Official Journal of the Animal Science and Production Association (ASPA)

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ISSN: 1828-051X

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http://www.tandfonline.com/tjas

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Italian Journal of Animal Science

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volume 18

supplement 1

2019

italian journal of animal science

ASPA 23rd CONGRESS

Sorrento, June 11–14, 2019

Book of Abstracts

Guest Editors: Fulvia Bovera (Coordinator), Marzia Albenzio, Mariangela Caroprese, Rosaria Marino, Gianluca Neglia, Giovanni Piccolo, Angela Salzano.

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Italian Journal of Animal Science

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and Production Association

Online ISSN: 1828-051X

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Signatures of selection in the genome of Italian Holstein cattle for cheese production

Michela Ablondi[1], Claudio Cipolat-Gotet[1], Jan-Thijs Van Kaam[2], Massimo Malacarne[1], Alberto Sabbioni[1], Andrea Summer[1]

[1]*Dipartimento di Scienze Medico-Veterinarie, University of Parma, Italy*

[2]*Associazione Nazionale Allevatori della razza Frisona Italiana, Cremona, Italy*

Contact: michela.ablondi@unipr.it

Dairy cattle breeds have been exposed to intense artificial selection for milk production traits over the last fifty years. In Italy, where over 75% of milk is processed into cheese, selection has also focussed on cheese-making traits. The most widely spread PDO Italian cheeses in the world are the Parmigiano Reggiano and the Grana Padano, which cover 16% and 24% of the total Italian milk production. Intensive selection programmes that aim at increasing production yield can cause loss of genetic variability and increased genomic homozygosity. To this end, recent advances in genome mapping have the potential both to improve our understanding of selection and to be used in the breeding programme. The present study aims to detect potential selection signatures in the genome of Italian Holstein dairy cows bred for PDO cheese productions. High-density genotype information from SNP-chip was available for 400 cattle, reared in certified farms for Parmigiano Reggiano (PR =200) and Grana Padano (GP =200). The quality control (QC) of the data was performed by excluding both animals and SNPs with a call rate <90% and by removing both unassigned and on-sex-chromosome SNP. We then performed a genomic scan for runs of homozygosity (ROH) which were detected in PLINK 1.9 by using a sliding window approach. ROH were defined based on at least 1 Mb-long homozygous segments, and by allowing for a maximum of one missing and one heterozygous SNP.

All animals passed the QC and 311,501 SNP were used to estimate ROH. In total, 142,211 ROH were detected (355.5 segments per animal), with an average length of 1.59 Mb. The mean number of homozygous segments in the PR and GP cattle was similar (354 and 356, respectively). For 115 PR and 122 GP cows, at least one ROH longer than 16 Mb was found, probably indicating recent inbreeding. Six genomic regions with ROH shared among more than 70% of the 400 cattle were located on the following chromosomes: BTA 11, 14, 16, 18, 21 and 29. As a small amount of regions showed a different rate of homozygosity when comparing PR and GP cattle, further studies will investigate any potentially-different signs of selection among PDO dairy chains. Further research is ongoing to demonstrate the role of those homozygous segments on cheese-making traits.

Acknowledgements

The research was funded by Sottomisura 10.2 of the PSRN-Biodiversità 'Latteco'

ENVIRONMENTAL SUSTAINABILITY – ENVIRONMENTAL IMPACT OF LIVESTOCK II

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Added value of dairy farming in mountain areas: an ecosystem services approach

Enrico Sturaro[1], Marco Berton[1], Stefano Bovolenta[2], Maurizio Ramanzin[1], Chiara Spiegarelli[2], Anna Zuliani[2]

[1]*Dipartimento di Agronomia, Animali, Alimenti, Risorse naturali e Ambiente, University of Padova, Italy*

[2]*Dipartimento di Scienze Agroalimentari Ambientali e Animali, University of Udine, Italy*

Contact: enrico.sturaro@unipd.it

This study aims to analyse synergies and trade-offs between efficiency, environmental footprint and non-provisioning ecosystem services in dairy cattle farms in Eastern Alps (Veneto, South Tyrol, Friuli and Carinthia). Seventy-five dairy cattle farms conferring milk to 10 cooperative dairies were sampled. The following methodological approaches were applied: environmental footprint (Life Cycle Assessment, LCA); animal welfare; analysis of biodiversity in the grasslands managed by each farm. A LCA approach was used to calculate: Global Warming Potential (GWP), Eutrophication (EP), Cumulative Energy Demand (CED) and Land Occupation (LO). Production efficiency was calculated as gross energy conversion ratio, considering also the diverting of human edible resources. Animal-based indicators of welfare were assessed through direct observation of cattle or through data retrieval from farm records according to the EFSA protocol on animal welfare assessment on small-scale dairy farms. Correlations among the different indicators were tested to analyse synergies and trade-offs between efficiency, environmental footprint, animal welfare and grassland biodiversity. The average herd size was 42 ± 27 LU, the milk yield was 6299 ± 1923 FPCM/cow per year and the agricultural area was 27 ± 20 ha, mainly grassland, with a large variability of farm self-sufficiency (from 14 to 100% of diet dry matter). The impact categories calculated with LCA approach were in line with literature: GWP =1.32 ± 0.42 kg CO_2-eq; EP =7.96 ± 3.36 g PO_4-eq; CED =3.96 ± 2.14 MJ; LO =2.18 ± 1.33 m^2/y, 1 kg of FPCM as functional unit. The higher production, the lower impact categories, but the use of external inputs, especially human edible concentrates, affected this result. Farms with high self-sufficiency can maintain grasslands with a good balance between production and species richness. Results on animal

