The impact of inbreeding on birth weight in the Pag sheep breed

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14.02.2024. | Dubrovnik | Croatia

Pag sheep

- Autochthonous breed
- Dual purpose (milk-meat)
- Population size ~ 30 000

- HARSH environment
  ("BURA" > 200 km/h)
- Forage enriched with sea salt
- Aromatic plants (special taste)

Pag sheep (dairy orientated breed)

- Modest milk yield ~ 0.8 Kg/day
  (120 kg in 5 months of milking)

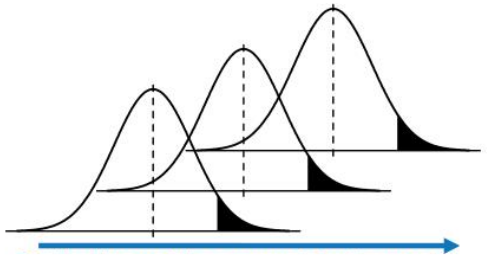
- OUTSTANDING profitability
  fresh milk (~2 €/L) – no surpluses
    cheese (30-40 €/kg)
      curd cheese (8 €/kg)
        fresh meat (~12 €/kg)

Pag sheep

- Long term goal → to increase milk yield
- Selection ~ 4 500 sheep
- Pedigre records + Milk control (ICAR)

$$\begin{bmatrix} \mathbf{b} \\ \mathbf{a} \end{bmatrix} = \begin{bmatrix} \mathbf{X'X} & \mathbf{X'Z} \\ \mathbf{Z'X} & \mathbf{Z'Z+A^{-1}\lambda} \end{bmatrix}^{-} \begin{bmatrix} \mathbf{X'y} \\ \mathbf{Z'y} \end{bmatrix}$$

Numerator relationship matrix

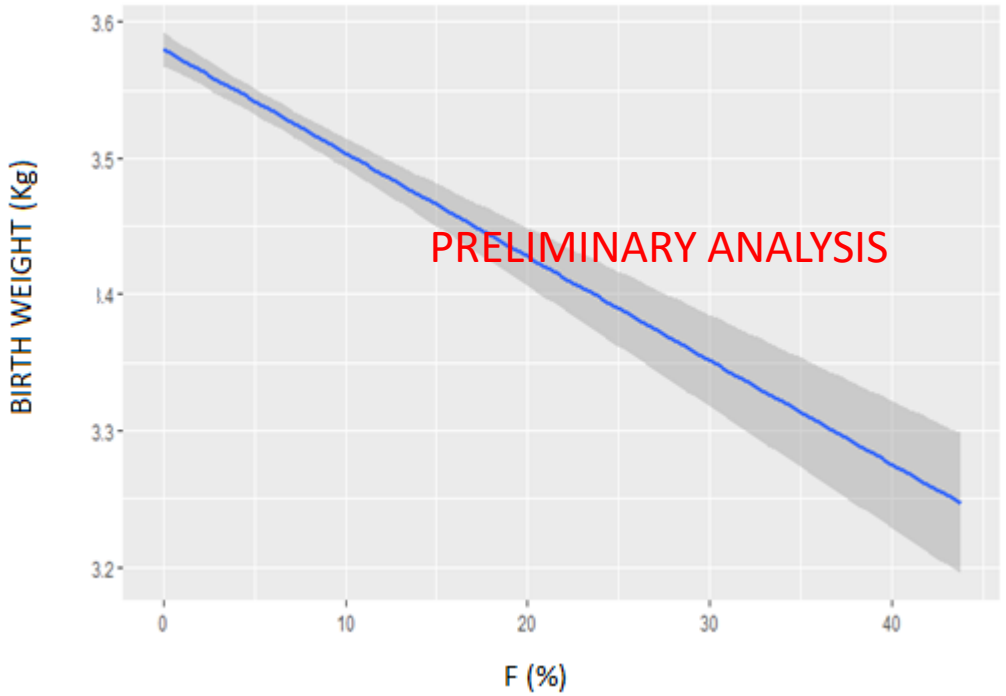


Single step Genomic BLUP

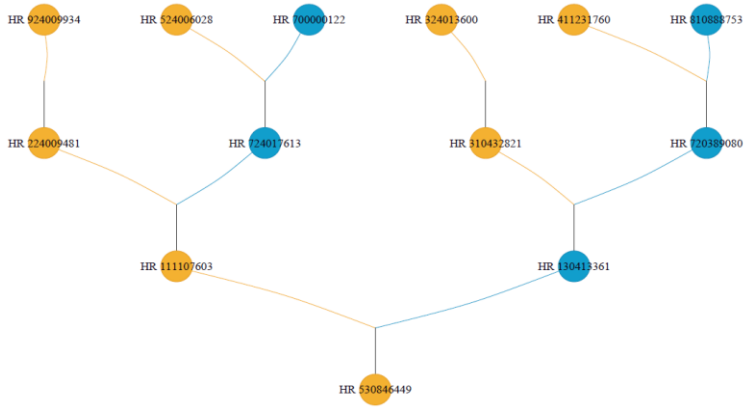
$$H^{-1} = A^{-1} + \begin{bmatrix} 0 & 0 \\ 0 & G^{-1} - A_{22}^{-1} \end{bmatrix}$$

Aim of the study

Is there any inbreeding depression on birth weight in Pag sheep????????



