskopolje | KR | 52 |
| Landrace | LA | 4 |
| Large White | LW | 4 |
| Lietuvos Vietines | LI | 48 |
| Mangulica | MA | 50 |
| Mora Romagnola | MR | 48 |
| Moravka | MO | 50 |
| Nero Siciliano | NS | 50 |
| Porc Negre Mallorquí | PN | 48 |
| Sarda | SA | 48 |
| Schwabisch Hallisches | SH | 49 |
| Senojo Tipo Lietuvos Vietines | SE | 51 |
| Turopojle | TU | 50 |
| Wild Boar | WB | 7 |

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# SOME RESULTS ALL BREEDS

MAF>0.01 & missing values< 0.1  51,221 SNPs were located in Ssc11.1 autosomes

| | MAF range values | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Breed** | 0-0.05 | 0.05-0.10 | 0.10-0.15 | 0.15-0.20 | 0.20-0.25 | 0.25-0.30 | 0.30-0.35 | 0.35-0.40 | 0.40-0.45 | 0.45-0.50 |
| **AL** | 18247 | 5800 | 4521 | 4426 | 4660 | 3757 | 4750 | 5046 | 4934 | 4311 |
| **BA** | 20434 | 6185 | 5575 | 4783 | 4357 | 4194 | 3802 | 3959 | 3580 | 3583 |
| **BI** | 4134 | 4830 | 5255 | 5933 | 6338 | 6615 | 6989 | 7030 | 7048 | 6280 |
| **CA** | 10786 | 6265 | 5159 | 6399 | 4770 | 4537 | 5966 | 5169 | 5135 | 6266 |
| **CS** | 8187 | 4816 | 5593 | 5497 | 6417 | 5598 | 6174 | 6432 | 5599 | 6139 |
| **CI** | 8379 | 7954 | 8017 | 5989 | 6141 | 4516 | 4561 | 5233 | 4618 | 5044 |
| **CR** | 5348 | 5019 | 5381 | 5992 | 6055 | 6290 | 6469 | 6741 | 6965 | 6192 |
| **DU** | 16254 | 9427 | 177 | 9567 | 195 | 9518 | 77 | 10076 | 0 | 5161 |
| **GA** | 12192 | 5098 | 5574 | 5328 | 5182 | 4345 | 6206 | 5917 | 5533 | 5077 |
| **IB** | 16255 | 6189 | 4581 | 4566 | 4671 | 4704 | 4847 | 4871 | 5133 | 4635 |
| **WB** | 18233 | 6326 | 5939 | 234 | 6172 | 6404 | 173 | 6717 | 6832 | 3421 |
| **KR** | 4921 | 4162 | 4981 | 5501 | 6194 | 6396 | 6807 | 7388 | 7595 | 6507 |
| **LA** | 11868 | 0 | 11782 | 122 | 14243 | 0 | 123 | 14580 | 0 | 7732 |
| **LW** | 7069 | 0 | 10998 | 151 | 14779 | 0 | 200 | 17434 | 0 | 9820 |
| **LI** | 8726 | 4567 | 5135 | 5732 | 5656 | 4923 | 6239 | 6657 | 6700 | 6117 |
| **MA** | 19086 | 4917 | 4787 | 4540 | 4537 | 4578 | 4777 | 4673 | 4415 | 4142 |
| **MR** | 22286 | 5509 | 6264 | 4933 | 4217 | 2713 | 3803 | 3723 | 3677 | 3327 |
| **MO** | 5226 | 4849 | 5734 | 5757 | 6062 | 6248 | 6834 | 6732 | 6931 | 6079 |
| **NS** | 3604 | 5057 | 5854 | 6419 | 6331 | 6499 | 6562 | 6821 | 6938 | 6367 |
| **PN** | 12377 | 7783 | 5741 | 5273 | 5067 | 4078 | 5094 | 5266 | 5095 | 4678 |
| **SA** | 1542 | 3500 | 4988 | 5929 | 6718 | 6786 | 7724 | 7906 | 8069 | 7290 |
| **SH** | 6718 | 4552 | 4857 | 5314 | 5782 | 6305 | 6392 | 6652 | 7030 | 6850 |
| **SE** | 6761 | 4688 | 5085 | 5631 | 5937 | 5179 | 6873 | 7043 | 6928 | 6327 |
| **TU** | 29743 | 4809 | 4619 | 4418 | 3141 | 3344 | 2988 | 2521 | 2438 | 2431 |