welfare assessment were similar to the ones presented in previous studies: for example, the average percentage of dairy cows with a level of somatic cells higher than 400,000 was 9.4%±1.06 and the average percentage of lameness (mild and severe) was 8.6%±1.06. These results evidenced that the alpine dairy farming systems are able to produce high-quality products by using local resources. A multi-indicators approach is recommended to analyse the sustainability and the efficiency of these systems, considering the trade-offs between production and non-provisioning ecosystem services.

Acknowledgements
The research was funded by the project 'TOP-VALUE, the Added Value of Mountain Products' – Interreg Italy-Austria ITAT2009.

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Carbon footprint of dairy sheep farms located in different forage systems of Sardinia

Mondina Francesca Lunesu, Alberto Stanislao Atzori, Fabio Correddu, Francesco Lai, Roberto Rubattu, Gesumino Spanu, Antonello Cannas

Dipartimento di Agraria, University of Sassari, Italy
Contact: mflunesu@uniss.it

The aim of this work was to estimate the carbon footprint (CF) of a sample of 15 Sardinia dairy sheep farms selected from 3 forage systems (FS) identified as: lowland (L), hill (H) and mountain (M). Farms were classified on the bases of their altimetry (<200, 200–500, >500 metres a.s.l.), flock size (low: <200 heads, medium: 200–500 heads, high: >500 heads) and type of soil (alluvial, calcareous, effusive and granitic land substrates).
Data were collected by interviewing the farmers for a complete life cycle inventory (LCI) of farm production processes from October 1st 2016 to September 30st 2017. The LCI included information on flock, animal diets, feed purchases, crops, farm stocks, and an energy use audit. Data were analysed with a modified Tier 2 of the IPCC, by using coefficients of IPCC for estimation of animal and manure CH_4 and N_2O emissions and literature coefficients for purchased feeds and for energy. Reported values of CF were allocated 100% to milk yield. Average milk production level of the flock (PL) was equal to 217, 198 and 173 kg of fat and protein corrected milk (FPCM) head^{-1} year^{-1} for H, L and M forage systems, respectively. When expressed per animal, emissions resulted higher in H than in the M and L forage systems (627, 620 and 612 kg of CO_2equivalent (CO_2eq. head^{-1} year^{-1}) respectively. In contrast, emission intensity was on average higher in the M than in the H and L forage systems (3.72, 3.31, 3.15 kg CO_2eq kg FPCM^{-1}, respectively). Production level was the best predictor of CF in M (CF= −0.016 × PL +6.4972; R^2=0.73), H (CF= −0.0139 × PL +6.3238; R^2=0.79) and L (CF= −0.0085 × PL +4.8104; R^2=0.73) forage systems.
The contribution to the total emission was about 50% from enteric methane in each of the forage systems. In terms of percentage, L forage system manure management and energy use were the most important variables contributing to CF, whereas in H and M the most important variable was the amount of purchased feeds. In conclusion, in Sardinia sheep farms emission mitigation should take into account increases of: (a) flock production level, (b) the farm efficiency and (c) the amount of on-farm produced feeds. However, this preliminary study needs to be improved considering the carbon sequestration from soil, natural pasture and forests and ecosystem service provided by the forage systems.

Acknowledgements
The authors gratefully acknowledge the Europe Union for financial support (Project Forage4CLimate LIFE 15 CCM/IT/000039).

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Environmental sustainability of dairy farms producing milk for Grana Padano and Parmigiano Reggiano cheese production

Daniela Lovarelli, Giuliana D'Imporzano, Alberto Tamburini

Dipartimento di Scienze Agrarie e Ambientali. Produzione, Territorio, Agroenergie, University of Milano, Italy
Contact: alberto.tamburini@unimi.it

Dairy cattle farms are known to be part of very complex production systems that require a huge amount of inputs for animals' breeding (e.g. cultivated and purchased feed) and that release emissions in the environment (e.g. methane, ammonia, N and P).
Following the worldwide spreading interest in environmentally sustainable productions, in this study, 81 farms located in the province of Mantova (Lombardy Region) and producing milk for Grana Padano (GP) and Parmigiano Reggiano (PR) cheese production were analysed.
The aim was to compare data collected on farms between the year 2016 and 2017 and to identify the improvements or worsening of the main parameters affecting dairy farms and their environmental sustainability. In particular, by analysing separately farms producing milk to GP (47 farms) and to PR (34 farms), the following main parameters were calculated: Dairy Efficiency (kg FPCM/kg DM feed), dry matter intake (kg DM/d per cow), Income Over Feed Cost (€/d per cow), herd composition and number of dairy cattle (n.), livestock units (LU/ha), land area (ha), farm self-sufficiency (%) and nitrogen (N) and phosphorous (P) farm balances (calculated as difference between input and output at farm level). All calculated data derived from primary data collected on the farm through questionnaires.