Materials and methods – F_{ped}



- Data → CMA & CAAF
- Pedigree → n=281760 animals
- F_{ped} → "OptiSel" in R (Wellmann, 2021.)
- Pedigree QC→ *NFG*≥3 & born after 2010.

Materials and methods – inbreeding depression

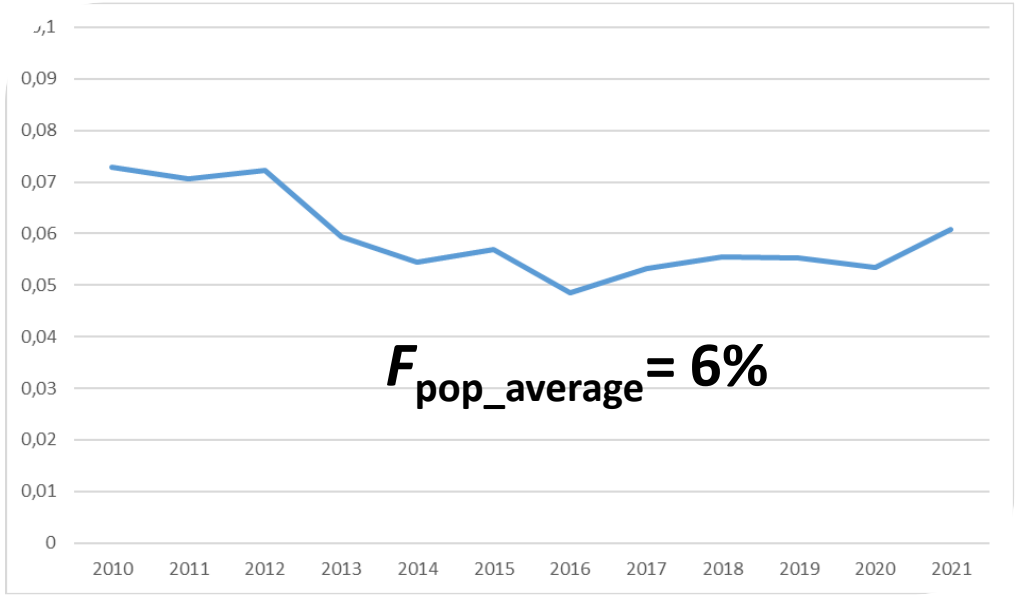
- 15,186 lambs with known birth weight and F_{ped}

- 5-way ANCOVA (direct inbreeding)
- Birth weigth ~ F_{ped} + Parity + Litter size + Sex + Season + Flock

- Linearity of the data and residual errors mean = 0 → (Residual vs Fitted plot) ✓ ✓
- Constant variance residual errors → Scale-Location plot and the Non-Constant Error Variance Test (p = 0.14833). ✓ ✓