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# SOME RESULTS ALL BREEDS

| | HO | HE | FIS |
|---|---|---|---|
| **Alentejano** | 0.248 | 0.259 | 0.041 |
| **Basque** | 0.240 | 0.233 | -0.026 |
| **Bisaro** | 0.338 | 0.355 | 0.046 |
| **Calabrese** | 0.258 | 0.305 | 0.138 |
| **Casertana** | 0.294 | 0.326 | 0.087 |
| **Cinta** | 0.299 | 0.300 | 0.012 |
| **Crna** | 0.332 | 0.346 | 0.040 |
| **Duroc** | 0.300 | 0.270 | -0.109 |
| **Gascon** | 0.299 | 0.298 | -0.005 |
| **Iberico** | 0.251 | 0.270 | 0.077 |
| **Wild Boar** | 0.240 | 0.254 | 0.041 |
| **Krskopolje** | 0.363 | 0.361 | -0.003 |
| **Landrace** | 0.372 | 0.310 | -0.194 |
| **Lietuvos** | 0.354 | 0.331 | -0.066 |
| **Large White** | 0.336 | 0.350 | 0.016 |
| **Mangulica** | 0.257 | 0.259 | 0.005 |
| **Mora** | 0.230 | 0.220 | -0.039 |
| **Moravka** | 0.349 | 0.353 | 0.012 |
| **Nero Siciliano** | 0.342 | 0.359 | 0.050 |
| **Porc negre** | 0.279 | 0.285 | 0.015 |
| **Sarda** | 0.360 | 0.383 | 0.056 |
| **Schwabisch** | 0.351 | 0.346 | -0.006 |
| **Senojo** | 0.358 | 0.341 | -0.049 |
| **Turopolje** | 0.195 | 0.187 | 0.046 |

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# SOME RESULTS ALL BREEDS

| | AL | BA | BI | CA | CS | CI | CR | DU | GA | IB | WB | KR | LA | LW | LI | MA | MR | MO | NS | PC | SA | SH | SE |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AL | | | | | | | | | | | | | | | | | | | | | | | |
| BA | 0,41 | | | | | | | | | | | | | | | | | | | | | | |
| BI | 0,39 | 0,48 | | | | | | | | | | | | | | | | | | | | | |
| CA | 0,46 | 0,55 | 0,51 | | | | | | | | | | | | | | | | | | | | |
| CS | 0,42 | 0,51 | 0,47 | 0,54 | | | | | | | | | | | | | | | | | | | |
| CI | 0,35 | 0,45 | 0,41 | 0,48 | 0,44 | | | | | | | | | | | | | | | | | | |
| CR | 0,36 | 0,46 | 0,42 | 0,49 | 0,45 | 0,38 | | | | | | | | | | | | | | | | | |
| DU | 0,52 | 0,61 | 0,57 | 0,64 | 0,60 | 0,53 | 0,54 | | | | | | | | | | | | | | | | |
| GA | 0,41 | 0,46 | 0,46 | 0,54 | 0,49 | 0,43 | 0,44 | 0,60 | | | | | | | | | | | | | | | |
| IB | 0,28 | 0,42 | 0,39 | 0,46 | 0,42 | 0,35 | 0,37 | 0,51 | 0,41 | | | | | | | | | | | | | | |
| WB | 0,37 | 0,49 | 0,46 | 0,53 | 0,49 | 0,41 | 0,43 | 0,59 | 0,48 | 0,37 | | | | | | | | | | | | | |
| KR | 0,40 | 0,48 | 0,44 | 0,51 | 0,47 | 0,41 | 0,42 | 0,56 | 0,46 | 0,40 | 0,46 | | | | | | | | | | | | |
| LA | 0,40 | 0,49 | 0,43 | 0,51 | 0,47 | 0,42 | 0,42 | 0,59 | 0,46 | 0,41 | 0,47 | 0,44 | | | | | | | | | | | |
| LW | 0,40 | 0,48 | 0,44 | 0,51 | 0,47 | 0,42 | 0,42 | 0,58 | 0,46 | 0,40 | 0,47 | 0,44 | 0,45 | | | | | | | | | | |
| LI | 0,49 | 0,58 | 0,53 | 0,60 | 0,56 | 0,50 | 0,51 | 0,56 | 0,55 | 0,49 | 0,56 | 0,53 | 0,55 | 0,53 | | | | | | | | | |
| MA | 0,33 | 0,44 | 0,41 | 0,48 | 0,44 | 0,37 | 0,38 | 0,54 | 0,43 | 0,34 | 0,40 | 0,42 | 0,43 | 0,42 | 0,51 | | | | | | | | |
| MR | 0,47 | 0,58 | 0,53 | 0,60 | 0,56 | 0,49 | 0,51 | 0,60 | 0,56 | 0,48 | 0,54 | 0,53 | 0,54 | 0,53 | 0,59 | 0,50 | | | | | | | |
| MO | 0,37 | 0,46 | 0,42 | 0,49 | 0,45 | 0,39 | 0,39 | 0,55 | 0,44 | 0,37 | 0,43 | 0,42 | 0,42 | 0,42 | 0,51 | 0,38 | 0,51 | | | | | | |
| NS | 0,33 | 0,43 | 0,40 | 0,47 | 0,43 | 0,36 | 0,37 | 0,53 | 0,41 | 0,34 | 0,40 | 0,40 | 0,40 | 0,40 | 0,49 | 0,36 | 0,49 | 0,37 | | | | | |
| PN | 0,31 | 0,42 | 0,39 | 0,46 | 0,42 | 0,35 | 0,37 | 0,52 | 0,41 | 0,32 | 0,38 | 0,40 | 0,40 | 0,40 | 0,49 | 0,34 | 0,48 | 0,37 | 0,34 | | | | |
| SA | 0,36 | 0,46 | 0,42 | 0,49 | 0,45 | 0,39 | 0,40 | 0,54 | 0,44 | 0,37 | 0,43 | 0,42 | 0,42 | 0,42 | 0,51 | 0,39 | 0,51 | 0,40 | 0,37 | 0,37 | | | |
| SH | 0,41 | 0,49 | 0,45 | 0,52 | 0,49 | 0,43 | 0,44 | 0,60 | 0,48 | 0,42 | 0,48 | 0,44 | 0,44 | 0,45 | 0,55 | 0,43 | 0,55 | 0,43 | 0,41 | 0,41 | 0,43 | | |
| SE | 0,45 | 0,53 | 0,47 | 0,55 | 0,52 | 0,46 | 0,47 | 0,63 | 0,50 | 0,45 | 0,52 | 0,48 | 0,48 | 0,45 | 0,56 | 0,47 | 0,58 | 0,46 | 0,44 | 0,45 | 0,45 | 0,49 | |
| TU | 0,39 | 0,49 | 0,46 | 0,53 | 0,49 | 0,42 | 0,42 | 0,59 | 0,48 | 0,39 | 0,46 | 0,47 | 0,47 | 0,47 | 0,56 | 0,41 | 0,55 | 0,44 | 0,41 | 0,40 | 0,44 | 0,48 | 0,52 |