Results – coefficient of inbreeding

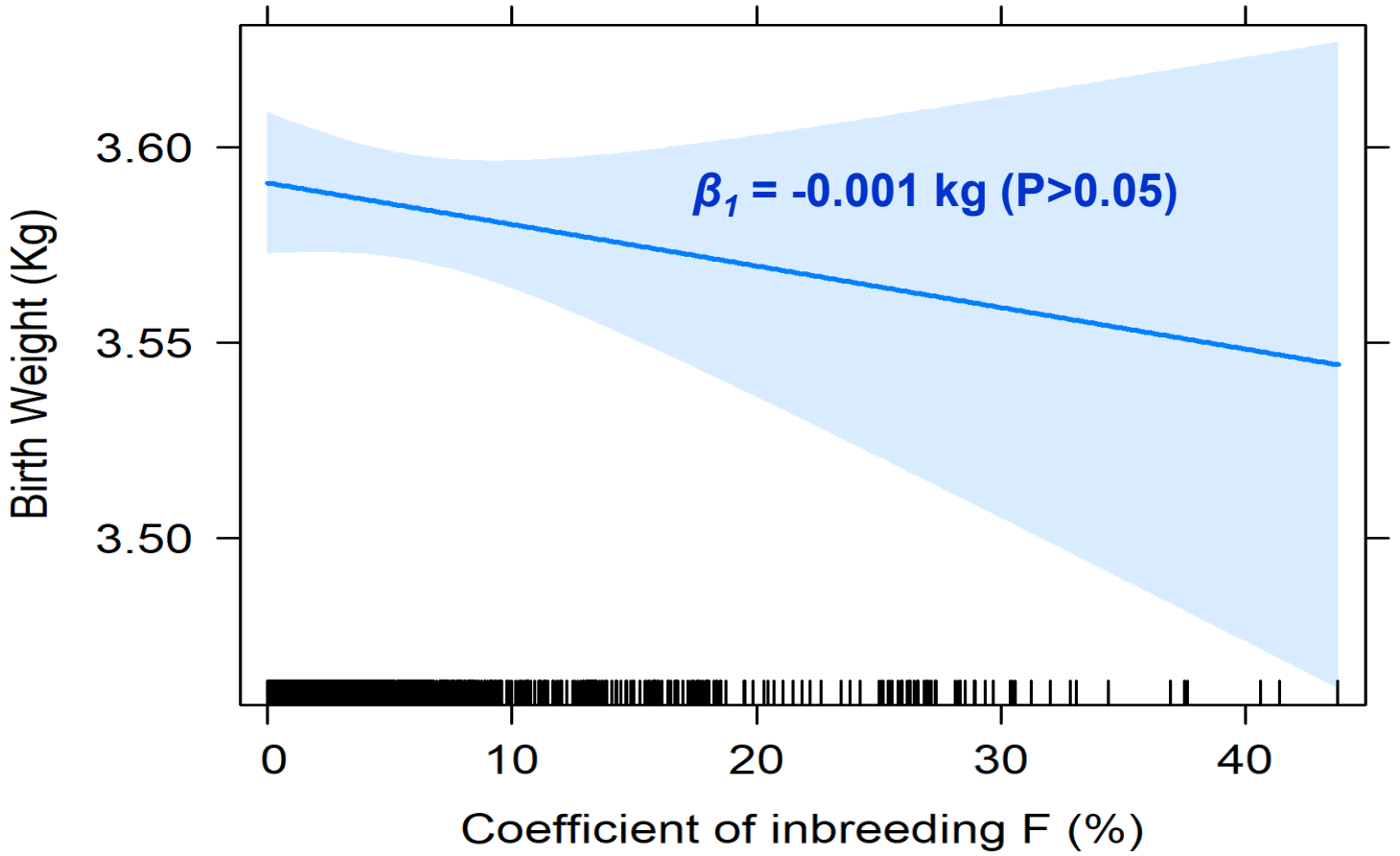
Class of F_{PED} (%)	Frequency	Percent (%)
0-9	12323	76.43
9-17	2760	17.12
18-26	682	4.23
27-35	339	2.10
36-44	19	0.12
Total	16123	100



Results – the estimate of categorical predictors

Category	marginal mean	Standard error	Lower CI	Upper CI
Parity				
1	3.013	0.014	2.985	3.040
2	3.281	0.013	3.255	3.307
3	3.417	0.014	3.391	3.444
4	3.469	0.014	3.441	3.497
5	3.468	0.015	3.439	3.497
6	3.498	0.017	3.466	3.531
7	3.458	0.019	3.421	3.495
8	3.491	0.022	3.449	3.534
9	3.477	0.026	3.426	3.528
Litter size				
singletons	3.609	0.006	3.598	3.619
twins	3.185	0.017	3.152	3.218
Gender				
females	3.354	0.010	3.334	3.374
males	3.440	0.010	3.420	3.460

Results – inbreeding depression



*F*or every 10% increase in F_{PED} it is expected decrease of BW for 0.01 kg

Discussion

- F_{PED} < 6.25% → acceptable for small populations undergoing selection (breeders take care to avoid inbreeding in their flocks) !!!
- Potential presence of the inbreeding depression on BW
- Small number of individuals with high F_{PED} → β_1 **underestimated** ???
- 10% (rule of the thumb)

Conclusion

- The obtained result calls for **attention in making further mating plans** in order to prevent a genetically influenced decrease of the birth weight.

- More evidence is needed to generalize this effect in sheep, preferably under the framework of the **animal genetic model**

- Fitting genomic inbreeding (F_{ROH}) in the AGM under the framework of the **ssGBLUP** will probably provide the most accurate estimates

Thank You for Your attention !

The research supported by Croatian Science Foundation (CSF). Project: *Genomic characterization, preservation, and optimum contribution selection of Croatian dairy sheep (OPTI-SHEEP). IP-2019-04-3559*