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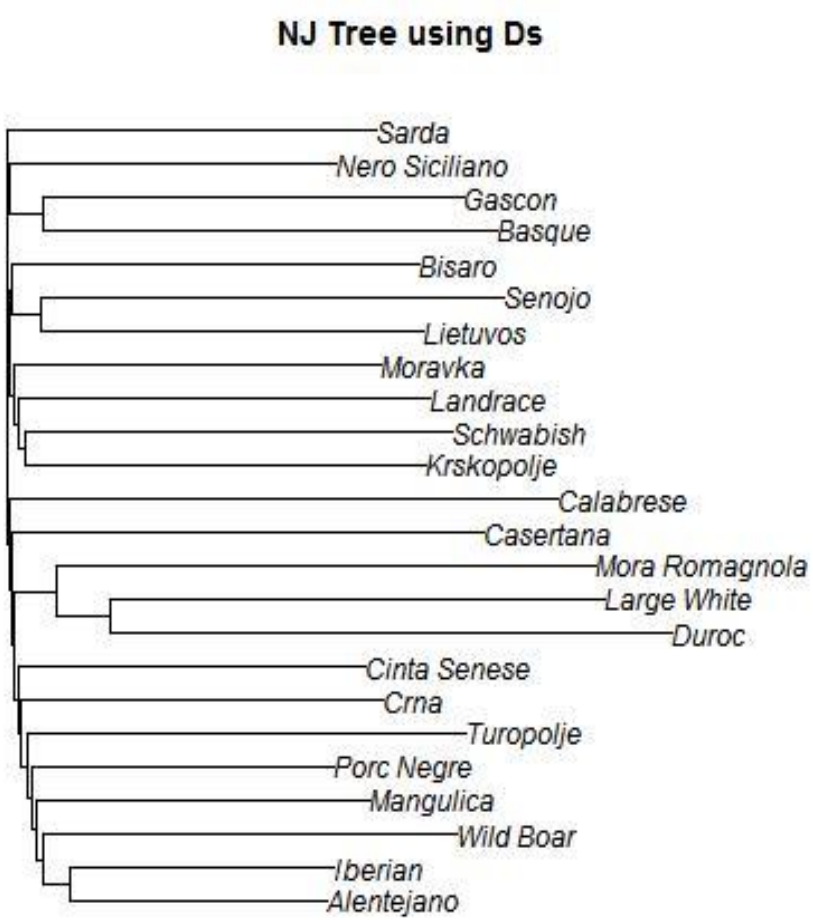
# SOME RESULTS ALL BREEDS

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# REMARKS

1. GeneSeek® Genomic Profiler™ for Porcine HD allow genetic characterization of autochthonous European pig breeds

2. Although in the pilot study **Iberian** is the breed with the highest number of **monomorphic** SNPs, **Turopolje** shows the highest value in the whole study

3. Duroc is the breed with the highest genetic distances both in the pilot study and in the whole one.

4. Further analyses (PCAs, STRUCTURE, LD …) are being carried out to complete the genetic characterization of the authocthonous breeds

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TREASURE

Diversity of local pig breeds and production systems for high quality traditional products and sustainable pork chains

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# Thank you very much!